Final

Environmental Assessment / Overseas Environmental Assessment

Navy Flight Experiment-2 (FE-2)

U.S. Department of the Navy Strategic Systems Programs

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14. ABSTRACT
This EA/OEA provides analysis of a proposed U.S. Navy SSP experimental flight test with an experimental payload from one of two candidate launch sites, which include the Kauai Test Facility, Pacific Missile Range Facility, Kauai, Hawai`i and the Wallops Flight Facility, Wallops Island, Virginia. Candidate impact areas include Illeginni Islet, U.S. Army Kwajalein Atoll, Ronald Reagan Ballistic Missile Defense Test Site, Republic of the Marshall Islands, and broad ocean areas in the Pacific and Atlantic Oceans. The purpose of the project is to collect data on a developmental payload by testing range performance and to demonstrate technologies for prospective strike capabilities specifically to flight test the developmental payload concept to demonstrate the maturity of key technologies including precision navigation, guidance and control, and enabling capabilities.

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Acronyms and Abbreviations

°C	Celsius
°F	Fahrenheit
μPa	Micropascal
AAOC	Administrative Agreement on Consent
AAQS	Ambient Air Quality Standards
ACHP	Advisory Council on Historic Preservation
ACM	Asbestos-Containing Material
AFB	Air Force Base
AGL	Above Ground Level
ALTRV	Altitude Reservation
ANSI	American National Standards Institute
AOC	Area of Concern
ARRW	Air-launched Rapid Response Weapon
ARSTRAT	Army Forces Strategic Command
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
AST	Aboveground Storage Tank
ATCAA	Air Traffic Control Assigned Airspace
BCC	Birds of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
BMP	Best Management Practices
BOA	Broad Ocean Area
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
CHRIMP	Consolidated Hazardous Materials Reutilization and Inventory Management Program
CITES	Convention on International Trade in Endangered Species
cm	Centimeter(s)
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dB	Decibel(s)
dBA	A-weighted Decibel(s)
dBpeak	Decibel Peak Exposure Levels

DEP	Document of Environmental Protection
DERP	Defense Environmental Restoration Program
DLIS	Defense Logistics Agency Logistics Information Service
DNL	Day Night Average Sound Level
DOD	Department of Defense
DOE	Department of Energy
DOT	U.S. Department of Transportation
DPS	Distinct Population Segment
DRMO	Defense Reutilization and Marketing Office
EA	Environmental Assessment
ECR	Environmental Compliance and Restoration
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EM	Electromagnetic
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERD	Environmental Resource Document
ESA	Endangered Species Act
ESQD	Explosive Safety Quantity-Distance
EEZ	Exclusive Economic Zone
FAA	Federal Aviation Administration
FACSFAC	Fleet and Area Control and Surveillance Facility
FACSFACPH	Fleet and Area Control and Surveillance Facility Pearl Harbor
FAR	Federal Aviation Regulations
FE-1	Flight Experiment-1
FE-2	Flight Experiment-2
FE-3	Flight Experiment-3
FONSI/FONSH	Finding of No Significant Impact/Finding of No Significant Harm
FR	Federal Register
ft	Foot/Feet
ft^2	Square Foot/Feet
FTS	Flight Termination System
FUDS	Formerly Used Defense Sites
FY	Fiscal Year
GHG	Greenhouse Gas
GRMI	Government of the Republic of the Marshall Islands
HAP	Hazardous Air Pollutants
HAPC	Habitat Areas of Particular Concern
HRC	Hawai`i Range Complex

HVP	Hypervelocity Projectile
Hz	Hertz
ICAO	International Civil Aviation Organization
ICBM	Intercontinental Ballistic Missile
ICP	Integrated Contingency Plan
IEEE	Institute of Electrical and Electronics Engineers
IFR	Instrument Flight Rules
in	Inch(es)
INRMP	Installation Natural Resources Management Plan
KEEP	Kwajalein Environmental Emergency Plan
kg/sec	Kilogram(s)/Second
KIUC	Kauai Island Utility Cooperative
km	Kilometer(s)
km^2	Square Kilometer(s)
KTF	Kauai Test Facility
KMISS	Kwajalein Missile Impact Scoring System
kW	Kilowatt
lb	Pound(s)
LBP	Lead Based Paint
LCU	Landing Craft Utility
L_{eq}	Equivalent Sound Level
LIDSS	LLNL Independent Diagnostic Scoring System
LLNL	Lawrence Livermore National Laboratory
m	Meter(s)
m^2	Square Meter(s)
MATSS	Mobile At-Sea Sensor
MBTA	Migratory Bird Treaty Act
MDA	Missile Defense Agency
mg/kg	Milligram(s) per Kilogram
$mg/m^2/hr$	Milligram(s) per Square Meter Per Hour
mi	Mile(s)
mi^2	Square Mile(s)
MMIII	Minuteman III
MMPA	Marine Mammal Protection Act
NMSDD	Navy's Marine Species Density Database
MPA	Marine Protected Area
ms	Millisecond(s)
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSAT	Mobile Source Air Toxics
MTR	Military Training Route

MUS	Management Unit Species
N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NAVSEA	Naval Sea Systems Command
NAVSEAOP	Naval Sea Systems Command Publication
NC/NG	Nitro Cellulose/Nitro Glycerine
NEPA	National Environmental Policy Act
NGA	National Geospatial-Intelligence Agency
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health
nm	Nautical Mile(s)
NMFS	National Marine Fisheries Service
NMSDD	Navy's Marine Species Density Database
NNSA	National Nuclear Security Administration
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NOTAM	Notice to Airmen
NTM	Notice to Mariners
NPA	Notice of Proposed Activity
NPDES	National Pollutant Discharge Elimination System
NPR	NASA Procedural Requirements
NRHP	National Register of Historic Places
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OPNAVINST	Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
OSP	Orbital/Sub-Orbital Program
Pb	Lead
PCB	Polychlorinated Biphenyl
PDARS	Performance Data Analysis and Reporting System
PEIS	Programmatic Environmental Impact Statement
PIRO	Pacific Islands Regional Office
PL	Public Law
$PM_{2.5}$	Fine particulate matter less than or equal to 2.5 microns in diameter
PM_{10}	Suspended particulate matter less than or equal to 10 microns in diameter
PMRF	Pacific Missile Range Facility
PMRFINST	Pacific Missile Range Facility Instruction
ppm	Parts Per Million

PTS	Permanent Threshold Shift
RCC	Range Commanders Council
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test, and Evaluation
RMI	Republic of the Marshall Islands
RMIEPA	RMI Environmental Protection Authority
RMIHPO	Republic of the Marshall Islands Historic Preservation Office
RMS	Root Mean Square
ROD	Record of Decision
ROI	Region of Influence
ROV	Remotely Operated Vehicle
RSL	Regional Screening Levels
RTS	Ronald Reagan Ballistic Missile Defense Test Site (Reagan Test Site)
RTV	Room-temperature-vulcanizing silicone
SEL	Sound Exposure Level
SFHC LV	Solid Fueled Launch Vehicle
SIP	State Implementation Plan
SNL	Sandia National Laboratories
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control, and Countermeasures
SPL	Sound Pressure Level
SR	Slow Routes
SSP	Strategic Systems Programs
STARS	Strategic Target System
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
tpy	Tons Per Year
TSCA	Toxic Substances Control Act
TTS	Temporary Threshold Shift
U.S.	United States
UAS	Unmanned Aircraft System
UCL	Upper Confidence Limit
UES	United States Army Kwajalein Atoll Environmental Standards
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USAG-KA	United States Army Garrison Kwajalein Atoll
USAKA	United States Army Kwajalein Atoll
USAPHC	United States Army Public Health Command
USASMDC	United States Army Space and Missile Defense Command

USASSDC	United States Army Space and Strategic Defense Command
USC	United States Code
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UST	Underground Storage Tank
UXO	Unexploded Ordnance
VAC	Virginia Administrative Code
VACAPES	Virginia Capes
VDEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compound
VR	Visual Route
WPRFMC	Western Pacific Regional Fishery Management Council
WFF	Wallops Flight Facility
yd^2	Square Yard(s)

Executive Summary

Proposed Action

The Proposed Action, Flight Experiment-2 (FE-2), is sponsored by the Office of the Under Secretary of Defense for Research and Engineering, which has designated the United States Department of the Navy (U.S. Navy) Strategic Systems Programs (SSP) as the lead agency and action proponent of the Proposed Action. The U.S. Navy SSP proposes to conduct a developmental flight test as described in this Environmental Assessment / Overseas Environmental Assessment (EA/OEA). The Proposed Action entails one experimental flight test to take place within the first half of fiscal year (FY) 2020 after the Finding of No Significant Impact/Finding of no Significant Harm (FONSI/FONSH) is signed, if approved. The U.S. Navy, along with the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) as Cooperating Agencies, and with the U.S. Army Space and Missile Defense Command (USASMDC) as a Participating Agency, has prepared this EA/OEA in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and U.S. Navy regulations for implementing NEPA and Executive Order 12114, Environmental Affects Abroad of Major Federal Actions.

Purpose and Need for the Proposed Action

The purpose of the Proposed Action, FE-2, is to continue to collect data on a developmental payload by testing one such flight experiment concept. The Proposed Action is needed to enable testing, modeling, and simulation of a developmental payload system and mature the technologies necessary to ultimately establish an operational strike capability. A range of possible flight experiment concepts is being studied to inform potential future strike capability determinations.

FE-2 is the next incremental step in the developmental process after Flight Experiment-1 (FE-1). FE-1 was a very similar test flight conducted in 2017 from the Pacific Missile Range Facility (PMRF) in Hawai`i to the Ronald Reagan Ballistic Missile Defense Test Site (RTS) in the Republic of the Marshall Islands (RMI). FE-2 would continue to develop, integrate, and flight test a payload system to demonstrate the maturity of key technologies. FE-2 would help further establish aerodynamic, thermal, and structural limits of the payload system. Data collected would be utilized to improve the models that predict the performance of the payload system. The Proposed Action would also provide an opportunity to observe the FE-2 missile and payload system from launch-to-impact and record all data that is transmitted throughout the flight path.

To meet the objectives described above, FE-2 must satisfy certain physical and technical constraints. FE-2 must use observational instrumentation with sufficient fidelity to characterize and evaluate system performance. In addition, to meet limitations of time and budget, there is a programmatic requirement to use the same type of booster used for FE-1. There is also a programmatic requirement to conduct FE-2 within the first half of FY 2020.

Alternatives Considered

The U.S. Navy considered eight alternate launch and impact locations and determined that the launch from PMRF at the Sandia National Laboratories/Kauai Test Facility (SNL/KTF) with impact near the RTS and the launch from NASA Wallops Flight Facility (WFF) with impact in the Atlantic Broad Ocean Area (BOA) both meet the test requirements for vehicle performance and data collection. This EA/OEA analyzes potential impacts for these two alternatives and the No Action Alternative. Alternative 1 includes PMRF, Barking Sands, Kauai, Hawai`i; the U.S. Army Kwajalein Atoll (USAKA); RTS, RMI; and the Pacific BOA. Alternative 2 includes WFF, Virginia; and the Atlantic BOA. Alternative 1 is the U.S. Navy's preferred alternative and includes a launch from PMRF with an impact at Illeginni Islet. Alternative 1 is preferred because it includes a launch site that is more familiar with real-time performance data and post-mission analyses being collected and stored at a classified level and it also includes a land impact that allows higher fidelity data collection than an impact in the BOA.

Environmental Resources Not Evaluated in the EA/OEA

CEQ regulations, NEPA, and Navy instructions for implementing NEPA, specify that an EA/OEA should address those resource areas potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact.

Because potential impacts were considered negligible or nonexistent, the following resources were not evaluated in this EA/OEA:

Alternative 1 (Preferred Alternative)

PMRF: Geological resources, cultural resources, land use, infrastructure, transportation, socioeconomics, environmental justice, visual resources, and marine sediments.

Over-Ocean Flight Corridor: Water resources, geological resources, cultural resources, land use, airspace, noise, infrastructure, transportation, public health and safety, hazardous materials and wastes, socioeconomics, environmental justice, visual resources, and marine sediments.

USAKA and RTS: Air quality; water resources, geological resources, land use, airspace, infrastructure, transportation, socioeconomics, environmental justice, visual resources, and marine sediments.

Alternative 2

WFF: Air quality and climate change, water resources, geological resources, land use, infrastructure, transportation, socioeconomics, environmental justice, visual resources, and marine sediments.

Atlantic BOA: Water resources, geological resources, cultural resources, land use, airspace, noise, infrastructure, transportation, public health and safety, hazardous materials and wastes, socioeconomics, environmental justice, visual resources, and marine sediments.

Summary of Environmental Resources Evaluated in the EA/OEA

The following resource areas have been analyzed in this EA/OEA:

Alternative 1
Pacific Missile Range Facility (PMRF)
Air Quality
Water Resources
Biological Resources
Airspace
Noise
Public Health and Safety
Hazardous Materials and Wastes
Pacific Ocean Flight Corridor
Air Quality
Biological Resources
USAKA, RMI – Illeginni Islet
Cultural Resources
Biological Resources
Noise
Public Health and Safety
Hazardous Materials and Wastes
USAKA, RMI – Offshore Waters – Southwest and Northeast
Cultural Resources
Biological Resources
Noise
Public Health and Safety
Hazardous Materials and Wastes

Alternative 2
NASA Wallops Flight Facility (WFF), Virginia
Biological Resources
Airspace
Public Health and Safety
Hazardous Materials and Wastes
Atlantic Broad Ocean Area
Air Quality
Biological Resources

Summary of Potential Environmental Consequences of the Action Alternatives and Major Mitigating Actions

Alternative 1 (Preferred Alternative)

PMRF

Air Quality. The Navy FE-2 flight test would result in temporary air emissions during the liftoff of the Strategic Target System (STARS) booster. The quantities of combustion products aluminum oxide, carbon monoxide, carbon dioxide, and hydrogen chloride generated by the entire first stage burn of the STARS booster are relatively minor amounts that are dispersed within a short time after liftoff. The minor amounts of combustion products would result in only very minor short-term impacts to air quality. The FE-2 flight test would have the potential to incrementally contribute to global emissions of greenhouse gases (GHGs). However, no significant impacts are anticipated.

Water Resources. Sampling and analyses of soil and water prior to and following previous STARS launches did not indicate impacts. Perchlorate analytical results indicated levels were within guidelines. The Proposed Action would not result in significant impacts to water resources.

Biological Resources. Based on prior analyses, and the effects of current and past missile launch activities, the potential impacts of the Proposed Action on terrestrial biological resources are expected to be minimal. No ground clearing or construction is expected, and no long-term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on PMRF, and critical habitat for the ohai and lau`ehu would not be affected by the action. The launch site at KTF is in an area that has routine human activity, equipment operation, and launch activity. Terrestrial species at PMRF are already habituated to high levels of noise associated with ongoing activities at this facility. The U.S. Navy has consulted with the U.S. Fish and Wildlife Service (USFWS) on effects of PMRF base-wide operations on terrestrial Endangered Species Act (ESA)-listed species, and USFWS issued a programmatic Biological Opinion for base-wide operations in 2014. Consultation was reinitiated for Newell's shearwaters in 2015, and a Biological Opinion was issued for effects of base-wide operations on this species in 2018 (USFWS 2018). USFWS concluded that PMRF base-wide operations (including launch activities) are not likely to jeopardize the continued existence of ESA-listed species. Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions. Marine species at PMRF are likely already habituated to high levels of noise associated with ongoing activities at this facility. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations.

Airspace. The U.S. Navy SSP FE-2 flight test would be similar to previous missile tests, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be minimal. The advanced planning and coordination with the FAA regarding scheduling of special use airspace, and coordination of the proposed FE-2 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace.

Noise. Launch of missiles is a routine activity from SNL/KTF. The STARS booster has been previously launched at SNL/KTF, and noise levels for the FE-2 flight test would be the same as for previous STARS launches and would not result in significant impacts to the noise environment.

Public Health and Safety. Launch of the FE-2 from the same site as previous STARS booster launches would have a similar potential health and safety impact as described for the No Action Alternative. The proposed solid propellants would be similar to past launches and would follow the same health and safety procedures developed under existing plans. Implementation of the Proposed Action would not result in significant impacts to public health and safety.

Hazardous Materials and Wastes. The FE-2 flight test launch would use similar hazardous materials and produce similar hazardous waste as previous STARS launches. The FE-2 launch fits within the overall number of missile launches proposed in the Hawaii Range Complex (HRC) Environmental Impact Statement / Overseas Environmental Impact Statement (EIS/OEIS).

Hazardous material usage and waste generation would continue to be managed by PMRF under appropriate state and federal requirements. Implementation of the Proposed Action would not result in significant impacts from hazardous materials and wastes.

Over Ocean Flight Corridor

Air Quality. Under the Proposed Action, following the FE-2 flight test, the majority of aluminum oxide would be removed from the stratosphere through dry deposition and precipitation. Emissions from a STARS vehicle launch would be relatively small compared to all emissions released on a global scale. The large air volume over which the STARS emissions are spread and the dispersion of the STARS emissions by stratospheric winds would reduce potential impacts. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that any incremental effects on the global atmosphere would be discountable and insignificant. The Proposed Action would not have a significant impact on stratospheric ozone or on the upper atmosphere. The amount of GHG emissions that would be released from activities associated with a single FE-2 flight test is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time for conducting the single FE-2 flight test activities. This limited amount of emissions would not likely contribute to global warming and climate change to any discernible extent. Implementation of the Proposed Action would not result in significant impacts to air quality or GHG emissions.

Biological Resources. Marine Wildlife. Noise: Sonic boom overpressures would not exceed permanent threshold shift (PTS), temporary threshold shift (TTS), or behavioral disturbance thresholds for organisms in the BOA, and therefore no adverse impacts from sonic booms are expected. Splashdown pressures would exceed PTS thresholds for cetaceans with high frequency hearing and the physical injury threshold for seabirds. These pressures would also exceed TTS thresholds for cetaceans with high and low frequency hearing, Hawaiian monk seals, birds, and fish. These organisms may also be exposed to sound pressure levels (SPLs) high enough to cause behavioral disturbance. While effects of elevated SPLs are possible, based on species abundance and distribution in the BOA, the chances of this occurring are likely very low. Any effects of elevated SPLs are likely to be temporary, behavioral modifications with no lasting effects. Therefore, no significant impacts from elevated SPLs are expected.

Direct contact: The chances of an FE-2 component directly contacting a marine mammal are very low (1 in 19,500 total for all species). The chances of direct contact with a sea turtle are also extremely low (1 in 710,000). Direct contact would not be expected to adversely impact cetaceans, sea turtles, birds, fish, or essential fish habitat (EFH) in the BOA.

Hazardous chemicals: The release of hazardous materials carried onboard a launch vehicle would not significantly impact marine life. Hazardous materials would be rapidly diluted in the seawater, and larger and heavier vehicle components would sink fairly quickly to the ocean floor to depths where consultation organisms would likely not be in contact with these materials.

Increased human and vessel activity: Vessel traffic is common in this area, and the increase in human activity and vessel traffic in the BOA would be expected to be minimal; these activities would not be expected to impact marine resources including threatened and endangered species or EFH.

A Biological Assessment was prepared to evaluate the effects of the Proposed Action on species protected under the ESA and MMPA and was provided to the National Marine Fisheries Service (NMFS) and USFWS during consultation. NMFS issued a Biological Opinion for the FE-2 on 27 September 2019 (NMFS 2019a, **Appendix C**) and determined that activities in the BOA may affect but are not likely to adversely affect ESA-listed species or designated critical habitats. USFWS issued a Letter of Concurrence with a may affect but no likely to adversely affect determination for Newell's Shearwaters in the BOA on 29 July 2019 (**Appendix A**). The terms and conditions of the NMFS Biological Opinion (**Appendix C**) as well as avoidance and minimization measure recommended by USFWS in their Letter of Concurrence (**Appendix A**) would be implemented as part of the Proposed Action.

USAKA RTS – Illeginni Islet

Cultural Resources. Archaeological surveys have not found indigenous cultural materials or evidence of subsurface deposits on the Islet. The Cold War-era properties potentially eligible for listing on the RMI National Register of Historic Places are in the central and eastern portions of the Islet. Because a land impact would not occur in proximity to known or potential cultural resources on Illeginni Islet, implementation of the Proposed Action would not result in significant impacts to cultural resources.

Biological Resources. Terrestrial Vegetation. Terrestrial vegetation in the payload impact zone at Illeginni Islet is vegetation of previously disturbed habitat and is predominantly managed vegetation. Therefore, no adverse impacts to terrestrial vegetation are expected.

Terrestrial Wildlife. Noise: It is likely that birds would be exposed to SPLs high enough to cause behavioral disturbance; any behavioral or physiological response is likely to be very brief, and no adverse impacts to birds on or near Illeginni Islet are expected due to elevated SPLs.

Direct contact: While direct contact from payload debris may impact any birds in the impact zone, very few birds are expected to be within this area. The U.S. Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-2 activities may but are not likely to adversely affect nesting sea turtles (U.S. Navy 2019). USFWS has concurred with this determination (**Appendix A**).

Vessel strike: No adverse impacts to birds are expected from vessels transiting to and from Illeginni Islet.

Exposure to hazardous chemicals: Hazardous chemicals are not expected to impact birds at Illeginni Islet.

Human disturbance: Disturbance from human activities and equipment operation has the potential to impact birds, especially nesting seabirds on Illeginni Islet; however, any disturbance is not expected to have a significant, long-term impact. Disturbance from human activities and equipment operation may but is not likely to adversely impact nesting sea turtles, sea turtle nests, and/or sea turtle nesting habitat.

Marine Wildlife. Noise: The maximum SPLs for sonic booms and payload impact at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans, sea turtles, or fish. Payload impact would result in SPLs above the injury threshold for fish but only out to 2.2 meters (m; 7.2 feet [ft]) from impact; therefore, injury to fish is unlikely. There is a potential for behavioral disruption in sea turtles and fish near the payload impact point. While there is a chance that up to 17 green sea turtles and 6 hawksbill turtles may be exposed to SPLs high enough to elicit behavioral response, any response is expected to be temporary, and turtles would be expected to return to normal behavior within minutes. Any behavioral disturbance in fish would likely be limited to a brief startle response, and behaviors would quickly return to normal. Therefore, no lasting adverse impacts are expected from elevated SPLs.

Direct contact: Payload impact is not expected to adversely affect cetaceans or sea turtles in the water through direct contact. Payload impact may adversely impact a very small, but indeterminable, number of larval fish, coral, or mollusks. The number of larvae potentially affected is likely to be trivially small relative to their population sizes, and the effects are considered discountable. Based on analyses of a worst-case scenario of a shoreline impact, direct contact from payload debris may also affect up to 5,692 coral colonies, 79 individual mollusks, and 100 juvenile and 8 adult humphead wrasses. The NMFS has been provided these analyses in a Biological Assessment, and they concluded that 10,404 coral colonies, 4 top shell snails, 63 clams, and 108 humphead wrasses could experience mortality from the payload impact on Illeginni Islet (NMFS 2019a; **Appendix C**). NMFS concluded that the potential loss of these adult coral, mollusk, and fish individuals would likely represent a tiny fraction of their species found at Illeginni Islet and across USAKA, and would not eliminate these species at Illeginni Islet or appreciably reduce the likelihood of their survival and recovery across USAKA (NMFS 2019a; **Appendix C**). Furthermore, NMFS determined that this level of anticipated take is not likely to result in the jeopardy of any of the UES consultation species that may be taken by the Proposed Action (NMFS 2019a; **Appendix C**).

Vessel strike: Marine wildlife has the potential to be impacted by vessel strike primarily by being at the surface when a vessel travels through an area. Due to species characteristics, abundance, and distribution, and mitigation measures, no adverse impacts due to vessel strike are expected.

Hazardous chemicals: Post-flight cleanup of the impact area would include recovery/cleanup of all visible floating debris. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish, or sea turtles in the area. Hazardous chemicals have the potential to impact sea turtle nests and nesting. USFWS has been provided a Biological Assessment and a request for concurrence, and their findings in their Letter of Concurrence (**Appendix A**) are included in the Final EA/OEA.

Human disturbance: Cetaceans, sea turtles in the water, and most fish are unlikely to be adversely impacted by increased human activity or equipment operation at Illeginni Islet. In shallow waters near Illeginni Islet, corals, mollusks, and reef- associated fish have the potential to be disturbed by shallow water debris recovery and/or backfill operations. NMFS has been provided a Biological Assessment, and the findings of their Final Biological Opinion are included in **Appendix C**.

Noise. While meteorological conditions can influence peak SPLs, the sonic boom generated by the approaching payload is estimated to peak at less than 180 decibels (dB). At the point of impact, the sonic boom footprint would narrow, and duration for sonic boom overpressures are expected to average 75 to 270 milliseconds (ms). Approximately 1 square kilometer (km^2; 0.4 square miles [mi^2]) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area. Mission vessel personnel may be required to use hearing protection. Noise levels during pre-test and post-flight activities at the predetermined target site would occur in an unpopulated area without resident receptors. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.

Public Health and Safety. In case of an anomaly, the payload FTS would cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. For impact, there are no resident populations in proximity to Illeginni Islet. Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs) would be issued to clear traffic from caution areas prior to the test. There would be no significant impacts to public health and safety from the Proposed Action.

Hazardous Materials and Wastes. Hazardous materials used in the payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, depleted uranium, beryllium, or radioactive materials would be carried on the payload. Flight test personnel would ensure all visible debris is removed from the impact site, and that all equipment and materials are recovered from Illeginni Islet. Any hazardous waste resulting from FE-2 flight test activities on Illeginni Islet would be disposed of in accordance with the U.S. Army Kwajalein Atoll Environmental Standards (UES). No significant impacts would occur from the Proposed Action.

USAKA RTS – Offshore Waters

Cultural Resources. There are no known cultural resources within either of the BOA deep water impact locations. No impacts would occur to cultural resources from either Alternative Action location.

Biological Resources. Terrestrial Wildlife. While no terrestrial habitat exists in the offshore waters, seabirds may forage in these areas. Based on likely seabird density and distribution in these areas, it is unlikely that seabirds would be exposed to SPLs high enough to cause injury or behavioral disturbance, direct contact, hazardous chemicals, vessel traffic, or human disturbance. Therefore, seabirds are unlikely to be adversely impacted.

Marine Wildlife. Noise: The maximum SPLs for sonic booms and payload impact at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans or sea turtles. Payload impact would result in SPLs above the injury threshold for fish but only out to 2.2 m (7.2 ft) from impact; therefore, injury to fish is unlikely. There is a potential for behavioral disruption in sea turtles and fish near the payload impact point. While there is a 1 in 57 chance that a sea turtle would be exposed to SPLs high enough to elicit behavioral response, any response is expected to be temporary, and turtles would be expected to return to normal behavior within minutes. Any behavioral disturbance in fish would likely be limited to a brief startle response, and behaviors would quickly return to normal. Therefore, no lasting adverse impacts are expected from elevated SPLs.

Direct contact: The total chance (all species combined) of a cetacean being directly contacted by payload impact in deep ocean waters is 1 in 684. There is a 1 in 98,310 chance that a sea turtle would be impacted by direct contact. Based on these chances, it is unlikely that a cetacean or sea turtle would be significantly impacted by direct contact from payload impact. Direct contact may adversely impact a very small, but indeterminable, number of larval fish, coral, or mollusks. The number of larvae potentially affected is likely to be trivially small relative to their population sizes, and the effects are considered discountable.

Vessel strike: Marine wildlife has the potential to be impacted by vessel strike primarily by being at the surface when a vessel travels through an area. Due to species characteristics, abundance, distribution, and mitigation measures, no adverse impacts due to vessel strike are expected.

Hazardous chemicals: Post-flight cleanup of the impact area would include recovery/cleanup of all visible floating debris. Considering the small quantities of hazardous materials contained in the payload and the dilution and mixing capabilities of the ocean and lagoon waters, the materials released during payload impact should be of little consequence to any cetaceans, fish, or sea turtles in the area.

Human disturbance: Cetaceans, sea turtles in the water, and fish are unlikely to be adversely impacted by increased human activity or equipment operation at Illeginni Islet.

Noise. While meteorological conditions can influence peak SPLs, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB. At the point of impact, the sonic boom footprint would narrow and duration for sonic boom overpressures are expected to average 75 to 270 ms. Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area. Mission vessel personnel may be required to use hearing protection. Noise levels during pre-test and post-flight activities at the predetermined target site would occur in an unpopulated area without resident receptors. Therefore, no significant impacts would occur from noise with implementation of the Proposed Action.

Public Health and Safety. In case of an anomaly, the payload FTS would cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. For impact, there are no resident populations in proximity to either Offshore Waters location. NOTAMs and NTMs would be issued to clear traffic from caution areas prior to the test. There would be no significant impacts to public health and safety from the Proposed Action.

Hazardous Materials and Wastes. Hazardous materials used in the payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, depleted uranium, beryllium, or radioactive materials would be carried on the payload. Any hazardous waste resulting from FE-2 flight test activities from vessels or equipment would be disposed of in accordance with the UES. No significant impacts would occur from the Proposed Action.

Alternative 2

WFF

Biological Resources. Terrestrial Vegetation. No ground clearing or construction is expected for the Proposed Action. The launch would take place at a previously disturbed, previously used, and previously analyzed location. Compliance with relevant Navy policies and procedures during this launch event should continue to minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. Terrestrial vegetation is not expected to be significantly impacted.

Terrestrial Wildlife. Terrestrial wildlife is not likely to be physically injured by launch noise. Behavioral disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause birds and other mobile wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound-producing activities have ended. Terrestrial wildlife are not expected to be impacted by direct contact during normal flight operations. No significant short- or long-term impacts to terrestrial wildlife are expected from launches at WFF.

Artificial lighting: Launches are not expected to take place at night, and lights are not expected to be turned on at night for any FE-2 activities. If program activities are required to occur at night during the sea turtle nesting season, the U.S. Navy would minimize lighting and coordinate these activities through WFF to avoid disorienting hatchling sea turtles with artificial lights. Given the limited time frame of launch activities, sea turtles hatchlings and other terrestrial wildlife species are not likely to be significantly impacted by artificial lighting from FE-2 activities.

Marine Wildlife. Noise from launches and launch related activity may startle nearby wildlife, but this startle reaction would be of short duration. Based on injury thresholds, marine wildlife would not be injured from elevated SPLs. Any behavioral disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations. Within offshore waters, the potential ingestion of contaminants by fish and other marine species would be remote because of atmospheric dispersion of the emission cloud, the diluting effects of the ocean water, and the relatively small area of the habitat that would be affected. No impacts on marine wildlife due to hazardous chemicals are expected during normal flight operations.

Airspace. There would be no impacts to airspace management beyond what has been analyzed in previous NEPA documents. Launch of the FE-2 would include flight monitoring at WFF Air Traffic Control, WFF Range Control Center, Washington Air Route Traffic Control Center, and Fleet and Area Control and Surveillance Facility Virginia Capes. NOTAMs and NTMs that are broadcast by the FAA and U.S. Coast Guard, when needed for operations in R-6604 A-E and W-386, would also remain unchanged. Therefore, implementation of the Proposed Action would have no impact on airspace management resources in R-6604 A-E or W-386.

Public Health and Safety. FE-2 launch activities would follow established protocols at WFF and would involve risks to safety similar to previously analyzed missile launch activities. WFF would implement protective measures to ensure risks to personnel and the general public from these operations are minimized. Therefore, implementation of the Proposed Action would have no significant impact on health and safety.

Hazardous Materials and Wastes. Types of hazardous materials, substances, and hazardous waste would be like those used or generated during similar missile launch operations at WFF and would continue to be managed according to standard procedures. All hazardous wastes would continue to be managed in accordance with standard procedures to protect human health and the environment. No significant impacts are anticipated.

Over-Ocean Flight Corridors and Atlantic BOA Impact Area

Air Quality. Under the Proposed Action, following the FE-2 flight test, the majority of aluminum oxide would be removed from the stratosphere through dry deposition and precipitation. Emissions from a STARS vehicle launch would be relatively small compared to all emissions released on a global scale. The large air volume over which the STARS emissions are spread, and the dispersion of the STARS emissions by stratospheric winds would reduce potential impacts. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that any incremental effects on the global atmosphere would be discountable and insignificant. The Proposed Action would not have a significant impact on stratospheric ozone or on the upper atmosphere. The amount of GHG emissions that would be released from activities associated with a single FE-2 flight test is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time for conducting the single FE-2 flight test activities. This limited amount of emissions would not likely contribute to global warming and climate change to any discernible extent. Implementation of the Proposed Action would not result in significant impacts to air quality or GHG emissions.

Biological Resources. Marine Vegetation. The FE-2 flight test flight is not expected to have a discernible or measurable impact on marine vegetation because of its abundance, wide distribution, and the protective influence of the mass of the ocean around them. While some individual phytoplankton and/or macro-algae would likely be affected by FE-2 component splashdown, FE-2 activities are not expected to alter marine vegetation communities, population structure, or overall abundance or distribution of marine vegetation species.

Marine Wildlife. Noise: Sonic booms overpressures would not exceed PTS or TTS thresholds for marine mammals, sea turtles, or fish in the BOA. Sonic boom sound pressure would exceed the injury threshold for seabirds, but given seabird density and distribution in the BOA, physical injury is unlikely. Therefore, no adverse impacts from sonic booms are expected. Splashdown pressures would exceed PTS thresholds for cetaceans with high frequency hearing (three species), seals (two species) and the physical injury threshold for seabirds. These pressures would also exceed TTS thresholds for cetaceans with high and low frequency hearing, seals, birds, and fish. These organisms may also be exposed to SPLs high enough to cause behavioral disturbance. While effects of elevated SPLs are possible, based on species abundance and distribution in the BOA, the chances of this occurring are likely very low. Any effects of elevated SPLs are likely to be temporary, behavioral modifications with no lasting effects. Therefore, no significant impacts from elevated SPLs are expected.

Direct contact: The chances of an FE-2 component directly contacting a marine mammal are very low. Even when summed across all components and all species, there is a 1 in 125 chance of a cetacean being exposed to direct contact and a 1 in 836,000,000 chance of a seal being exposed. For the stage 1 motor, the chances of direct contact with a sea turtle are also extremely low (1 in 14,100). Direct contact would not be expected to adversely impact cetaceans, sea turtles, loggerhead turtle critical habitat, birds, fish, or EFH in the BOA.

Hazardous chemicals: The release of hazardous materials carried onboard a launch vehicle and payload would not significantly impact marine life. Hazardous materials would be rapidly diluted in the seawater, and larger and heavier vehicle components would sink fairly quickly to the ocean floor to depths where consultation organisms would likely not be in contact with these materials.

Increased human and vessel activity: Vessel traffic is common in this area, and the increase in human activity and vessel traffic in the BOA would be expected to be minimal; these activities would not be expected to impact marine resources including threatened and endangered species or EFH.

The anticipated impacts to resources associated with Alternatives 1 and 2 are summarized in **Table ES-1** and **Table ES-2**, respectively.

Table ES-1. Summary of the Anticipated Impacts to the Resources Associated with Alternative 1 PMRF – USAKA Alternative Actions Analyzed

Location / Resource Area	No Action Alternative	Proposed Action Alternative
Pacific Missile Range Facility		
Air Quality	No change	Minor, short-term impact
Water Resources	No change	Minor, short-term impact
Biological Resources	No change	No significant impact
Airspace	No change	No impact
Noise	No change	Minor, short-term impact
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact
Pacific Ocean Flight Corridor		
Air Quality	No change	No significant impact
Biological Resources	No change	No significant impact
USAKA, RMI – Illeginni Islet		
Cultural Resources	No change	No impact
Biological Resources	No change	No significant impact
Noise	No change	Minor, short-term impact
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact
USAKA, RMI – Offshore Waters – Southwest and Northeast		
Cultural Resources	No change	No impact
Biological Resources	No change	No significant impact
Noise	No change	Minor, short-term impact
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact

Table ES-2. Summary of the Anticipated Impacts to the Resources Associated with Alternative 2 WFF – BOA Alternative Actions Analyzed

Resource Area	No Action Alternative	Alternative 2
NASA Wallops Flight Facility (WFF), Virginia		
Biological Resources	No change	No significant impact
Airspace	No change	No impact
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact
Atlantic Broad Ocean Area		
Air Quality	No change	No significant impact
Biological Resources	No change	No significant impact

Public Involvement

The Navy circulated the Draft EA/OEA for public review for 30 days from 24 August 2019 to 26 September 2019. The comments received from U.S. agencies on the Draft EA/OEA and their responses are provided in the Final EA/OEA, Appendix B. No comments were received from the RMI agencies or the public.

1.0 Purpose of and Need for the Proposed Action

1.1 Introduction

The Proposed Action, Flight Experiment-2 (FE-2), is sponsored by the Office of the Under Secretary of Defense for Research and Engineering, which has designated the United States Department of the Navy (U.S. Navy) Strategic Systems Programs (SSP) as the lead agency for the Proposed Action. That makes SSP the action proponent for this EA under Chief of Naval Operations Instruction (OPNAVINST) 5090.1E. The U.S. Navy SSP proposes to conduct a developmental flight test as described in this Environmental Assessment / Overseas Environmental Assessment (EA/OEA). The Proposed Action entails one experimental flight test to take place within the first half of fiscal year (FY) 2020 after the Finding of No Significant Impact / Finding of No Significant Harm (FONSI/FONSH) is signed, if approved. The U.S. Navy, along with the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) as Cooperating Agencies, and with the U.S. Army Space and Missile Defense Command (USASMDC) as a Participating Agency, has prepared this EA/OEA in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and U.S. Navy regulations for implementing NEPA.

1.2 Locations

The U.S. Navy is considering two primary locations, one with sites in the Pacific Ocean and one on the east coast with sites in the Atlantic Ocean. The Pacific locations analyzed in this EA/OEA are the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawai`i; the U.S. Army Kwajalein Atoll (USAKA); the Ronald Reagan Ballistic Missile Defense Test Site (RTS), Republic of the Marshall Islands (RMI); and the Broad Ocean Area (BOA) in the Pacific. The east coast locations include the NASA Wallops Flight Facility (WFF), Virginia; and the Atlantic BOA. Notional trajectories are shown in **Figure 1-1** and **Figure 1-2**.

Various other Government facilities would participate in support operations related to the Proposed Action. These additional facilities, listed in **Table 1-1**, maintain NEPA documentation and/or regulatory permitting for their ongoing activities. As such, analysis of these support operations is not included in this EA/OEA.

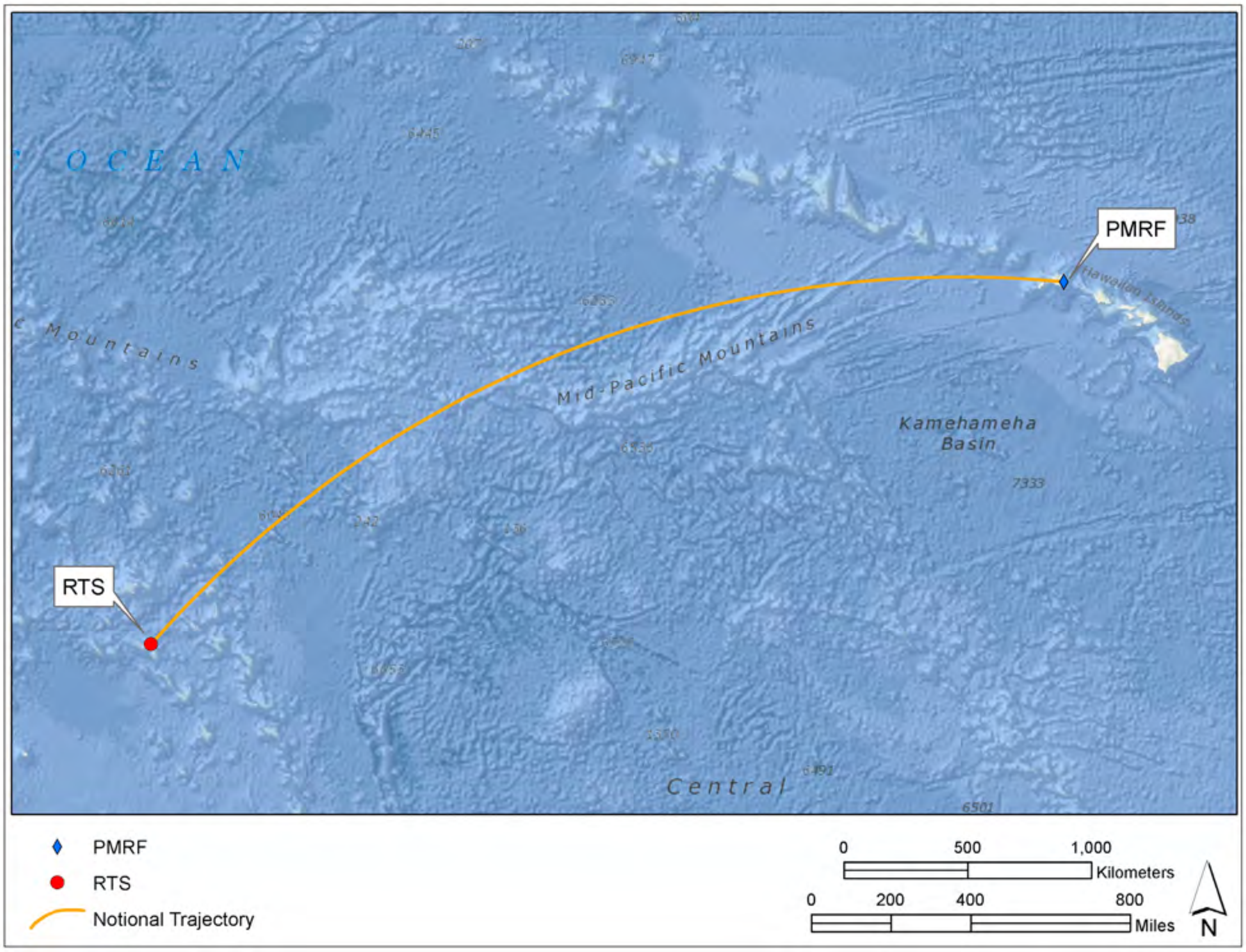


Figure 1-1. FE-2 Activity Location Map Pacific – General Map with PMRF – RTS

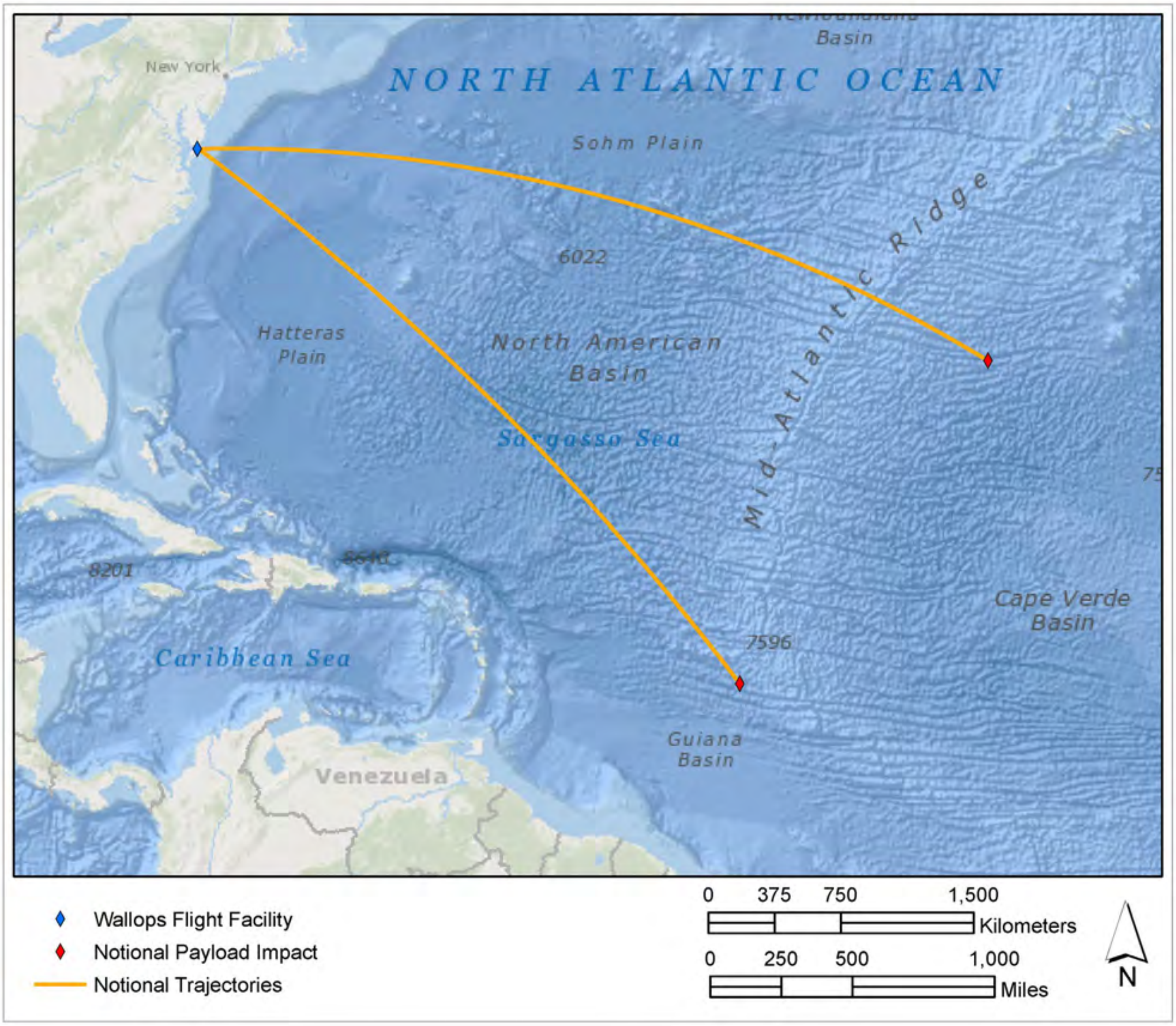


Figure 1-2. FE-2 Activity Location Map Atlantic: General Map with WFF – BOA Impact.

Table 1-1. Support Locations Not Analyzed in this EA/OEA

Location	Support Activity
Draper Labs, Cambridge, Massachusetts	• Provide navigation for the payload system
Lawrence Livermore National Laboratory (LLNL), Livermore, California	• Component development
Redstone Arsenal, Alabama	U.S. Army Space and Missile Defense Command (USASMDC) • Mission planning • Test execution U.S. Army Aviation and Missile Research Development and Engineering Center • Component development and testing Naval Sea Systems Command (NAVSEA) Crane • Perform Strategic Target System (STARS) motor processing • Logistics Missile Defense Agency (MDA) • Test instrumentation
Sandia National Laboratories, Albuquerque, New Mexico	• Vehicle assembly, integration, and testing

1.3 Purpose of and Need for the Proposed Action

The purpose of the Proposed Action, FE-2, is to continue to collect data on a developmental payload by testing one such flight experiment concept. The Proposed Action is needed to enable testing, modeling, and simulation of a developmental payload system and mature the technologies necessary to ultimately establish an operational strike capability. A range of possible flight experiment concepts is being studied to inform potential future strike capability determinations.

FE-2 is the next incremental step in the developmental process after Flight Experiment-1 (FE-1). FE-1 was a very similar test flight conducted in 2017 from PMRF in Hawai`i to RTS in the RMI. FE-2 would continue to develop, integrate, and flight test a payload system to demonstrate the maturity of key technologies. These technologies include precision navigation, guidance and control, and other capability enhancements. FE-2 would help further establish aerodynamic, thermal, and structural limits of the payload system. Data collected would be utilized to improve the models that predict the performance of the payload system. The Proposed Action would also provide an opportunity to observe the FE-2 missile and payload system from launch-to-impact and record all data that is transmitted throughout the flight path.

To meet the objectives described above, FE-2 must satisfy certain physical and technical constraints. For example, it is essential that the payload system is capable of executing the planned flight profile within acceptable tolerances. FE-2 must use observational instrumentation with sufficient fidelity to characterize and evaluate system performance. In addition, to meet limitations of time and budget, there is a programmatic requirement to use the same type of booster used for FE-1. There is also a programmatic requirement to conduct FE-2 within the first half of FY 2020.

1.4 Scope of Environmental Analysis

This EA/OEA includes an analysis of potential environmental impacts associated with the Proposed Action and the No Action Alternative. The U.S. Navy has considered alternate launch and impact locations, and only the launch from PMRF at the Sandia National Laboratories/Kauai Test Facility (SNL/KTF) with impact near RTS and the launch from WFF with impact in the Atlantic BOA meet the screening criteria / evaluation factors and the test requirements for vehicle performance and data collection. This EA/OEA analyzes potential impacts to the launch area (PMRF/KTF and WFF), the over-ocean flight corridors in the Pacific and Atlantic, booster drop zones in the Pacific and Atlantic, the three impact scenarios at RMI (Illeginni Islet and two ocean impact zones), and the BOA impact zones in the Atlantic. The U.S. Navy's preferred alternative is a launch from PMRF with an impact at Illeginni Islet because it best meets the requirements of the Purpose of and Need for the Proposed Action.

The environmental resource areas considered in this EA/OEA include air quality, water resources, geological resources, cultural resources, biological resources, land use, airspace, noise, infrastructure, public health and safety, hazardous materials and wastes, socioeconomics, environmental justice, aesthetics/visual resources, and marine sediments. The study area for each resource may differ due to how the Proposed Action interacts with or impacts the resource. For instance, the study area for geological resources may only include the construction footprint of a building, whereas the noise study area would expand to include areas that may be impacted by airborne noise. **Table 1-2** and **Table 1-3** summarize the potential impacts to the resources associated with each of the alternative actions analyzed.

Table 1-2. Summary of the Anticipated Impacts to the Resources Associated with Alternative 1 PMRF – USAKA Alternative Actions Analyzed

Location / Resource Area	No Action Alternative	Proposed Action Alternative
Pacific Missile Range Facility		
Air Quality	No change	Minor, short-term impact
Water Resources	No change	Minor, short-term impact
Biological Resources	No change	No significant impact
Airspace	No change	No impact
Noise	No change	Minor, short-term impact
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact
Pacific Ocean Flight Corridor		
Air Quality	No change	No significant impact
Biological Resources	No change	No significant impact
USAKA, RMI – Illeginni Islet		
Cultural Resources	No change	No impact
Biological Resources	No change	No significant impact
Noise	No change	Minor, short-term impact

Location / Resource Area	No Action Alternative	Proposed Action Alternative
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact
USAKA, RMI – Offshore Waters – Southwest and Northeast		
Cultural Resources	No change	No impact
Biological Resources	No change	No significant impact
Noise	No change	Minor, short-term impact
Public Health and Safety	No change	Minor, short-term impact
Hazardous Materials and Wastes	No change	No significant impact

Table 1-3. Summary of the Anticipated Impacts to the Resources Associated with Alternative 2 WFF – BOA Alternative Actions Analyzed

Resource Area	No Action Alternative	Proposed Action Alternative
NASA Wallops Flight Facility (WFF), Virginia		
Biological Resources	No change	No significant impact
Airspace	No change	No impact
Public Health and Safety	No change	No significant impact
Hazardous Materials and Wastes	No change	No significant impact
Atlantic Broad Ocean Area		
Air Quality	No change	No significant impact
Biological Resources	No change	Minor, short-term impact

1.4.1 Key Documents

Key documents are sources of information incorporated into this EA/OEA. These documents are considered to be key because they address similar actions, analyses, or impacts that may apply to this Proposed Action.

Alternative 1 – PMRF – USAKA

- *Final Environmental Assessment/Overseas Environmental Assessment for Flight Experiment-1 (FE-1), 2017.* This assessment addresses the probable environmental effects of conducting Navy FE-1 from PMRF on Kauai, Hawai`i to Illeginni Islet, RTS, RMI.
- *Advanced Hypersonic Weapon Flight Test 2 Hypersonic Technology Test Environmental Assessment*, 2014. This EA documents the demonstration flight test of a flight test vehicle launched from the Kodiak Launch Complex, using an existing three-stage Strategic Target System (STARS). Following booster separation, the test vehicle would fly to an impact site in the vicinity of Illeginni Islet at USAKA in the RMI.
- *Hawai`i–Southern California Training and Testing Final Environmental Impact Statement/Overseas Environmental Impact Statement*, 2018. The U.S. Navy identified its need to support and conduct current, emerging, and future training and testing activities in the Hawai`i–Southern California Study Area, which is made up of air and sea space off

Southern California, around the Hawaiian Islands, and the air and sea space connecting them.

- *Advanced Hypersonic Weapon Program Environmental Assessment*, 2011. This EA analyzes the impacts of launching a flight test vehicle from PMRF, Kauai, Hawai`i, using an existing STARS with three stages. The payload on the STARS vehicle would fly to a land or ocean impact at the USAKA/RTS (on or near Illeginni Islet) in the RMI.
- *Hawaii Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS),* 2008. The U.S. Navy has identified the need to support and conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) activities in the Hawai`i Range Complex (HRC). The alternatives—the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3—are analyzed in this Final EIS/OEIS. All alternatives include an analysis of potential environmental impacts associated with the use of mid-frequency active and high-frequency active sonar. The No Action Alternative stands as no change from current levels of HRC usage and includes HRC training, support, and RDT&E activities, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises.
- *Environmental Assessment for Minuteman III Modification*, 2004. This EA documents the potential environmental impacts of (1) Minuteman III (MMIII) missile flight tests using modified reentry system hardware/software, in addition to the continuation of Force Development Evaluation flight tests; (2) deployment of new and modified reentry system hardware/software; and (3) deployment activities for new command and control console equipment. The locations covered in this EA include: F.E. Warren Air Force Base (AFB), Wyoming; Hill AFB, Utah; Malmstrom AFB, Montana; Minot AFB, North Dakota; Vandenberg AFB, California; and USAKA, RMI.
- *North Pacific Target Launch Environmental Assessment*, 2001. This EA analyzed the impacts of using the STARS launch vehicle for strategic target launch services from Kodiak Launch Complex, Kodiak Island, Alaska. The STARS target would also continue to be launched from KTF at PMRF, Kauai, Hawai`i to the BOA near USAKA in the Marshall Islands. The proposed action was to increase the launch capability of the STARS by adding a new STARS flight trajectory from KTF and providing a launch capability from Kodiak Launch Complex. The proposed action would provide ballistic missile targets to test North American sensors, and for possible use in testing various sensors and ground-based interceptors at USAKA and various sensors and ship-based interceptors at PMRF.
- *U.S. Army Kwajalein Atoll (USAKA) Supplemental Environmental Impact Statement (EIS)*, 1993. This Final Supplemental EIS evaluates the environmental impacts of two proposed actions at USAKA. The first proposed action is the types and levels of test activities, including test facilities and support services at USAKA. The second proposed action is the adoption of new environmental standards and procedures for U.S. Government activities at USAKA.

- *Kauai Test Facility Environmental Assessment*, 1992. This EA documents the results of an analysis of the potential for and magnitude of impacts from pre-launch and launch activities from SNL/KTF.
- *Strategic Target System Environmental Impact Statement*, 1992. This EIS documents the results of an analysis of the potential for and magnitude of impacts from launch activities of the STARS from KTF at PMRF on the island of Kauai, Hawai`i.
- *Strategic Target System Environmental Assessment*, 1990. This EA/OEA documents the results of an analysis of the potential for and magnitude of impacts from pre-launch and launch activities of the STARS from PMRF.
- *Environmental Assessment Missile Impacts, Illeginni Island at the Kwajalein Missile Range, Kwajalein Atoll Trust Territory of the Pacific Islands*, 1977. This assessment addresses the probable environmental effects of missile impacts on Illeginni Islands District, Trust Territory of the Pacific Islands.

Alternative 2 – WFF – BOA

- *Wallops Flight Facility Site-Wide Final Programmatic Environmental Impact Statement (PEIS), NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia*, 2019. The PEIS evaluates the environmental consequences of constructing and operating new facilities and infrastructure at WFF, to support a growing mission base in the areas of civil, commercial, defense, and academic aerospace while also preserving NASA's ability to safely conduct its historical baseline of operations.
- *Environmental Resources Document (External Version – Redacted), Goddard Space Flight Center, Wallops Flight Facility, Wallops, Virginia*, 2017. This document has been developed to serve as the primary reference for current environmental conditions at WFF. It addresses the ongoing operations of WFF rather than a proposed project.
- *Atlantic Fleet Training and Testing Final EIS/OEIS, 2018.* This EIS/OEIS evaluates the potential environmental effects associated with military readiness training and research, development, testing, and evaluation activities conducted within the Virginia Capes (VACAPES) Range Complex.
- *Environmental Assessment – U.S. Navy Testing of Hypervelocity Projectiles and an Electromagnetic Railgun, National Aeronautics and Space Administration's Wallops Flight Facility, Wallops Island, Virginia*, 2014. This EA covers the installation of a 5-inch powder gun and an electromagnetic (EM) railgun, testing of hypervelocity projectiles (HVPs), integrating HVPs with the EM railgun, and integrating the HVP/EM railgun weapon system with combat systems at NAVSEA's Surface Combat Systems Center located on WFF. The guns would fire into the VACAPES Range Complex in the Atlantic Ocean, which is used by the Navy for training and testing activities.

- *Environmental Assessment for Launch of NASA Routine Payloads*, 2011. This EA includes the potential impacts of processing and launching NASA Routine Payloads spacecraft from several sites including WFF. Seven routine payload launch vehicles were analyzed, some of which are similar to the proposed FE-2 launch vehicle.
- *Final Report – Environmental Assessment for the Expansion of the Wallops Flight Facility Launch Range*, 2009. This EA addresses the proposed expansion of the launch range at WFF. Under the Proposed Action, NASA and Mid-Atlantic Regional Spaceport facilities would be upgraded to support up to and including medium large class suborbital and orbital expendable launch vehicle launch activities from WFF.
- *Virginia Capes Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), United States Fleet Forces*, 2009. This EIS/OEIS was prepared to assess the potential environmental impacts over a 10-year planning horizon associated with Navy Atlantic Fleet training, research, development, testing, and evaluation activities, and associated range capabilities enhancements (including infrastructure improvements) in the VACAPES Range Complex.
- *Request for Letter of Authorization for the Incidental Harassment of Marine Mammals Resulting from Navy Training Operations Conducted within the VACAPES Range Complex*, 2008. The Department of the Navy has prepared a request for Letter of Authorization to analyze the potential environmental effects associated with Atlantic Fleet training in the VACAPES Range Complex.
- *Final Environmental Assessment for the Orbital/Sub-Orbital Program (OSP)*, 2006. This EA documents the environmental analysis of implementing the OSP, which will provide enhanced capability and flexibility to the development of space launch and target vehicles using excess MM and PK rocket motors including launches from WFF. The EA addresses applicable site modifications and construction activities (including some demolitions), rocket motor transportation, pre-flight preparations, flight activities, and post-launch operations. At each range, the OSP will use existing facilities, with limited construction and facility modifications.

1.5 Relevant Laws and Regulations

The U.S. Navy has prepared this EA/OEA based on federal and state laws, statutes, regulations, and policies that are pertinent to the implementation of the Proposed Action, including the following:

- NEPA (42 United States Code [USC] Sections 4321-4370h), which requires an environmental analysis for major federal actions that have the potential to significantly impact the quality of the human environment
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508)

- Navy regulations for implementing NEPA (32 CFR Part 775), which provides Navy policy for implementing CEQ regulations and NEPA
- Clean Air Act (CAA) (42 USC Section 7401 et seq.)
- Clean Water Act (CWA) (33 USC Section 1251 et seq.)
- Coastal Zone Management Act (CZMA) (16 USC Section 1451 et seq.)
- National Historic Preservation Act (NHPA) (54 USC Section 306108 et seq.)
- Endangered Species Act (ESA) (16 USC Section 1531 et seq.)
- Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 USC Section 1801 et seq.)
- Marine Mammal Protection Act (MMPA) (16 USC Section 1361 et seq.)
- Migratory Bird Treaty Act (MBTA) (16 USC Sections 703-712)
- Bald and Golden Eagle Protection Act (16 USC Section 668-668d)
- Executive Order (EO) 11988, Floodplain Management
- EO 12088, Federal Compliance with Pollution Control Standards
- EO 12114, Environmental Effects Abroad of Major Federal Actions
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations
- EO 13045, Protection of Children from Environmental Health Risks and Safety Risks
- EO 13089, Coral Reef Protection
- EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management
- EO 13175, Consultation and Coordination with Indian Tribal Governments
- EO 13693, Planning for Federal Sustainability in the Next Decade
- Compact of Free Association Between the United States and the Republic of the Marshall Islands, which became effective on October 21, 1986, under Presidential Proclamation No. 5564 on November 3, 1986; and was amended pursuant to Public Law 108-188 – December 17, 2003; 17 STAT 2723
- Compact of Free Association Military Use and Operating Rights Agreement between the United States of America and the Marshall Islands, March 23, 2004
- Environmental Standards and Procedures for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands. Fifteenth Edition. September 2018

1.6 Public and Agency Participation and Intergovernmental Coordination

The DOE National Nuclear Security Administration (NNSA) SNL and NASA WFF accepted the U.S. Navy SSP invitation to participate as cooperating agencies (40 CFR Part 1501.6) in the preparation of this EA/OEA (refer to **Appendix A** for relevant correspondence). Regulations from the CEQ (40 CFR Part 1506.6) direct agencies to involve the public in preparing and implementing their NEPA procedures.

The U.S. Navy has coordinated or consulted with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the other UES Appropriate Agencies regarding the Proposed Action. A project specific Notice of Proposed Activity (NPA) and Document of Environmental Protection (DEP) were prepared and submitted to the UES Appropriate Agencies and to the RMI public for a 30-day review and comment period.

The UES Appropriate Agencies include:

- RMI Environmental Protection Authority (RMIEPA)
- U.S. Environmental Protection Agency (USEPA)
- USFWS
- NMFS
- U.S. Army Corps of Engineers (USACE)

A Notice of Availability (NOA) was published, indicating when the document would be issued; where copies could be obtained or reviewed; the duration of the comment period; where comments should to be sent; and location, date, and times regarding the Draft EA and Draft FONSI/FONSH. The NOA was published as follows:

- *The Kwajalein Hourglass*
- *The Marshall Islands Journal*

Comments on the EA/OEA and FONSI/FONSI were requested to be submitted to Comments@ FE-2-EAOEA.com or mailed to the following address:

U.S. Army Space and Missile Defense Command/Army Forces Strategic Command
Attention: SMDC-ENE (Mark Hubbs)
Post Office Box 1500
Huntsville, AL 35807-3801

In accordance with CEQ and Department of Defense (DOD) regulations for implementing NEPA, the U.S. Navy circulated the Draft EA/OEA for public review from 23 August 2019 to 26 September 2019. Substantive comments received on the Draft EA/OEA and their responses are provided in the Final EA/OEA (See **Appendix B**). Copies of the Draft EA/OEA and Draft FONSI/FONSH were placed in local repositories for public access and made available over the Internet at http://www.FE-2-EAOEA.com. Those agencies, organizations, and repositories that were directly notified about the NOA or received a copy of the document are listed in **Appendix B**.

Following the public review period (as specified in the newspaper notice), the U.S. Navy will decide whether to sign the FONSI/FONSH, which would allow the Proposed Action to be implemented, or to prepare an EIS. If the U.S. Navy decides to sign the FONSI/FONSH, the Final EA/OEA will include both the written comments (i.e., letters and electronic messages received) and their resolutions. The Final EA/OEA and FONSI/FONSH will be accessible on the internet at http://www.FE-2-EAOEA.com.

2.0 Description of the Proposed Action and Alternatives

2.1 Proposed Action

The U.S. Navy SSP FE-2 Proposed Action would consist of a flight test designed to prove various aspects of the system's capabilities. The FE-2 launch vehicle consists of a three-stage STARS booster system (**Figure 2-1**). This test would be designed to collect data to provide a basis for ground testing, modeling, and simulation of payload performance.

The Proposed Action entails ground preparations for the flight test; launch and flight test; impact of the payload; and post launch operations.

Characteristics of the launch vehicle are presented in **Table 2-1.** The payload system characteristics are presented in **Table 2-2**. The Proposed Action would occur within the first half of FY 2020 after signing of the FONSI/FONSH, if approved.

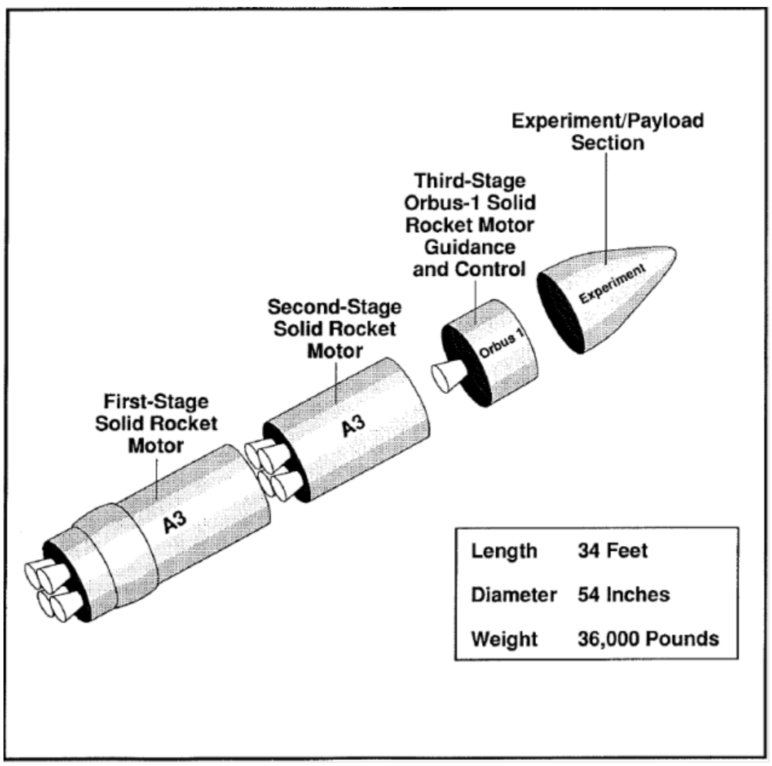


Figure 2-1. Typical Strategic Target System Vehicle

Table 2-1. Launch Vehicle Characteristics

Major Components	Rocket motors, propellant, magnesium thorium (booster interstage)[1], nitrogen gas, halon, asbestos (contained in second stage), battery electrolytes (lithium-ion, silver zinc)
Communications	Various 5- to 20-watt radio frequency transmitters; one maximum 400-watt radio frequency pulse
Power	Up to nine lithium ion polymer and silver zinc batteries, each weighing between 1.3 and 18 kilograms (kg; 3 and 40 pounds [lb])
Propulsion/Propellant	Rocket propellant and approximately 1.3 kg (3 lb) of pressurized nitrogen gas
Other	Small Class C (1.4) electro-explosive devices

Table 2-2. Payload System Characteristics

Structure	Aluminum, steel, titanium, magnesium and other alloys, copper, fiberglass, chromate coated hardware, tungsten, plastic, teflon, quartz, room temperature vulcanizing silicone
Communications	Two up-to 20-watt radio frequency transmitters
Power	Up to three lithium ion polymer batteries, each weighing between 1 and 23 kg (3 and 50 lb)
Propulsion/Propellant	None
Other	Class C (1.4) electro-explosive devices for safety and payload system subsystems operations

2.2 Screening Factors

NEPA's implementing regulations provide guidance on the consideration of alternatives to a federally proposed action and require rigorous exploration and objective evaluation of reasonable alternatives. Only those alternatives determined to be reasonable and meet the purpose and need require detailed analysis.

The alternatives for the FE-2 flight test were derived through the following screening criteria/ evaluation factors:

1. The launch and impact location must have the specialized infrastructure and personnel capable of conducting an FE-2 flight test such that:

[1] The skin of the STARS first/second interstage structure was manufactured from a magnesium-thorium alloy (HK31A-H24). This is a surplus Polaris A3R asset that has been adapted to STARS, and it contains less than 3% (<80 microcuries [μCi]) thorium. The interstage alloys are commercially available products containing magnesium-thorium alloy and are exempted from controls by the Nuclear Regulatory Commission (10 CFR 40.13) and the Radiological Procedures Protection Manual (Chapter 6, Attachment 6-2) since there is no physical, chemical, or metallurgical processing performed on the items.

   a. The launch pad is capable of supporting a STARS III booster system;
   b. Data such as pre-mission analyses, real-time performance data and post-mission analyses can be collected and stored at a classified level and analyzed in the required timeframe;
   c. FE-2 motors and explosive materials can be stored according to requirements; and
   d. The number and type of equipment required to support the test (e.g., trailers, tractors, cranes, trucks, forklifts and manlifts) is currently available or will be available when required.
2. The launch and impact location must provide the required range distance to conduct the test.
3. The launch and impact location must be available for and capable of conducting the test within the required timeframe.
   a. Capable of conducting the test in the first half of FY 2020; and
   b. Able to complete all documentation required to support/authorize the test prior to the launch (e.g., memorandum of agreement/memorandum of understanding, range request letter, range safety data package, launch approval letter).
4. The launch and impact location must be capable of providing required range safety, including explosive safety.
5. The launch and impact location must meet security requirements.

Section 2.3 describes the alternatives carried forward for analysis; Section 2.4 describes the No Action Alternative; Section 2.5 describes the Proposed Action; and Section 2.6 describes the Alternatives considered but not carried forward for detailed analysis.

2.3 Alternatives Carried Forward for Analysis

Based on the screening criteria/evaluation factors, the Navy has identified two action alternatives that meet the Proposed Action’s purpose and need. These two alternatives are analyzed in this EA/OEA. Alternative 1 includes launch from SNL/KTF, over-ocean flight corridors in the Pacific, booster impact zones in the Pacific BOA, and three impact scenarios at RMI (Illeginni Islet and two ocean impact zones).

Alternative 2 includes launch from WFF, over-ocean flight corridors in the Atlantic, booster impact zones in the Atlantic BOA, and payload impact in the Atlantic BOA.

Alternative 1 is the U.S. Navy’s preferred alternative and includes a launch from PMRF with an impact at Illeginni Islet. Alternative 1 is preferred because it includes a launch site that is more familiar with real-time performance data and post-mission analyses being collected and stored at a classified level and it also includes a land impact that allows higher fidelity data collection than an impact in the BOA.

2.4 No Action Alternative

U.S. Navy SSP has been directed by the U.S. Department of Defense (DOD) to perform the FE-2 flight test. The flight test must meet certain mission and program objectives to provide the data required by DOD. In accordance with OPNAVINST 5090.1E, *Environmental Readiness Program*, the No Action Alternative is an alternative that must be analyzed.

Under the No Action Alternative, the Proposed Action would not occur. Under the No Action Alternative, the U.S. Navy would not pursue the FE-2 program. The No Action Alternative would not meet the purpose and need for the Proposed Action; however, as required by NEPA and OPNAVINST 5090.1E, the No Action Alternative is carried forward for analysis in this EA/OEA and provides a baseline for measuring the environmental consequences of the action alternatives.

2.5 Flight Experiment-2 Proposed Action

2.5.1 Pre-Flight Activities

Various other Government facilities would participate in pre-flight support operations related to the Proposed Action. Those additional locations maintain NEPA documentation and/or regulatory permitting for their ongoing activities. As such, analysis of these support operations is not included in this EA/OEA.

2.5.2 Rocket Motor Transportation

All transportation, handling, and storage of the rocket motors and other ordnance would occur in accordance with DOD, Navy, and U.S. Department of Transportation (DOT) policies and regulations to safeguard the materials from fire or other mishap.

2.5.2.1 Alternative 1

All shipments would be inspected to prevent the introduction of alien species of plants and animals into the environment at Hawai`i and the RMI.

The U.S. Navy SSP would arrange for the U.S. Air Force to transport the rocket motors to the PMRF airfield on Barking Sands, Kauai, Hawai`i. The U.S. Navy would transport the hazardous material and test items from the PMRF airfield to SNL/KTF once the aircraft has landed in Hawai`i.

2.5.2.2 Alternative 2

The U.S. Navy SSP would arrange to transport the rocket motors via truck or military aircraft. Once unloaded, they would be placed either in the Hazardous Processing Facility on Wallops Island (Y-15), or in the Payload Processing Facility (H-100) on the Wallops Main Base.

2.5.3 Launch Site Preparations and Operations

2.5.3.1 Alternative 1

PMRF is located in Hawai`i on and off the western shores of the island of Kauai and includes BOAs to the north, south, and west. The relative isolation of PMRF, a year-round tropical climate, and an open ocean area relatively free of human presence are significant factors in PMRF's excellent record of safely conducting testing and training activities. PMRF's mission includes providing training for U.S. Navy and other DOD personnel using existing equipment and technologies to meet real world requirements to maintain and achieve required states of readiness. PMRF's mission also includes providing support to RDT&E programs being developed by the DOD and the MDA.

The DOE/NNSA's SNL operates KTF on the western coast of Kauai in the Hawaiian Islands for the DOE. SNL/KTF, which is a tenant of PMRF, fulfills multiple purposes in support of DOE research and development activities including launching of rockets carrying experimental non-nuclear payloads. SNL/KTF has been an active rocket launching facility since 1962. Most of these launches are targeted to various areas of the South Pacific, including USAKA in the RMI.

SNL/KTF is located on and is a tenant activity of PMRF. SNL/KTF is operated independently by SNL personnel, but relies on base operations and logistic support from PMRF. For the purposes of this document, references to PMRF include all current range assets and tenants on Kauai and at remote locations regardless of ownership. PMRF is the standard reference for the land-based installations on Kauai, the underwater ranges, and their assets unless referring to a specific site or facility complex. PMRF on Kauai includes the main base complex (PMRF/Main Base), the DOE/NNSA's SNL/KTF, as a tenant within the base complex, Makaha Ridge, Kokee, Kamokala Magazines, and U.S. Navy activities at Port Allen. In addition, there are range assets on Niihau, Oahu, and Maui.

Figure 2-2 shows the primary existing facilities that would support the Proposed Action at PMRF and SNL/KTF.

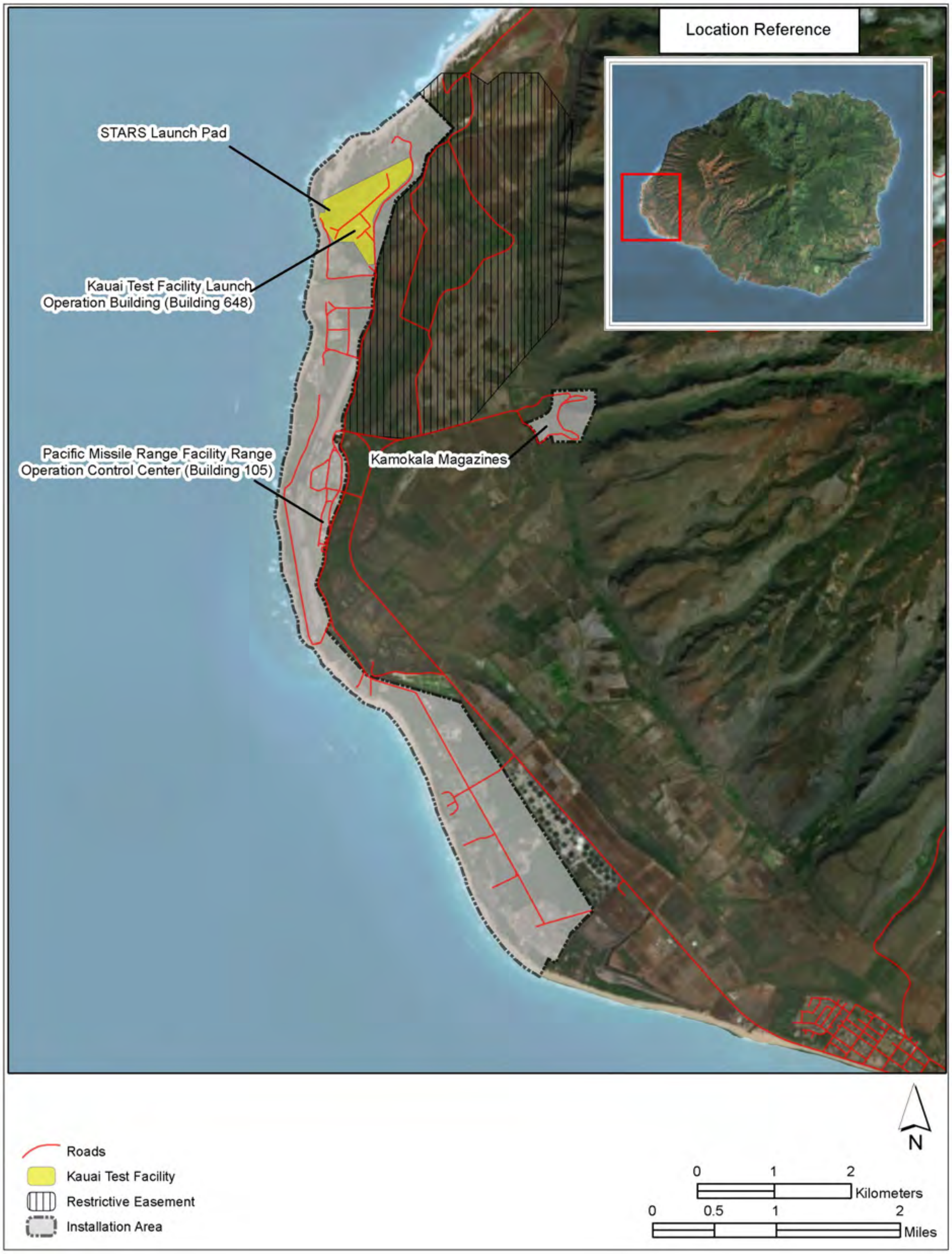


Figure 2-2. Primary Support Locations at PMRF and SNL/KTF

Prior to launch, routine activities would take place at SNL/KTF to prepare for flight testing. While working within the guidance and limitations of PMRF and SNL/KTF oversight, project personnel would execute ground equipment checkout, flight vehicle-to-booster assembly and checkout, and other preparations for flight testing. These activities would be directed by the U.S. Navy SSP representatives who would coordinate activities with PMRF, SNL/KTF, and other range organizations. All activities would use existing facilities and infrastructure systems. An existing modified 3,048-meter (m) (10,000-foot [ft]) Ground Hazard Area adjacent to PMRF would be used. Other launch supporting activities would include the following:

- Final motor and experiment assembly and integration
- Placement of missile on existing pad
- Mechanical and electrical checkouts (equipment tested, controls of electronic components-systems exercised before launch activities)
- Demonstration of system performance prior to launch
- Preflight checkouts, recommendations, consultation
- Advisory role throughout launch operations

As regular SNL routine operations for any launch at KTF, SNL personnel would also conduct various range responsibilities to ensure appropriate launch preparation, including explosive safety, support to PMRF range safety and inter-range coordination.

2.5.3.2 Alternative 2

WFF, located on the Eastern Shore of Virginia, United States, approximately 160 kilometers (km; 100 miles [mi]) north-northeast of Norfolk, is operated by the Goddard Space Flight Center in Greenbelt, Maryland, primarily as a rocket launch site to support science and exploration missions for NASA and other federal agencies. WFF includes an extensively instrumented range to support launches of more than a dozen types of sounding rockets, small expendable suborbital and orbital rockets, high-altitude balloon flights carrying scientific instruments for atmospheric and astronomical research, and—using its Research Airport—flight tests of aeronautical research aircraft including unmanned aerial vehicles.

WFF has been located on Wallops Island since its inception in 1945. The unique location on the coast, controlled airspace, adjacency to DOD Atlantic operational areas, and large hazard buffer zones, all contribute to the WFF launch range operating in a safe and effective manner. **Figure 2-3** shows the primary areas that would be used to support the Proposed Action.

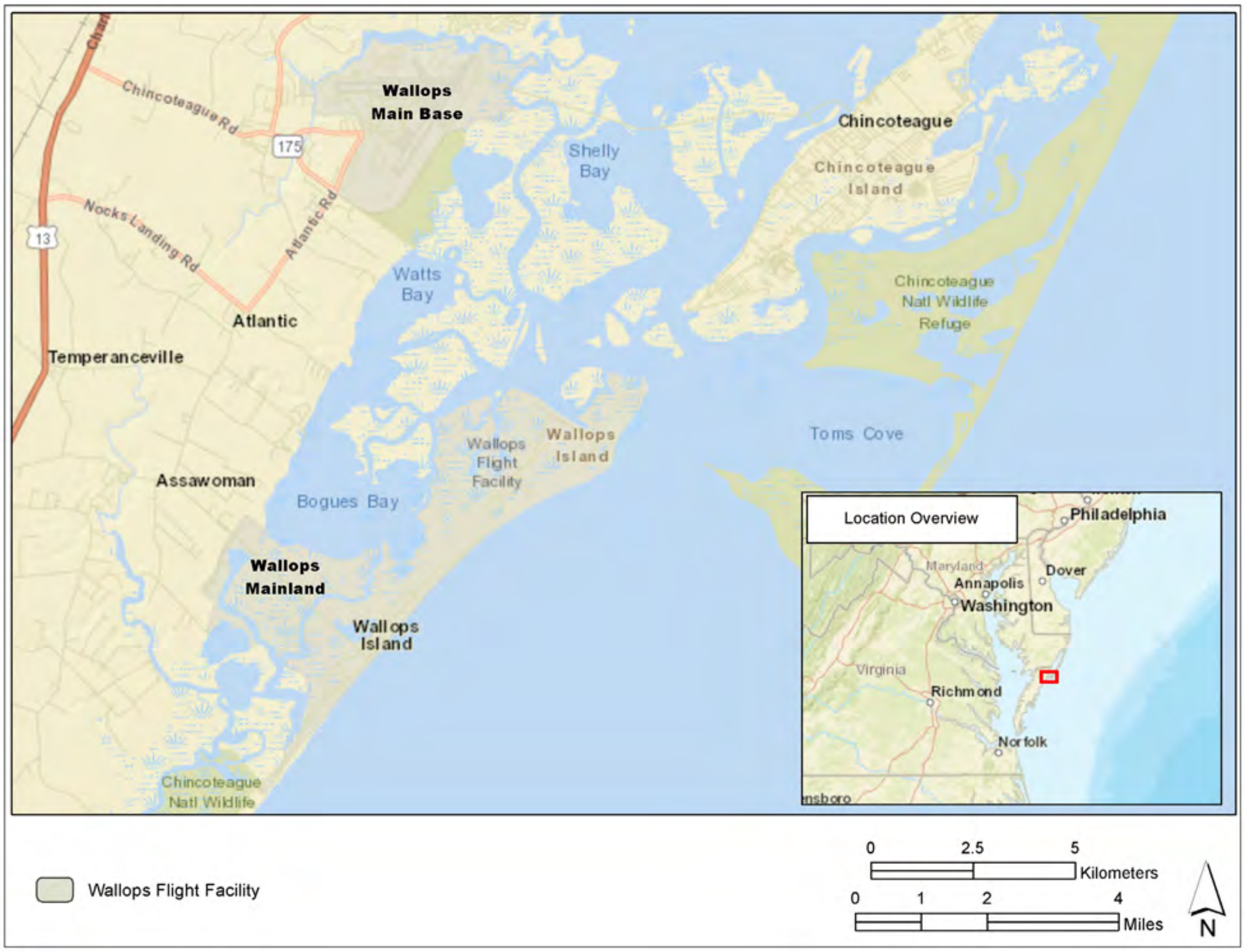


Figure 2-3. Location Map for WFF Support

Prior to launch, routine activities would take place at WFF to prepare for flight testing. While working within the guidance and limitations of WFF oversight, project personnel would execute ground equipment checkout, flight vehicle-to-booster assembly and checkout, and other preparations for flight testing. These activities would be directed by the U.S. Navy SSP representatives who would coordinate activities with WFF and other range organizations. All activities would use existing facilities and infrastructure systems. Other launch supporting activities would include the following:

- Final motor and experiment assembly and integration
- Placement of missile on existing pad
- Mechanical and electrical checkouts (equipment tested, controls of electronic components-systems exercised before launch activities)
- Demonstration of system performance prior to launch

- Preflight checkouts, recommendations, consultation
- Advisory role throughout launch operations

As regular WFF routine operations for any launch, WFF personnel would also conduct various range responsibilities to ensure appropriate launch preparation, including explosive safety, range safety, and inter-range coordination.

2.5.4 Terminal Location Preparations and Operations

2.5.4.1 Alternative 1

U.S. Army Garrison Kwajalein Atoll (USAG-KA) and RTS support of the FE-2 flight test would include base support, range safety, flight test support, and test instrumentation. The U.S. Navy SSP would ensure that all relevant personnel associated with the Proposed Action are fully briefed on the best management practices (BMP) and the requirement to adhere to them for the duration of the Proposed Action. All activities would comply with the UES (USASMDC/ARSTRAT 2018). A project-specific DEP would be prepared to present requirements and limitations.

The U.S. Navy developmental payload would impact at USAKA with three possible impact zone scenarios (**Figure 2-4**). Two of these scenarios would involve deep ocean impact, while the third zone would involve a land impact. The first possible impact zone would be in the deep-water region southwest of Illeginni Islet. This zone would have an approximate area of 488 m by 244 m (1,600 ft by 800 ft) (**Figure 2-4**). The second possible impact location would be a land impact on Illeginni Islet. This zone is approximately a 290 m by 137 m (950 ft by 450 ft) area on the northwest end of the islet, as limited by available land mass. The third possible impact zone would be within the Kwajalein Missile Impact Scoring System (KMISS) area southeast of Gagan Islet and would have an approximate area of 2,400 m by 366 m (7,874 ft by 1,200 ft). The mission planning process would avoid to the maximum extent possible all potential risks to environmentally significant areas. All actual impact zones would be sized based on range safety requirements and chosen as part of the mission analysis process. Range safety issues would also be part of selecting the impact scenario. For the deep-water impact zone to the northeast of Kwajalein Atoll, the use of the existing KMISS would be factored into the final data collection architecture.

Deep Water Impact Zones

For a nominal mission, it is anticipated that up to 4 weeks of increased activities would be required for either of the deep-water impact zones. Included among these activities are:

- Set up mobile terminal area scoring using an ocean-going tug to tow and set up a station-keeping barge
- Deploy landing craft mechanized, landing craft utility (LCU), and Lawrence Livermore National Laboratory (LLNL) Independent Diagnostic Scoring System (LIDSS)-type rafts (as many as a dozen)
- Deploy telemetry assets

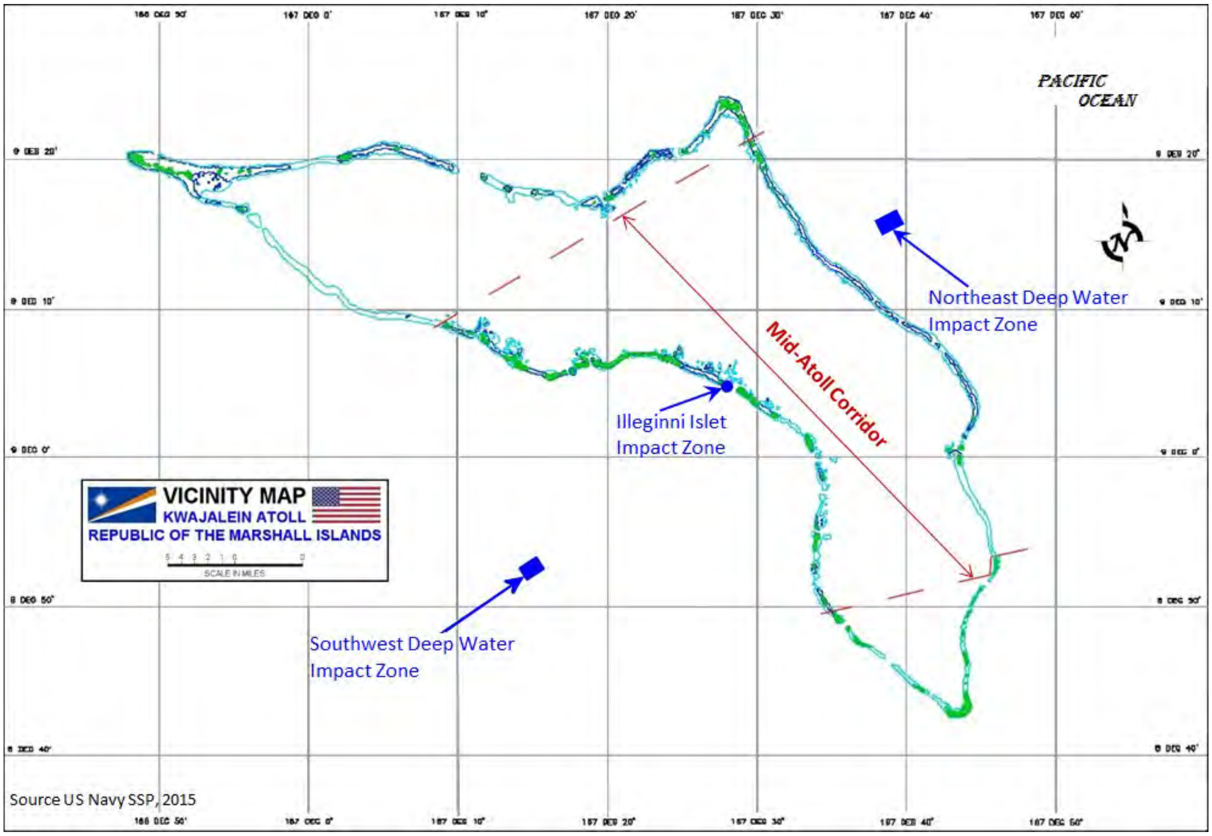


Figure 2-4. Notional Impact Areas in the Vicinity of Kwajalein Atoll

The main instrumentation raft would be supplemented with the LIDSS self-stationing rafts with associated radar, acoustic, and optical sensors. The main instrumentation raft includes considerations for maritime safety (e.g., running lights and station-keeping), international policy (e.g., no intentional ocean dumping should the instrumentation raft be inadvertently struck during the conduct of the mission), and visual deterrents to birds loafing or resting on the raft (e.g., scarecrows, mylar flags, helium-filled balloons, and strobe lights). It is anticipated that the instrumentation suite would be installed on the raft at the dock prior to being deployed to the test support location. After transit, it is expected that the raft would remain on station for up to 2 weeks while waiting for the test to occur.

The self-stationing rafts generally use twin battery-powered trolling motors for differential thrust navigation and station-keeping to ensure proper positioning for the flight impacts. Power to the trolling motors is provided by marine gel-cell batteries. None of the rafts would require an anchoring system. These rafts would also be outfitted and checked out at port prior to being emplaced for the test. This emplacement would also occur from the same sea craft that tows the main instrumentation raft to the test support location.

During ocean travel to and from impact and test support areas, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes and would report any observations (including location, date, time, species or taxa, and number of individuals) to the USAG-KA Environmental Engineer who would maintain records of these observations and report sightings to NMFS and/or USFWS. Vessel operators would also adjust their speed or raft deployment based on expected animal densities, and on lighting and turbidity conditions. Any marine mammal or sea turtle sightings during overflights or ship travel would be reported to the USAG-KA Environmental Engineer, the RTS Range Directorate, and the Flight Test Operations Director for consideration in approving the launch. Vessel operations, particularly in the BOA, would only occur when weather and sea conditions are acceptable for safe travel. Vessel operations would not involve any intentional ocean discharges of fuel, toxic wastes, or plastics and other solid wastes that could potentially harm marine life.

Illeginni Land Impact

For the Proposed Action at Illeginni Islet, activities would include several vessel round-trips and helicopter trips. Additionally, raft-borne sensors would be deployed and recovered on both the ocean and lagoon sides. There would also be increased human activity on Illeginni Islet that would involve up to 24 persons over a 3-month period. Heavy equipment placement and use would occur at times.

For the Illeginni Islet vicinity scenario, the proposed impact point for the U.S. Navy SSP payload would be in the non-forested area to avoid affecting the bird habitat (**Figure 2-5**). A reef or shallow water impact is not part of the Proposed Action, would be unintentional, and is unlikely.

Up to four radars that fit within a 24-inch by 15-inch by 6-inch container would be placed within the impact area. These radars are powered by shore/generator power. The impact area would be searched for black-naped tern nests and chicks prior to any pre-flight equipment mobilization. Any discovered nests would be covered with an A-frame structure per USFWS guidance. The area would be monitored to ensure no black-naped tern nests are disturbed when heavy equipment would position diagnostic equipment. To prevent birds from nesting on the support equipment after initial setup, the equipment would be appropriately covered with tarps or other materials and “scare” techniques (e.g., scarecrows, mylar ribbons, and/or flags) would be used on or near the equipment. Additionally, radars could be placed on previously disturbed areas on Illeginni Islet outside the impact area to gather information on the payload.

Figure 2-5. Potential Land Impact Area on Illeginni Islet

For at least 8 weeks preceding the FE-2 flight test launch, Illeginni Islet would be surveyed by qualified persons for sea turtles, sea turtle nesting activity, and sea turtle nests. If possible, these persons would also inspect the area within days of the launch. On-site personnel and in vessels traveling to and from Illeginni Islet would report any observations of sea turtles or sea turtle nests on Illeginni Islet (including location, date, time, species, and number of individuals) to the USAG-KA Environmental Engineer who would maintain records of these observations and report sightings to USFWS. During travel to and from impact zones, including Illeginni Islet, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.

In addition to land-based and sensor vessel support, up to 12 LIDSS rafts with onboard optical, acoustical, and/or radar sensors (**Figure 2-6**) may be placed in the Kwajalein Atoll lagoon near Illeginni Island. Within a day of the flight test, one or two of the range LCU vessels would be used to deploy the rafts. The rafts would be equipped with battery-powered electric motors for propulsion to maintain position in the water. Sensors on the rafts would collect data during the payload's descent until impact.

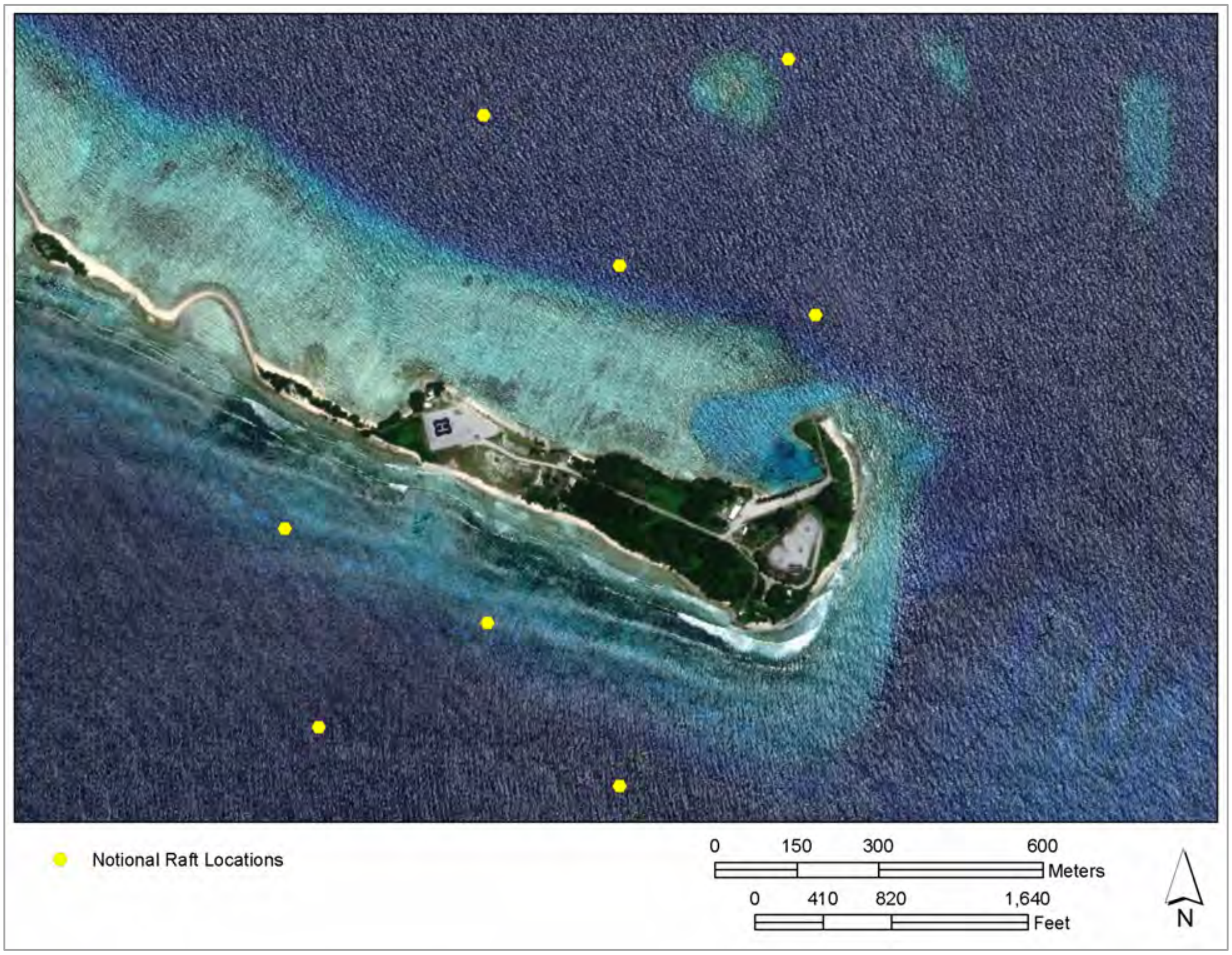


Figure 2-6. Notional Locations of Precision Scoring Augmentation Rafts

To ensure the safe conduct of flight testing, a Mid-Atoll Corridor Impact Area has been established across the mid-section of the Atoll (**Figure 2-4**). When a test is to occur in this area, a number of strict precautions are taken to protect personnel. Such precautions may consist of evacuating nonessential personnel and sheltering all other personnel remaining within the Mid-Atoll Corridor. Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs) are published and circulated in accordance with established procedures to provide warning to persons, including native Marshallese citizens, concerning any potential hazard areas that should be avoided. For public notification within USAKA before any flight test occurs, standard practice is to distribute an announcement from Kwajalein Islet regarding the upcoming mission that is then provided to the public in Marshallese and English on the Roller and in radio announcements. Additionally, notices of upcoming missions are provided by the U.S. Embassy to the Government of the RMI (GRMI) for the GRMI to distribute. A fact sheet describing the project and the environmental controls would be prepared in English and Marshallese and would be provided at locations on Ebeye and Kwajalein Islets. Radar and visual sweeps of the hazard area are accomplished immediately prior to test flights to ensure the clearance of non-critical personnel.

During travel to and from impact zones, including Illeginni Islet, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions and would report any observations (including location, date, time, species or taxa, and number of individuals) to the USAG-KA Environmental Engineer who would maintain records of these observations and report sightings to NMFS and/or USFWS.

2.5.4.2 Alternative 2

Self-stationing sensor rafts, deployed from a support ship, would be placed around the targeted site in the BOA to record and measure payload impacts. The support ship would then sail outside the target safety zone. Shipboard and other radars and sensors on the support ship would also gather information on the FE-2 flight test during terminal flight and impact. For a nominal mission, it is anticipated that up to 4 weeks of increased activities would be required. Included among these activities are:

- Set up mobile terminal area scoring
- Deploy the LIDSS-type rafts at the impact area (as many as a dozen)
- Deploy telemetry assets

The support ship would be supplemented with the LIDSS self-stationing rafts with associated radar, acoustic, and optical sensors. It is anticipated that the instrumentation suite would be installed on the support ship prior to being deployed to the test support location. After transit, it is expected that the support ship would remain on station for up to 2 weeks while waiting for the test to occur.

The self-stationing LIDSS rafts generally use twin battery-powered trolling motors for differential thrust navigation and station-keeping to ensure proper positioning for the flight impacts. Power to the trolling motors is provided by marine gel-cell batteries. None of the rafts would require an anchoring system. These rafts would also be outfitted and checked out at port prior to being emplaced for the test. This emplacement would also occur from the same sea craft that tows the main instrumentation raft to the test support location.

During travel to and from impact zones, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.

2.5.5 Flight Test

2.5.5.1 Alternative 1

Flight testing activities would include the launch from the SNL/KTF and the impact of the payload at RTS. Following motor ignition and liftoff from the launch location, the first-stage motor would burn out downrange and separate from the second stage. Farther into flight, the second-stage would also burn out and separate, with the shroud assembly also being jettisoned prior to third stage ignition. Farther into flight, the third-stage would also burn out and separate from the payload. Splashdown of all three spent motor stages and the shroud assembly would occur at different points in the open ocean between 130 and 2,778 km (70 and 1,500 nautical miles [nm]) from the launch pad. **Figure 2-7** depicts the rocket motor drop zones for the launches from KTF toward USAKA.

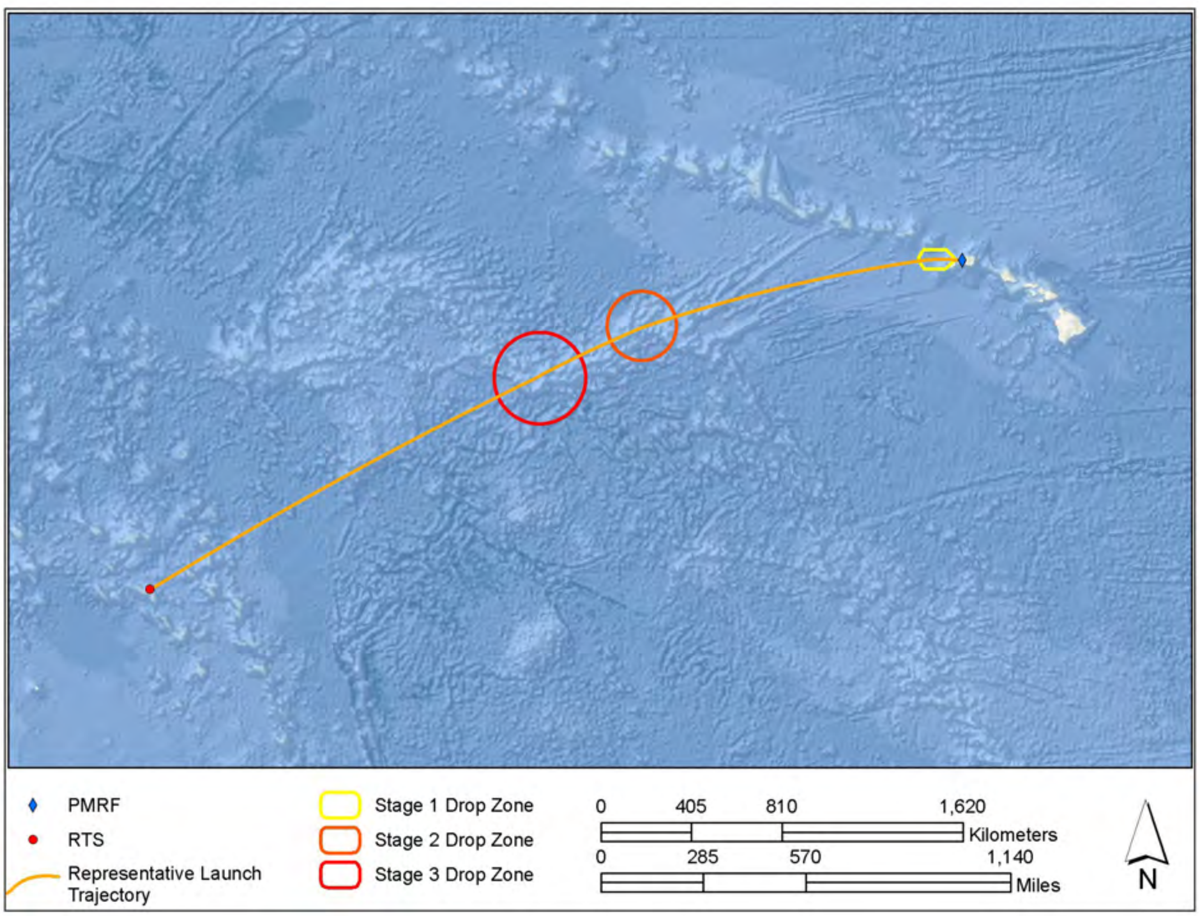


Figure 2-7. Representative Trajectory and Drop Zones for Jettisoned Objects – Alternative 1

The booster would fly in a southwesterly direction from PMRF in the Hawaiian Islands. Jettison of the fairing and separation of the payload would occur outside the atmosphere, and the payload's flight path would avoid flying over the Northwestern Hawaiian Islands. The payload would fly toward pre-designated target sites at Illeginni Islet or in the Offshore Waters. If data from payload onboard sensors indicate that there is insufficient energy to reach the target area, the payload could be directed to descend in a controlled termination of the test flight into the over-ocean flight corridor BOA.

Flight Safety

If the launch vehicle were to deviate from its course or should other problems occur during flight that might jeopardize public safety, the onboard flight termination system (FTS) would be activated. This action would initiate a predetermined safe mode for the vehicle, causing it to fall towards the ocean and terminate flight. No inhabited land areas would be subject to unacceptable risks of falling debris. Computer-monitored destruct lines, based on no-impact lines, are pre-programmed for the flight safety software to avoid any debris falling on inhabited areas, as per Space System Software Safety Engineering protocols and U.S. range operation standards and practices. In accordance with U.S. range operation standards, the risk of casualty (probability for serious injury or death) from falling debris for an individual of the general public cannot exceed 1 in 1,000,000 during a single flight test or mission (Range Commanders Council [RCC] 2017).

In addition to the commanded FTS operation, an FTS on the payload would include a failsafe operation to further ensure the safety of the Marshall Islands. This failsafe requires positive action to be taken by range safety personnel to allow the payload to continue flight to the vicinity of Illeginni Islet. Data would be transmitted to range safety personnel to allow a complete evaluation of the "health" of the FTS and the performance of the payload against the safety criteria.

The FTS also would contain logic to detect a premature separation of the booster stages and initiate a thrust termination action on all of the prematurely separated stages. Thrust would be terminated by initiation of an explosive charge to vent the motor chamber, releasing pressure and significantly reducing propellant combustion. This action would stop the booster's forward thrust, causing the launch vehicle to fall along a ballistic trajectory into the ocean.

The FTS would be designed to prevent any debris from falling into any protected area.

Sensor Coverage

The flight path would essentially be the same as that analyzed in the *Final Environmental* Assessment*/Overseas Environmental Assessment for Flight Experiment-1 (FE-1), 2017.* A series of sensors would overlap coverage of the flight from launch at KTF until impact at USAKA. The sensors would include:

- Ground based optics, telemetry, and radars at PMRF
- Sea based sensors include the Mobile At-Sea System (MATSS), the Range Safety System onboard the U.S. Motor Vessel *Pacific Collector*, and the Pacific Tracker.

- Additional airborne and waterborne sensors on military or commercial aircraft are not planned as part of the FE-2 flight test. Other agencies might collect data on FE-2 for their own purposes, but these extra sensors are speculative and outside the scope of this EA/OEA.

All of these sensors are existing programs and would be scheduled for use based on availability.

2.5.5.2 Alternative 2

For the flight test, the booster would lift off from WFF and fly in an east or southeasterly direction from WFF. Jettison of boosters and of the fairing and separation of the payload would occur outside the atmosphere over the Atlantic Ocean. The flight path would be designed to avoid any impacts to Bermuda. The payload would fly toward pre-designated target sites in the BOA. If data from payload onboard sensors indicate that there is insufficient energy to reach the target area, the payload could be directed to descend in a controlled termination of the test flight into the over-ocean flight corridor BOA. **Figure 2-8** depicts the notional trajectories and drop zones in the Atlantic.

Flight Safety

Flight safety would be similar to that described for Alternative 1.

Sensor Coverage

A series of sensors would overlap coverage of the flight from launch at WFF until impact in the BOA. The sensors to be included are similar to those in Alternative 1 and include:

- Ground based optics, telemetry and radars at WFF and on Bermuda.
- Sea based sensors include ship-based mobile instrumentation.
- Safety Relay aircraft may be used as additional range safety support "off-axis" to ensure public safety. Takeoff and landing operations would be required at the WFF or another airfield. These activities could occur in the day or night.
- Additional airborne and waterborne sensors on military or commercial aircraft are not planned as part of the FE-2 flight test. Other agencies might collect data on FE-2 for their own purposes, but these extra sensors are speculative and outside the scope of this EA/OEA.
- All sensors would be existing programs and would be scheduled for use based on availability.

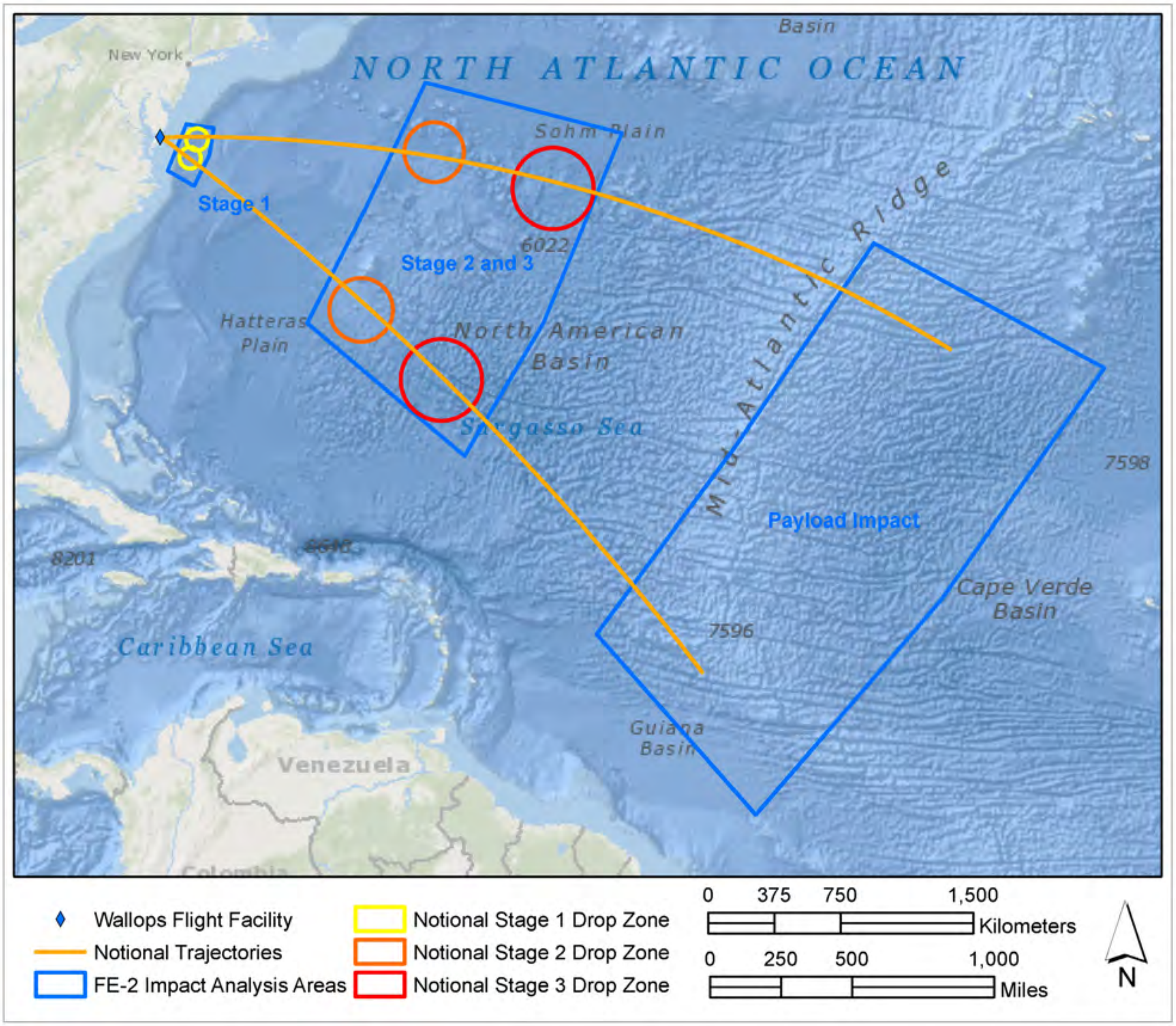


Figure 2-8. Representative Trajectories and Maximum Expected Drop Zones for all Jettisoned and Impact Objects – Alternative 2

2.5.6 Post Flight Test Operations

2.5.6.1 Alternative 1

At the launch location on SNL/KTF, the launch pad area would be checked for safe access after vehicle liftoff. Post-launch activities would include inspection of the launch pad facilities and equipment for damage, as well as general cleanup and performance of maintenance and repairs necessary to accommodate launches for other programs. The expended rocket motors and other vehicle hardware would not be recovered from the ocean following flight.

For the deep-water impact zone scenarios, the proposed impact would occur in the deep ocean waters surrounding the Kwajalein Atoll. No residual debris is expected following impact; however, a recovery team would be sent to inspect the impact location as soon as range safety clears the area. The deep-water areas surrounding the Kwajalein Atoll are too deep to allow safe recovery of any hardware that might survive the impact with the water and still have sufficient mass to sink. Visible debris still on the surface of the water would be recovered and removed. Within either deep-water impact zone, the self-stationing rafts and the large instrumentation raft would be recovered, and the data collected for analysis.

The payload debris would include numerous items including tungsten as listed in **Table 2-2.** Exact quantities of tungsten are unknown at this time and are not expected before the EA/OEA is completed. To provide an appropriate conservative assessment, a quantity of up to 454 kg (1,000 lb) of tungsten alloy is used for the environmental impact analysis. Vehicle impacts from other tests have occurred within the Kwajalein Atoll lagoon, on and in the vicinity of Illeginni Islet, and in the deep-water impact zones near RTS, USAKA. These and other actions within the geographical scope of this EA/OEA have undergone environmental analysis and review, which is provided in **Section 1.3**, Related Environmental Documentation, and the analyses all resulted in FONSIs.

On land, the impact could form a crater. Should the FE-2 impact in areas adjacent to the existing paved helipad at Illeginni Islet, soil containing residual concentrations of beryllium and depleted uranium from prior intercontinental ballistic missile (ICBM) flight tests could be scattered over the area. Prior to debris recovery and cleanup actions on Illeginni Islet, unexploded ordnance (UXO) personnel would first inspect the impact crater and surrounding area for any residual explosive materials. Test support personnel would conduct an impact assessment and cleanup and recovery operations once the site is clear for safe entry.

Following completion of the impact area assessment, personnel would manually recover FE-2 debris from land and, if present, from surrounding shallow waters (less than 180 ft or 55 m deep) as reasonably possible. The impact area would be wetted with freshwater to stabilize the disturbed soil. The impact crater would be excavated using a backhoe or front-end loader transported to the island by an LCU, and the excavated material would be screened to recover debris. Following debris removal, the crater would be backfilled and, if necessary, repairs made to surrounding structures. USAG-KA and RTS personnel would be involved in these operations. Accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be appropriately stored and returned to Kwajalein Islet for proper disposal. Following cleanup and repairs to the Illeginni Islet site, soil samples would be collected at various locations around the impact area and tested for pertinent contaminants.

Visible debris would be removed following any unintentional shallow water impact that would need to be recovered. Post-test debris recovery and cleanup operations on Illeginni Islet could cause some short-term disturbance to small areas of migratory bird habitat and possibly to coral reef habitat. Post-survey monitoring would be conducted to observe any impacts to adult black-naped terns of their nests. Results of the monitoring would be reported to the USAG-KA Environmental Engineer to provide to USFWS.

When feasible, within 1 day after the land impact test at Illeginni Islet, USAG-KA environmental staff would survey the islet and the near-shore waters for any injured wildlife, damaged coral, or damage to sensitive habitats. For recovery and rehabilitation of any injured migratory birds or sea turtles found at Illeginni Islet, USFWS and NMFS would be notified to advise on best care practices and qualified biologists would be allowed to assist in recovering and rehabilitating any injured sea turtles found. During inspections of the islet and near-shore waters, USAG-KA environmental staff would assess any sea turtle mortality. Any impacts to biological resources would be reported to the Appropriate Agencies, with USFWS and NMFS offered the opportunity to inspect the impact area to provide guidance on mitigations.

If an inadvertent impact occurs on the reef, reef flat, or in shallow waters less than 3 m (10 ft) deep, an inspection by project personnel would occur within 24 hours. Representatives from NMFS and USFWS would also be invited to inspect the site as soon as practical after the test. The inspectors would assess any damage to coral and other natural and biological resources and, in coordination with SSP, USAG-KA and RTS representatives, decide on any response measures that may be required. Payload recovery/cleanup operations and removal of surface floating debris in the lagoon and ocean reef flats, within 150 to 300 m (500 to 1,000 ft) of the shoreline, would be conducted similarly to land operations when tide conditions and water depth permit. A backhoe would be used to excavate any crater. Excavated material would be screened for debris and the crater would be back-filled with material ejected around the rim of the crater. Following removal of all experiment items and any remaining debris from the impact area, all waste materials would be returned to Kwajalein Islet for proper disposal.

Should the payload inadvertently impact in the deeper waters of the Atoll lagoon (up to approximately 55 m [180 ft]), a dive team from USAG-KA or RTS would be brought in to conduct underwater searches. Due to the potential presence of coral reef development on the deep lagoon bottom, NMFS would be notified of an inadvertent impact in lagoon waters and a remotely operated vehicle (ROV) video or dive inspection would be conducted to evaluate the presence of UES consultation species. If UES consultation species were found at a lagoon bottom impact site, recovery efforts would be coordinated with NMFS. Using a ship for recovery operations, the debris field would be located and certified divers in scuba gear would attempt to recover the debris manually. If warranted due to other factors, such as significant currents or mass of the debris to be recovered, the recovery team would consider the use of remotely operated vehicles instead of divers.

In general, payload recovery operations would not be attempted in deeper waters on the ocean side of the Atoll. Searches for debris would be attempted out to depths of up to 55 m [180 ft]). An underwater operation similar to a lagoon recovery (including inspection for benthic UES consultation species) would be used if debris were located in this area.

The U.S. Navy and USASMDC performed a bench study to measure the dissolution and potential for migration of the tungsten alloy in Illeginni Islet soils to inform future biological resources analyses of any potential effects (LLNL 2017, U.S. Navy 2017a). LLNL prepared a report detailing the sampling and analysis of materials from Illeginni Islet. Samples were collected in July and November 2017 and February 2018. Additional work initiated by LLNL on Illeginni Islet includes soil sampling, groundwater monitoring, well installation, and groundwater sampling. These efforts will help to establish baseline uranium, beryllium, and tungsten concentrations in soil and groundwater for comparison to future sample results; and to establish whether current uranium, beryllium, and tungsten concentrations are sufficient to present an unacceptable risk to human health. (LLNL 2018) The results of this work are discussed further in Chapter 3.0, Affected Environment and Chapter 4.0, Environmental Consequences.

In accordance with the Final Biological Opinion (**Appendix C**) provided by NMFS on 27 September 2019, the following reasonable and prudent measures would be necessary and appropriate to minimize impacts of the Proposed Action and monitor levels of incidental take. The measures described below are non-discretionary and must be undertaken in order for the Incidental Take Statement to apply. (NMFS 2019a)

1. The U.S. Navy SSP shall reduce impacts on UES-protected corals, top shell snails, clams and their habitats through the employment of BMP and conservation measures.
2. The U.S. Navy SSP shall record and report all action-related take of UES-consultation species.

The U.S. Navy SSP must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To meet reasonable and prudent measure 1 above, the U.S. Navy SSP shall ensure that their personnel comply fully with the BMP and conservation measures identified in the Biological Assessment (U.S. Navy and USASMDC 2017) and below.

    a. The U.S. Navy SSP shall ensure that all relevant personnel associated with this project are fully briefed on the BMP and the requirement to adhere to them for the duration of this project.

    b. In the event the payload impact affects the reef at Illeginni Islet, the U.S. Navy SSP shall require its personnel to secure or remove from the water any substrate or coral rubble from the ejecta impact zone that may become mobilized by wave action as soon as possible.

        i. Ejecta greater than 6 inches in any dimension shall be removed from the water or positioned such that it would not become mobilized by expected wave action, including replacement in the payload crater.

ii. If possible, coral fragments greater than 6 inches in any dimension shall be positioned on the reef such that they would not become mobilized by expected wave action, and in a manner that would enhance its survival; away from fine sediments with the majority of the living tissue (polyps) facing up.

iii. UES consultation coral fragments that cannot be secured in-place should be relocated to suitable habitat where it is not likely to become mobilized.

c. In the event the payload impact affects the reef at Illeginni Islet, the U.S. Navy SSP shall require its personnel to reduce impacts on top shell snails.

i. Rescue and reposition any living top shell snails that are buried or trapped by rubble.

ii. Relocate to suitable habitat any living top shell snails that are in the path of any heavy equipment that must be used in the marine environment.

d. In the event the payload land impact affects the reef at Illeginni Islet, the U.S. Navy SSP shall require its personnel to reduce impact on clams.

iii. Rescue and reposition any living clams that are buried or trapped by rubble.

iv. Relocate to suitable habitat any living clams that are in the path of any heavy equipment that must be used in the marine environment.

2. To meet reasonable and prudent measure 2 above:

a. The U.S. Navy SSP shall assign appropriately qualified personnel to record all suspected incidences of take of any UES-consultation species.

b. The U.S. Navy SSP shall utilize digital photography/videography to record any UES-consultation species found injured or killed in or near the ocean target areas and/or at Illeginni Islet. As practicable: (1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; (2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and (3) Record the location of the photograph.

c. In the event the payload impact affects the reef at Illeginni Islet, the U.S. Navy SSP shall require its personnel to survey the ejecta field for impacted corals, top shell snails, and clams. The personnel shall also be mindful for any other UES-consultation species that may have been affected.

d. Within 60 days of completing post-test clean-up and restoration, provide photographs/ videos and records to the USAG-KA environmental office. USAG-KA and NMFS biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible to assess impacts on consultation species.

e. Within 6 months of completion of the action, USAG-KA will provide a report to NMFS. The report shall identify: (1) The flight test and date; (2) The target area; (3) The results of the pre- and post-flight surveys; (4) The identity and quantity of affected resources (include photographs and videos as applicable); and (5) The disposition of any relocation efforts.

Reinitiating formal consultation would be required where discretionary federal agency involvement or control over the action has been retained or is authorized by law, and if:

1. The amount or extent of anticipated incidental take is exceeded;
2. New information reveals that the action may affect UES-protected marine species or critical habitat in a manner or to an extent not considered in the NMFS Final Biological Opinion;
3. The action is subsequently modified in a manner that may affect UES-protected marine species or critical habitat to an extent, or in a manner not considered in the NMFS Final Biological Opinion; or
4. A new species is listed, or critical habitat designated that may be affected by the action.

2.5.6.2 Alternative 2

At the launch location on WFF, the launch pad area would be checked for safe access after vehicle liftoff. Post-launch activities would include inspection of the launch pad facilities and equipment for damage, as well as general cleanup and performance of maintenance and repairs necessary to accommodate launches for other programs. The expended rocket motors and other vehicle hardware would not be recovered from the ocean following flight.

The proposed impact would occur in the deep Atlantic Ocean waters. No residual debris is expected following impact; however, a support asset would be sent to inspect the impact location as soon as range safety clears the area. The impact area is too deep to allow safe recovery of any hardware that might survive the impact with the water and still have sufficient mass to sink. Visible debris still on the surface of the water would be recovered and removed. The payload debris would include numerous items including tungsten as shown on **Table 2-2**. Exact quantities of tungsten are unknown at this time and are not expected before the EA/OEA is completed. In order to provide an appropriate conservative assessment, a quantity of up to 454 kg (1,000 lb) of tungsten alloy is used for the environmental impact analysis.

2.6 Alternatives Considered But Not Carried Forward for Detailed Analysis

The following alternatives were considered, but not carried forward for detailed analysis in this EA/OEA as they did not meet the purpose and need for the Proposed Action and satisfy the screening criteria / evaluation factors presented in **Section 2.2**. **Table 2-3** provides a summary of these alternatives and whether they meet the screening criteria.

Table 2-3. Alternatives Considered But Not Carried Forward and Screening Criteria

Potential Site	Screening Criteria				
	Site Infrastructure & Personnel Capabilities	Required Range Distance	Launch & Impact Locations Available	Launch & Impact Locations Range Safety	Launch & Impact Locations Security
Johnson Atoll to USAKA	No	No	No	No	No
Pacific Spaceport, AK to PMRF BOA	No (PMRF BOA)	Yes	No	Yes	Yes
PMRF to Farallon De Medinilla	No (Farallon De Medinilla)	No	No	No	No
Guam to BOA	No	Yes	No	No	No
Wake Island to Guam BOA	No	Yes	No	Yes	Yes
Guam to Wake Island BOA	No	Yes	No	No	No
RTS (Launch) to BOA	No	Yes	No	Yes	Yes
Pt Mugu / San Nicolas Island to BOA	No	Yes	No	No	Yes
Vandenberg AFB to BOA	No	Yes	No	Yes	Yes

2.6.1 Johnston Atoll

An alternative would be launching a STARS booster from Johnston Atoll with an impact in USAKA. Johnston Atoll is an unincorporated territory of the United States, currently administered by USFWS. The Atoll is managed as part of the Pacific Remote Islands Marine National Monument, established in 2009. It had been formerly under control of the U.S. DOD, but was closed in 2004. Johnston Atoll was the site of various missile launches in the past, but that capability no longer exists. This alternative would not meet the purpose of the Proposed Action because the launch equipment has not been used or maintained since the facility closed in 2004 and therefore would not meet performance requirements. The cost and schedule that would be needed to refurbish or replace the launch facilities would significantly delay the completion of the Proposed Action.

2.6.2 Pacific Spaceport Complex Alaska

An alternative to the flight test between KTF and USAKA would be to launch the STARS booster from the Pacific Spaceport Complex Alaska on the island of Kodiak, Alaska, with an impact in the BOA north of PMRF. This alternative would not meet the purpose of the Proposed Action because there are limited launch facility sensors and instrumentation to accommodate mission requirements. The cost and schedule that would be needed to provide mobile assets to satisfy the safety and diagnostic requirements of FE-2 would significantly delay the completion of the Proposed Action.

2.6.3 Farallon De Medinilla

Another alternative would be launching a STARS booster from KTF at PMRF with an impact in the Farallon De Medinilla in the Northern Marianna Islands. This alternative would not meet the purpose of the Proposed Action because the test would not meet mission requirements and there is no existing instrumentation at Farallon De Medinilla to collect data that could verify the payload performance in support of capability needs. The cost and schedule that would be needed to develop and test a new BOA instrumentation suite near Farallon De Medinilla would significantly delay the completion of the Proposed Action.

2.6.4 Guam

An alternative entailing a launch from Guam into the BOA east of Guam was considered. Guam hosts Naval Base Guam and Anderson AFB, under the command of Joint Region Marianas. However, there is currently no infrastructure at either base or elsewhere on the island to support rocket motor processing and launch operations. The cost and schedule that would be needed to develop and certify such infrastructure would significantly delay the completion of the Proposed Action and significantly exceed programmed resources.

2.6.5 Wake Island

Similar to Guam, an alternative to launch from Guam into the BOA west/southwest of Wake was considered. Wake Island is used for launching target missiles in support of MDA programs. Although there is some existing launch infrastructure on Wake Island, it would require significant augmentation to support motor processing and missile launch operations for the Proposed Action. Like Guam, the cost and schedule that would be needed to develop and certify such infrastructure would significantly delay the completion of the Proposed Action and significantly exceed programmed resources.

2.6.6 Reagan Test Site (as a Launch Site)

The MDA occasionally conducts missile launches from Meck Island, and an alternative was considered to use RTS as a launch site with an impact in the BOA to the north or east. However, the launch facility and missile processing facilities would require extensive augmentation to support the FE-2 mission. Moreover, the logistical effort to transport equipment and personnel to RTS would be significant compared to the proposed alternative. Like Wake and Guam, the cost and schedule that would be needed to develop and certify such infrastructure would significantly delay the completion of the Proposed Action and significantly exceed programmed resources.

2.6.7 Pt. Mugu/San Nicolas Island

San Nicolas Island currently hosts missile launches and was considered as an alternative for launching FE-2. However, the STARS booster is Class 1 propellent and the San Nicolas infrastructure is not adequate to meet the safety restrictions associated with this class of propellant.

2.6.8 Vandenberg Air Force Base

Vandenberg Air Force Base (VAFB) currently supports U.S. Air Force ICBM launches as well as space launch orbital missions. However, the potential launch locations would not be available to support the FE-2 schedule. In addition, lack of required STARS-specific site infrastructure precludes VAFB as a launch site at this time.

3.0 Affected Environment

This chapter describes the environmental conditions that could be affected by the Proposed Action and No Action Alternatives. In compliance with NEPA, CEQ, and 32 CFR Part 775 guidelines, the information and data presented are commensurate with the importance of the potential impacts to provide the proper context for evaluating such impacts. Sources of data used and cited in the preparation of this chapter include past EAs and EISs, environmental resource documents and other related environmental studies, installation and facility personnel, and regulatory agencies.

3.1 Pacific Missile Range Facility/Kauai Test Facility

This section includes descriptions of the affected environment for air quality, water resources, biological resources, airspace, noise, public health and safety, and hazardous materials and wastes at the PMRF/KTF launch site.

The potential impacts to the following resource areas are considered to be negligible or non-existent, so they were not analyzed in detail in this EA/OEA:

Geological Resources: The Navy FE-2 flight test requires no ground-disturbing activities; thus, no impacts to geological resources would be expected.

Cultural Resources: The Navy FE-2 flight test requires no ground-disturbing activities; thus, no impacts to cultural resources would be expected.

Land Use: The Navy FE-2 flight test represents activities that are consistent with the mission and well within the limits of current operations of both PMRF and KTF. Thus, there would be no adverse effects on land use.

Infrastructure: The Navy FE-2 flight test represents activities that are consistent with the mission and well within the limits of current operations of both PMRF and KTF. Thus, there would be no adverse effects on infrastructure.

Transportation: The Navy FE-2 flight test represents activities that are consistent with the mission and well within the limits of current transportation operations of both PMRF and KTF. Thus, there would be no adverse effects on transportation.

Socioeconomics: There would be little increase in personnel on base; thus no socioeconomic concerns are anticipated. Any increase would be temporary and only for the duration of the Proposed Action.

Environmental Justice: The Navy FE-2 flight test includes a launch trajectory, range safety regulations and procedures, and dispersing of noise over a wide area that precludes disproportionate impacts to minority populations and low-income populations under EO 12898.

Visual Resources: The Navy FE-2 flight test does not require any new construction, and the visual aesthetics of PMRF and KTF would not be changed.

Marine Sediments: The Navy FE-2 flight test does not require any new construction and the marine sediments of PMRF and KTF would not be changed.

3.1.1 Air Quality (PMRF/KTF)

This discussion of air quality includes criteria pollutants, standards, sources, permitting and greenhouse gases. Air quality in a location is defined by the concentration of various pollutants in the atmosphere. A region's air quality is influenced by many factors including the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions.

Most air pollutants originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Air pollutants are also released from natural sources such as volcanic eruptions and forest fires.

3.1.1.1 Regulatory Setting

Criteria Pollutants and National Ambient Air Quality Standards

The principal pollutants defining the air quality, called "criteria pollutants," include carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, suspended particulate matter less than or equal to 10 microns in diameter (PM_{10}), fine particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead. carbon monoxide, sulfur dioxide, lead, and some particulates are emitted directly into the atmosphere from emissions sources. Ozone, nitrogen dioxide, and some particulates are formed through atmospheric chemical reactions that are influenced by weather, ultraviolet light, and other atmospheric processes.

Under the CAA, the USEPA has established National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) for these pollutants. NAAQS are classified as primary or secondary. Primary standards protect against adverse health effects; secondary standards protect against welfare effects, such as damage to farm crops and vegetation and damage to buildings. Some pollutants have long-term and short-term standards. Short-term standards are designed to protect against acute, or short-term, health effects, while long-term standards were established to protect against chronic health effects.

Areas that are in compliance with the NAAQS are designated as attainment areas. Areas that violate a federal air quality standard are designated as nonattainment areas. Areas that have transitioned from nonattainment to attainment are designated as maintenance areas and are required to adhere to maintenance plans to ensure continued attainment.

The CAA requires states to develop a general plan to attain and maintain the NAAQS in all areas of the country and a specific plan to attain the standards for each area designated nonattainment for a NAAQS. These plans, known as State Implementation Plans (SIPs), are developed by state and local air quality management agencies and submitted to USEPA for approval.

In addition to the NAAQS for criteria pollutants, national standards exist for hazardous air pollutants (HAPs), which are regulated under Section 112(b) of the 1990 CAA Amendments. The *National Emission Standards for Hazardous Air Pollutants* regulate HAP emissions from stationary sources (40 CFR Part 61).

Mobile Sources

HAPs emitted from mobile sources are called Mobile Source Air Toxics (MSATs). MSATs are compounds emitted from highway vehicles and non-road equipment that are known or suspected to cause cancer or other serious health and environmental effects. In 2001, USEPA issued its first MSAT Rule, which identified 201 compounds as being HAPs that require regulation. A subset of six of the MSAT compounds was identified as having the greatest influence on health and included benzene, butadiene, formaldehyde, acrolein, acetaldehyde, and diesel particulate matter. More recently, USEPA issued a second MSAT Rule in February 2007, which generally supported the findings in the first rule and provided additional recommendations of compounds having the greatest impact on health. The rule identified several engine emission certification standards that must be implemented (40 CFR Parts 59, 80, 85, and 86; Federal Register Volume 72, No. 37, pp. 8427–8570, 2007). Unlike the criteria pollutants, there are no NAAQS for benzene and other HAPs. The primary control methodologies for these pollutants for mobile sources involves reducing their content in fuel and altering the engine operating characteristics to reduce the volume of pollutant generated during combustion.

General Conformity

The USEPA General Conformity Rule applies to federal actions occurring in nonattainment or maintenance areas when the total direct and indirect emissions of nonattainment pollutants (or their precursors) exceed specified thresholds. The emissions thresholds that trigger requirements for a conformity analysis are called *de minimis* levels. *De minimis* levels (in tons per year [tpy]) vary by pollutant and depend on the severity of the nonattainment status for the air quality management area in question. De minimis threshold emissions are presented in **Table 3-1**.

Permitting

The Title V Operating Permit Program consolidates all CAA requirements applicable to the operation of a source, including requirements from the SIP, preconstruction permits, and the air toxics program. It applies to stationary sources of air pollution that exceed the major stationary source emission thresholds, as well as other non-major sources specified in a particular regulation. Navy installations subject to Title V permitting shall comply with the requirements of the Title V Operating Permit Program, which are detailed in 40 CFR Part 70 and all specific requirements contained in their individual permits.

Table 3-1. General Conformity De minimis Levels

Pollutant	Area Type	TPY
Ozone (VOC or nitrogen oxides)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (nitrogen oxides)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
Carbon monoxide, sulfur dioxide, and nitrogen dioxide	All nonattainment and maintenance	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$ Direct emissions, sulfur dioxide, nitrogen oxides (unless determined not to be a significant precursor), VOC or ammonia (if determined to be significant precursors)	All nonattainment and maintenance	100
Lead (Pb)	All nonattainment and maintenance	25

Source: U.S. Navy 2018

Abbreviations: tpy = tons per year, VOC = volatile organic compounds

Greenhouse Gases

Greenhouse gases (GHGs) are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change associated with this global warming is predicted to produce negative economic and social consequences across the globe.

On 26 June 2019 the CEQ issued draft guidance on when and how federal agencies should consider GHG emissions and climate change in NEPA analyses. As stated in the guidance, a projection of a proposed action’s direct and reasonably foreseeable indirect GHG emissions may be used as a proxy for assessing potential climate effects. Agencies should attempt to quantify a proposed action’s projected direct and reasonably foreseeable indirect GHG emissions when the amount of those emissions is substantial enough to warrant quantification, and when it is practicable to quantify them using available data and GHG quantification tools. The amount of emissions from the FE-2 flight test is not substantial enough to warrant quantification, and GHG impacts will be analyzed qualitatively.

The USEPA issued the *Final Mandatory Reporting of Greenhouse Gases Rule* on September 22, 2009. GHGs covered under the *Final Mandatory Reporting of Greenhouse Gases Rule* are carbon dioxide, methane, nitrogen oxides, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. Each GHG is assigned a global warming potential. The global warming potential is the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to carbon dioxide, which has a value of one. The equivalent carbon dioxide rate is calculated by multiplying the emissions of each GHG by its global warming potential and adding the results together to produce a single, combined emissions rate representing all GHGs. Under the rule, suppliers of fossil fuels or industrial GHGs, manufacturers of mobile sources and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions as carbon dioxide equivalent are required to submit annual reports to USEPA.

Hawai`i's 2015 Greenhouse Gas Emissions Inventory states that, emissions from the energy sector accounted for the vast majority (more than 87%) of GHG emissions in Hawai`i. At 90% of the total, carbon dioxide is the largest single contributor to GHG emissions from in-state sources. (Hawaii Department of Health 2019)

The global annual temperature has increased at an average rate of 0.07 degrees Celsius [°C] (0.13 degrees Fahrenheit [°F]) per decade since 1880 and at an average rate of 0.17°C (0.31°F) per decade since 1970. The warmest global average temperatures on record have all occurred within the past 15 years, with the warmest years being 2010, 2013, 2014, and 2015 (NOAA 2016). With this in mind, the Navy has established energy targets to reduce GHG by 2020. The targets of significance to this EA/OEA include: (1) by 2020, half of the Navy's energy consumption (ashore and afloat) will come from alternative sources; (2) by 2020, half of Navy installations will be net-zero energy consumers, using solar, wind, ocean, and geothermal power generated on base; (3) by 2015, the Navy will cut in half the amount of petroleum used in Government vehicles through phased adoption of hybrid, electric, and flex fuel vehicles; and (4) effective immediately, Navy contractors will be held contractually accountable for meeting energy efficiency targets.

In an effort to reduce energy consumption, reduce GHGs, reduce dependence on petroleum, and increase the use of renewable energy resources, the Navy has implemented a number of renewable energy projects. The Navy has established fiscal year 2020 GHG emissions reduction targets of 34% from a FY 2008 baseline for direct GHG emissions and 13.5% for indirect emissions. Examples of Navy-wide GHG reduction projects include energy efficient construction, thermal and photovoltaic solar systems, geothermal power plants, and the generation of electricity with wind energy. The Navy continues to promote and install new renewable energy projects.

3.1.1.2 Region of Influence

Air quality in Hawai`i is defined with respect to compliance with primary and secondary NAAQS (40 CFR Part 50) established by the USEPA and adopted by the State of Hawai`i. The CAA (42 USC 7401-7671q), as amended, gives USEPA the responsibility to set safe concentration levels for six criteria pollutants: particulate matter measuring less than 10 and 2.5 microns in diameter

(PM_{10} and $PM_{2.5}$), sulfur dioxide, carbon monoxide, nitrogen oxides, lead, and 8-hour ozone (measured by its precursors, volatile organic compounds [VOCs] and nitrogen oxides).

For inert pollutants (all pollutants other than ozone and its precursors: VOCs and nitrogen oxides), the region of influence (ROI) is generally limited to an area extending several kilometers (miles) downwind from the source. Consequently, for the air quality analysis, the ROI for project activities is the existing airshed (the geographic area responsible for emitting 75% of the air pollution reaching a body of water) surrounding the various sites, which encompasses the KTF located on PMRF, Kauai, Hawai`i. The ROI for ozone may extend much farther downwind than the ROI for inert pollutants. As the project area has no heavy industry and relatively few automobiles, ozone and its precursors are not of concern. The ROI for ozone depleting gases and GHG emissions is global.

Climate

Weather is an important factor in the dispersion of air pollutants. PMRF is located just south of the Tropic of Cancer and has a mild and semi-tropical climate. Typical temperatures for the area are 27 to 29°C (80 to 84°F) during the day and 18 to 20°C (65 to 68°F) during the night. The trade winds are from the northeast and are typically light—mean trade winds between 29 to 34 kilometers per hour (18 to 21 miles per hour). Precipitation in the area averages 104 centimeters (cm; 41 inches [in]) annually. Most of the rain falls during the October through April wet season. Relative humidity is approximately 60% during the day throughout the year.

Regional Air Quality

Air quality data in Hawai`i are collected by the Hawai`i State Department of Health, Clean Air Branch. In 2015, the state maintained 14 air monitoring stations on 4 islands. In addition, Hawaiian Electric Company maintains stations on Oahu and the National Park Service maintains one station on Maui and one on Hawai`i. Between 2004 and 2013, of the monitored ambient air concentrations in the state only sulfur dioxide exceeded the annual average Ambient Air Quality Standards (AAQS). (Hawai`i State Department of Health, Clean Air Branch 2015). Therefore, Hawai`i is in attainment for all NAAQS.

USEPA's general air conformity rule applies to federal actions occurring in nonattainment or maintenance areas when the total indirect and direct emissions of the subject air pollutant exceed specific thresholds. An air conformity analysis is not required for the Proposed Action because as of 2015, the State of Hawai`i was in attainment for all NAAQS.

Existing Emission Sources

PMRF and KTF power is supplied by Kauai Island Utility Cooperative (KIUC) during non-testing times. KIUC is in the process of reducing power cost by decreasing use of imported fossil fuels and increasing the amount of energy generated from Kauai's own resources. The KIUC initiative is to generate 50 percent of its electricity from renewable sources by 2023. In 2016, 38 percent of the electricity generated on Kauai came from a mix of solar, hydropower, and biomass sources. On the sunniest days, 60 percent of Kauai's daytime energy needs are met by solar. (KIUC 2017)

The only major stationary sources of air emissions at PMRF are generators used by and permitted for PMRF/Main Base, KTF, the Advanced Radar Detection Laboratory, and the Aegis Ashore Missile Defense program during testing events and when electrical demand is high.

Stationary emission sources at PMRF include three 320-kilowatt (kW) and the two 600-kW generators that are operational in addition to the KIUC power system. These generators are covered under the PMRF Title V Noncovered Source Permit. The Title V permit controls the nitrogen dioxide and sulfur dioxide emissions from each generator by restricting the hours of use and limiting the diesel fuel supplied for the generators to ultra-low sulfur diesel with a sulfur content not to exceed 0.0015% by weight.

Stationary emission sources at KTF include two standby 320-kW diesel engine generators that are permitted for operation by the State of Hawai`i under a Non-covered Source Permit.

Mobile sources from PMRF-associated testing include aircraft, missile launches, diesel-fueled vehicles, and vehicular traffic. Aircraft are operated and supported at PMRF Airfield. Missile launches are a source of mobile emissions at PMRF. Currently, there are as many as 46 missile launches per year from PMRF and KTF, which includes launches of interceptor and target missiles. These systems use both solid and liquid propellants. The most common exhaust components for typical missiles include aluminum oxide, carbon dioxide, carbon monoxide, hydrogen, hydrogen chloride, nitrogen, water, ferric chloride, ferric oxide, nitric oxide, chlorine, and sulfur dioxide.

3.1.2 Water Resources (PMRF/KTF)

This section describes the existing water resource conditions at the proposed sites. Water resources include those aspects of the natural environment related to the availability and characteristics of water. For the purposes of this document, water resources can be divided into three main sections: surface water, groundwater, and flood hazard areas.

Surface water includes discussions of runoff, changes to surface drainage, and general surface water quality. Surface water resources generally consist of wetlands, lakes, rivers, and streams. Surface water is important for its contributions to the economic, ecological, recreational, and human health of a community or locale. A Total Maximum Daily Load (TMDL) is the maximum amount of a substance that can be assimilated by a water body without causing impairment. A water body can be deemed impaired if water quality analyses conclude that exceedances of water quality standards occur.

Groundwater discussions focus on aquifer characteristics, general groundwater quality and water supply. Groundwater is water that flows or seeps downward and saturates soil or rock, supplying springs and wells.

Wetlands are jointly defined by USEPA and USACE as “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetlands generally include "swamps, marshes, bogs and similar areas" (40 CFR Section 230.3[t] and 33 CFR Section 328.3[b]).

Where practicable, water resources are described quantitatively (volume, mineral concentrations, salinity, etc.); otherwise they are described qualitatively (good, poor, etc.) when necessary.

3.1.2.1 Regulatory Setting

Groundwater quality and quantity are regulated under several statutes and regulations, including the Safe Drinking Water Act.

The CWA establishes federal limits, through the National Pollutant Discharge Elimination System (NPDES) program, on the amounts of specific pollutants that can be discharged into surface waters to restore and maintain the chemical, physical, and biological integrity of the water. The NPDES program regulates the discharge of point (i.e., end of pipe) and nonpoint sources (i.e., storm water) of water pollution.

Waters of the United States are defined as (1) traditional navigable waters, (2) wetlands adjacent to navigable waters, (3) non navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow perennially or have continuous flow at least seasonally (e.g., typically 3 months), and (4) wetlands that directly abut such tributaries under Section 404 of the CWA, as amended, and are regulated by USEPA and the USACE. The CWA requires that Hawai`i establish a Section 303(d) list to identify impaired waters and establish TMDLs for the sources causing the impairment. Wetlands are currently regulated by the USACE under Section 404 of the CWA as a subset of all "Waters of the United States."

Flood potential of a site is usually determined by the 100-year floodplain, which is defined as the area that has a 1% chance of inundation by a flood event in a given year. All of PMRF Barking Sands and the Mana Plain up to the foothills are now in the Tsunami Evacuation Zone, which is coincident with the Federal Flood Hazard Zone (Burger 2017).

The CZMA of 1972 provides assistance to states, in cooperation with federal and local agencies, for developing land and water use programs in coastal zones. Section 307 of the CZMA stipulates that where a federal project initiates reasonably foreseeable effects to any coastal use or resource (land or water use, or natural resource), the action must be consistent to the maximum extent practicable with the enforceable policies of the affected state's federally approved coastal management plan. The Hawai`i Coastal Zone Management (CZM) program is the lead agency for coastal management and, along with state and county partners, is responsible for enforcing the state's federally approved coastal management plan. However, federal lands, which are "lands the use of which is by law subject solely to the discretion of…the Federal Government, its officers, or agents," are statutorily excluded from the state's "coastal zone". If, however, the proposed federal activity affects coastal resources or uses beyond the boundaries of the federal property (i.e., has spillover effects), the CZMA Section 307 federal consistency requirement applies. As a federal agency, the Navy is required to determine whether its proposed activities would affect the coastal zone. This takes the form of either a Negative Determination or a Consistency Determination.

Military testing and training at PMRF have been included in a list of U.S. Navy de minimis activities under the CZMA. The Hawai`i CZM program determined the listed activities “are expected to have insignificant direct or indirect (cumulative and secondary) coastal effects and should not be subject to further review by the Hawai`i CZM program.” (Mayer 2009)

The following discussions provide a description of the existing conditions for each of the categories under water quality resources at PMRF.

3.1.2.2 Region of Influence

The ROI includes the area within and surrounding the PMRF property boundaries, including KTF and the restrictive easement. The Mana Plain and the Ground Hazard Area are also included.

Surface Water

The surface water within the PMRF boundary is in the canals that drain the agricultural areas east of PMRF. Apart from these drainages, no surface drainage has been established because the rain sinks into the permeable sand. There are numerous drains and several irrigation ponds in the agricultural land.

The waters in the irrigation ponds generally do not meet drinking water standards for chloride salts but have near neutral to slightly alkaline pH. A surface water quality study for chloride was conducted in the Mana Plain/KTF area. The chloride levels do not indicate residual hydrochloric acid effects of the past launches at KTF (U.S. Army Program Executive Office 1995). Because the drainage ditches are designed to move water away from the agricultural fields during irrigation and rainfall, and to leach salts from the soil, no residual effects of past launches are expected (U.S. Army Program Executive Office 1995). The Agribusiness Development Corporation administers the activity on the agricultural aspects of the Mana Plain (Burger 2017).

Surface water in the area of the restrictive easement on the Mana Plain is limited to drains and agricultural irrigation ponds. Within the restrictive easement boundary, the surface water and storm water runoff drain onto former Amfac Sugar-Kauai lands and agricultural ponds below the Mana cliffs. The Mana Plain is drained by canals that flow seaward. Typically, the water from the canals that drain from the sugar cane fields is brackish. (USASSDC 1993b)

The waters in the agricultural ponds along the Mana cliffs generally do not meet drinking water standards for chloride salts but are near neutral to slightly alkaline. The highest chloride salt levels, near those of seawater, were observed in water from the Mana Pond Wildlife Sanctuary near the north gate of PMRF. This may be due to the infiltration of brackish to saline groundwater into the pond basin or excessive evaporation to a low surface level. (USASSDC 1993b)

Water quality along the PMRF shoreline was within Department of Health standards, with the exception of two locations where sugar cane irrigation water, pumped from the sugar cane fields, is discharged to the ocean. In these areas, Department of Health water quality criteria are exceeded within 50 m (164 ft) of the shoreline. Mixing processes are sufficient to dilute the drainage water to near background levels within 50 to 993 m (164 to 328 ft) of the shoreline). These outfall locations are currently monitored under a NPDES permit that is held by the Agribusiness Development Corporation (U.S. Navy 2010).

Groundwater

Bedrock, alluvium, and sand dunes make up hydraulically connected aquifers within the ROI. The bedrock (primarily basalt) is highly permeable, containing brackish water that floats on seawater. (USASSDC 1993b)

The overlying sediments are saturated, but they are not exploitable as an aquifer because of unfavorable hydraulic characteristics. The groundwater in the sediments originates as seepage from irrigation percolation and rainfall in the basalt aquifer, especially where the sediments are thin near the inland margin of the Mana Plain.

The dune sand aquifer on which PMRF/Main Base lies has a moderate hydraulic conductivity and moderate porosity of about 20%. It consists of a lens of brackish groundwater that floats on seawater and is recharged by rainfall and by seepage from the underlying sediments. The only record of an attempt to exploit this groundwater is of a well drilled for the Navy in 1974, 6.4 to 8 km (4 to 5 mi) south of KTF. The well was drilled to a depth of 13 m (42 ft) and tested at 1,136 liters per minute (300 gallons per minute). In 1992, the water was too brackish for plants and animals to consume; consequently, the well is not used. (U.S. Army Program Executive Office 1995)

The nearest fresh groundwater sources are in the Napali formation at the inland edge of the coastal plain along the base of the Mana cliffs. Groundwater in the region is generally considered to be potable at the base of the cliffs, increasing in salinity closer to the coast. (USASSDC 1993b)

Sampling for perchlorate was initiated at PMRF in 2006. USEPA adopted an oral reference dose for perchlorate in 2009, following a National Academy of Sciences recommendation that it not exceed 15 parts per billion in drinking water. Until USEPA promulgates standards for perchlorate, the DOD has established 15 parts per billion as the current level of concern for managing perchlorate. This level has also been adopted in the Navy Perchlorate Sampling and Management Policy.

As part of the implementation of the Navy policy, perchlorate sampling has been conducted at two drinking water supply locations. One location is the “Mana well,” which is the former Kekaha Sugar/AMFAC well from which PMRF obtains drinking water, referenced as “BS 335,” and supplies the “north end” of PMRF. It is a hand-dug well, now concrete-lined, approximately 27.4 m (90 ft) deep, and is located at the base of the ridge near the Kamokala Caves. The pumps and electric motors are down in the well. The other location is the water tank at the southern end of the base identified as reference code “BS 820.” Water in the tank comes from the County of Kauai. Perchlorate concentrations at both sites were less than the initial screening level of 4.0 parts per billion. Based on guidance PMRF received from Navy Region Hawai`i, since the two consecutive samples were less than 4 parts per billion, no further analysis was required.

Flood Hazard Areas

The primary flood hazard is from overflow of the ditches that drain the Mana Plain. Extended periods of heavy rainfall have resulted in minor flooding of low-lying areas of PMRF/Main Base. In addition, all PMRF/Main Base is within the tsunami evacuation area.

3.1.3 Biological Resources (PMRF/KTF)

For the purposes of this EA/OEA, biological resources are defined as living, native or naturalized plant and animal species and the habitat in which they occur. Plants, algae, and plant or algae communities are referred to as vegetation, and animal species are referred to as wildlife. Habitat is defined as the biotic and abiotic conditions that support a plant or animal species. Terrestrial is broadly defined as any species occurring on land, and marine as those occurring in ocean waters. Within this EA/OEA, biological resources are divided into four major categories: (1) terrestrial vegetation, (2) terrestrial wildlife, (3) marine vegetation, and (4) marine wildlife. This EA/OEA summarizes information on plant and animal species and their habitats, with emphasis on special-status species listed by state and federal agencies. Threatened, endangered, and other special status species are discussed in their respective categories. The biological resources described in this section are those within the affected environment at PMRF/KTF, specifically those areas subject to pre- and post-launch operations as well as launch activities.

The biological resources at PMRF/KTF were recently evaluated for the effects of STARS launches in the FE-1 EA/OEA (U.S. Navy 2017a), Advanced Hypersonic Weapon Program EA (USASMDC/ARSTRAT 2011), and the HRC EIS/OEIS (U.S. Navy 2008).

3.1.3.1 Regulatory Setting

For the purposes of this EA/OEA, special status species are those species listed as threatened or endangered under the ESA, species protected under the MMPA, and species protected under the MBTA. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) also applies to biological resources in this area as discussed below.

The purpose of the ESA is to conserve the ecosystems upon which threatened and endangered species depend and to conserve and recover listed species. Section 7 of the ESA requires action proponents to consult with USFWS or National Oceanic and Atmospheric Administration (NOAA) Fisheries to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species or result in the destruction or adverse modification of designated critical habitat (16 USC §§ 1531-1544). For all ESA listed species, the ESA defines "harm" as an act which kills or injures wildlife including significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (16 USC §§ 1531-1544). The ESA defines harassment as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to breeding, feeding, or sheltering.

All marine mammals are protected under the provisions of the MMPA (16 USC §1361 et seq.). The MMPA prohibits any person or vessel from "taking" marine mammals in the United States or the high seas without authorization. As defined by the MMPA, level A harassment of cetaceans is any act that has the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment is defined as any act that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing behavioral pattern disruptions, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering. Under the MMPA, marine mammal stocks can be listed as depleted. The term depleted is defined by the MMPA as any case in which a species or population stock is determined to be below its optimum sustainable population.

Birds, both migratory and most native-resident bird species, are protected under the MBTA (16 USC §§ 703-712), and their conservation by federal agencies is mandated by EO 13186 (Migratory Bird Conservation). Under the MBTA it is unlawful by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, [or] possess migratory birds or their nests or eggs at any time, unless permitted by regulation. Under EO 13186, federal agencies must evaluate the effects of actions on migratory birds with emphasis on species of concern, which were later defined as birds of conservation concern (BCC) by USFWS (USFWS 2008). Birds listed as BCC are species with the highest conservation priority which without additional conservation actions are likely to become candidates for listing under the ESA (USFWS 2008). The 2003 National Defense Authorization Act gave the Secretary of the Interior authority to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during authorized military readiness activities. The final rule authorizing the DOD to take migratory birds in such cases includes a requirement that the Armed Forces must confer with USFWS to develop and implement appropriate conservation measures to minimize or mitigate adverse effects of the proposed action if the action will have a significant negative effect on the sustainability of a population of a migratory bird species.

The MSA (16 USC § 1801 et seq.) provides for the conservation and management of the fisheries. Under the MSA, essential fish habitat (EFH) consists of the waters and substrate needed by fish to spawn, breed, feed, or grow to maturity. An EFH may include U.S. waters within exclusive economic zones (EEZ; seaward boundary out to a distance of 39 km [200 nm]) and covers all fish species within in a fishery management unit (50 CFR §600.805). Under the MSA, an adverse effect means any impact that reduces quality and/or quantity of EFH (50 CFR §600.810). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH (50 CFR §600.810). EFH and its geographic boundaries are defined by regional fisheries management councils. Federal agencies must evaluate the effects of an action on EFH and must consult with NMFS on actions that may adversely affect EFH (67 FR 2343 [17 January 2002]).

The CZMA establishes a federal–state partnership to provide for the comprehensive management of coastal resources (16 USC §§ 1451-1465). Coastal states and territories develop management programs based on enforceable policies and mechanisms to balance resource protection and coastal development needs. Federal actions that affect any land or water use or natural resource of the coastal zone must be carried out consistent with enforceable policies of approved state management programs, to the extent practicable (16 USC § 1456).

3.1.3.2 Biological Resources in the PMRF/KTF Region of Influence

Biological resources in the PMRF/KTF ROI include terrestrial and marine vegetation as well as terrestrial and marine wildlife. The ROI is the area within SNL/KTF boundaries on PMRF Main Base, Kauai, as well as adjacent areas that may be affected by elevated sound levels, deposition of debris or hazardous chemicals, and increased human activity. Biological resources have been most recently analyzed for the effects of launches in the FE-1 EA/OEA (U.S. Navy 2017a), Advanced Hypersonic Weapon Program EA (USASMDC/ARSTRAT 2011), and the HRC EIS/OEIS (U.S. Navy 2008). Special status species present at or near PMRF/KTF are listed in **Table 3-2**.

Table 3-2. Special Status Species Known to Occur or with the Potential to Occur at or near PMRF/KTF and Critical Habitat Present at PMRF.

Common Name	Scientific Name	Federal Listing Status	Likelihood of Occurrence at or near KTF	Critical Habitat Present?
Plants				
Lau'ehu	*Panicum niihauense*	E	U	Yes
Ohai	*Sesbania tomentosa*	E	U	Yes
Terrestrial Mammals				
Hawaiian hoary bat	*Lasiurus cinereus semotus*	E	P	
Marine Mammals				
Minke whale	*Balaenoptera acutorostrata*	MMPA	P	
Sei whale	*B. borealis*	E, MMPA	U	
Bryde's whale	*B. edeni*	MMPA	P	
Blue whale	*B. musculus*	E, MMPA	U	
Fin whale	*B. physalus*	E, MMPA	U	
Pygmy killer whale	*Feresa attenuata*	MMPA	P	
Short-finned pilot whale	*Globicephala macrorhynchus*	MMPA	P	
Risso's dolphin	*Grampus griseus*	MMPA	P	
Longman's beaked whale	*Indopacetus pacificus*	MMPA	P	
Pygmy sperm whale	*Kogia breviceps*	MMPA	P	
Dwarf sperm whale	*K. sima*	MMPA	P	
Fraser's dolphin	*Lagenodelphis hosei*	MMPA	U	
Humpback whale[1]	*Megaptera novaeangliae*	MMPA	L	
Blainville's beaked whale	*Mesoplodon densirostris*	MMPA	P	

Common Name	Scientific Name	Federal Listing Status	Likelihood of Occurrence at or near KTF	Critical Habitat Present?
Northern elephant seal	*Mirounga angustirostris*	MMPA	U	
Hawaiian monk seal	*Neomonachus schauinslandi*	MMPA	L	
Killer whale	*Orcinus orca*	MMPA	P	
Melon-headed whale	*Peponocephala electra*	MMPA	P	
Sperm whale	*Physeter macrocephalus*	E, MMPA	P	
False killer whale	*Pseudorca crassidens*	E (Insular Hawaiian DPS), MMPA	P	
Pantropical spotted dolphin	*Stenella attenuata*	MMPA	P	
Striped dolphin	*S. coeruleoalba*	MMPA	P	
Spinner dolphin	*S. longirostris*	MMPA	L	
Rough-toothed dolphin	*Steno bredanensis*	MMPA	P	
Bottlenose dolphin	*Tursiops truncatus*	MMPA	P	
Cuvier's beaked whale	*Ziphius cavirostris*	MMPA	P	
Birds				
Koloa maoli (Hawaiian duck)	*Anas wyvilliana*	E, MBTA	L	
Nene (Hawaiian goose)	*Branta sandvicensis*	E, MBTA	L	
\`Alae ke\`oke\`o (Hawaiian coot)	*Fulica alai*	E, MBTA	L	
\`Alae \`ula (Hawaiian common gallinule	*Gallinula galeata sandvicensis*	E, MBTA	L	
Ae\`o (Hawaiian black-necked stilt)	*Himantopus mexicanus knudseni*	E, MBTA	L	
Band-rumped storm-petrel	*Oceanodroma castro*	E, MBTA	P	
Short-tailed albatross	*Phoebastria albatrus*	E, MBTA	U	
\`Ua\`u (Hawaiian petrel)	*Pterodroma sandwichensis*	E, MBTA	P	
\`A\`o (Newell's Townsend's shearwater)	*Puffinus auricularis newelli*	T, MBTA	P	
Sea Turtles				
Loggerhead turtle	*Caretta caretta*	E	P	
Green turtle	*Chelonia mydas*	T, Central North Pacific DPS	L	
Leatherback turtle	*Dermochelys coriacea*	E	P	
Hawksbill turtle	*Enetmochelys imbricata*	E	L	
Olive ridley turtle	*Lepidochelys olivacea*	T	P	

Abbreviations: ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, MBTA = Migratory Bird Treaty Act, E = federal endangered; T = federal threatened; L = Likely; P = Potential; U = Unlikely.
[1] The Hawai\`i distinct population segment (DPS) is not listed under the ESA. The eastern north Pacific DPS is listed as endangered. There is some evidence that eastern north Pacific DPS whales may winter in Hawai\`i.

Terrestrial Vegetation at PMRF/KTF

Vegetation includes terrestrial plant communities and constituent plant species. SNL/KTF is located in the northern portion of PMRF Main Base and is covered primarily with coastal dune vegetation. Naupaka, beach morning glory, and \`a\`ali\`i (*Dodonaea viscosa*) are common species at SNL/KTF (U.S. Navy 2008). PMRF also has areas of native scrub vegetation and coastal strand. In areas where natural vegetation has been disturbed within SNL/KTF, the habitat is managed by mowing (USASMDC/ARSTRAT 2011). No threatened or endangered plants have been observed at SNL/KTF (USASMDC/ARSTRAT 2011). Two ESA listed endangered plants have been observed north of PMRF, lau'ehu (*Panicum niihauense*) and ohai (*Sesbania tomentosa*; USASMDC/ARSTRAT 2011). Critical habitat has been designated for these species, and an area on the northwestern end of PMRF near Polihale Park is a portion of the critical habitat for the endangered ohai and lau`ehu. In February 2003, USFWS published a final rule which included a portion of PMRF as critical sand dune and coastal shrubland habitat for the lau`ehu (68 FR 9116 [27 February 2003]).

Terrestrial Wildlife at PMRF/KTF

Wildlife includes all animal species (including insects and other invertebrates, fish, amphibians, reptiles, birds, and mammals) focusing on the species with special status and habitat features of greatest importance.

Mammals. The Hawaiian hoary bat (*Lasiurus cinereus semotus*) is the only strictly terrestrial special-status mammal species potentially found at PMRF/KTF. This federally and Hawaiian state listed endangered species is the only land mammal endemic to Hawai`i. Hawaiian hoary bats generally occur in or near forest habitat, and apparently use native vegetation more frequently than non-native vegetation (USASMDC/ARSTRAT 2011). Their diet consists of flying insects, and Hawaiian hoary bats have been observed foraging over open fields, over open ocean near the mouths of river or stream outlets, and over streams and ponds (USASMDC/ARSTRAT 2011). The current population size of Hawaiian hoary bats is unknown, but the greatest threats to populations are thought to be habitat loss, use of pesticides, and predation. This species has not been recorded at PMRF for over a decade and the abundance and distribution of this species in the area remains largely unknown.

Hawaiian monk seals (*Neomonachus schauinslandi*) are found on and near Kauai, especially in shallow waters within 22 km (12 nm) of the PMRF coastline. While these marine mammals do haul out on beaches and rock coastlines, the closest observed Hawaiian monk seal haul out area is approximately 1.6 km (1 mi) south of Launch Pad 42 (USASMDC/ARSTRAT 2011). Critical habitat has been established for the Hawaiian monk seal at Kauai and most other Hawaiian Islands; however, there is no designated critical habitat for this species at PMRF Main Base.

Birds. Birds on PMRF/KTF include both resident and migratory bird species. Resident bird species include the red junglefowl (*Gallus gallus*), ring-necked pheasant (*Phasianus colchicus*), and northern mockingbird (*Mimus polyglottos*) (USASMDC/ARSTRAT 2011). Migratory seabirds and shorebirds commonly observed at PMRF Main Base include brown boobies (*Sula leucogaster*), sanderlings (*Calidris alba*), wandering tattlers (*Tringa incana*), ruddy turnstones (*Arenaria interpres*), and Pacific golden plovers (*Pluvialis fulva*; USASMDC/ARSTRAT 2011). Wedge-tailed shearwaters (*Puffinus pacificus*) nest in the Nohili dunes area and near the beach cottages (USASMDC/ARSTRAT 2011). Laysan albatross also nest in maintained, disturbed areas at PMRF (USASMDC/ARSTRAT 2011).

Nine species of ESA listed bird species occur or have the potential to occur at PMRF (**Table 3-2**). The endangered Hawaiian goose or nene (*Branta sandvicensis*) is known to occur on PMRF/KTF, and four endangered waterbirds, the Hawaiian coot (*Fulica alai*), Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*), Hawaiian common moorhen (*Gallinula galeata sandvicensis*), and Hawaiian duck (*Anas wyvilliana*), are potentially present or confirmed within or near the SNL/KTF area (USASMDC/ARSTRAT 2011). The Hawaiian coot, black-necked stilt, and common moorhen are known to nest on the island of Kauai year-round (USASMDC/ARSTRAT 2011). Short-tailed albatross (*Phoebastria albatrus*) are rarely observed at PMRF (USASMDC/ARSTRAT 2011). While the band-rumped storm petrel (*Oceanodroma castro*), Hawaiian petrel (*Pterodroma sandwichensis*), and Newell's shearwater (*Puffinus auricularis newelli*) are not known to nest or roost at PMRF Main Base, they are known to fly over or near the area. These seabirds can be subject to fallout, which occurs when fledgling seabirds making their first flights to the ocean from their natal colony are disoriented by artificial light sources and fall to the ground or strike artificial structures. In September 2016, PMRF instituted a "Dark Skies" program involving turning off all non-essential lighting on the base and modifying night time operations between September 15 and December 15 of each year, to prevent disorientation of sea birds during nocturnal flight.

No designated critical habitat for bird species is found at or near SNL/KTF.

Sea Turtles. Although five species of sea turtles potentially inhabit the nearshore and offshore area of Hawai`i, green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles account for nearly all sightings in the area (Hanser et al. 2017). While sea turtle nesting at PMRF has been relatively rare, green sea turtles have regularly nested along the beachfront on PMRF. In 2015, at least 6 green sea turtle nests hatched successfully between July 18 and September 3, with a total of 468 hatchlings on PMRF (Burger 2017). No designated critical habitat for sea turtles is found at or near SNL/KTF.

Marine Vegetation near PMRF/KTF

Common vegetation found in the rocky intertidal habitats offshore of PMRF includes algae such as sea lettuce (*Ulva*), Sargasso or kala (*Sargassum*), coralline red algae (*Hydrolithon*), red fleshy algae (*Melanamansia, Pterocladiella,* and *Jania*), brown algae (*Padina, Turbinaria,* and *Dictyota*), and fleshy green algae (*Neomeris, Halimeda*, and *Caulerpa*; U.S. Navy 2008). Algal species on the limestone bench fronting Nohili Point that are preferred by green turtles include but are not limited to lipuupuu (*Dictyospheria versluysii*), kala-laununui (*Sargassum echinocarpum*), pahalahala (*Ulva fasciatus*), and mane`one`o (*Laurencia nidifica*; U.S. Navy 2008). The algal and macroinvertebrate survey in Majors Bay noted that four macroalgal species were present (U.S. Navy 2008). No special-status marine vegetation is located near PMRF/KTF.

Marine Wildlife Near PMRF/KTF

Marine wildlife near PMRF/KTF that are considered in this EA/OEA are those that have the potential to be in the area exposed to elevated noise levels from the FE-2 launch. No designated critical habitat for any cetacean or sea turtle species is found near KTF.

Marine Mammals. Of the 26 species of marine mammals with the potential to occur near PMRF (**Table 3-2**), the Hawaiian monk seal, humpback whale (*Megaptera noveangliae*), and spinner dolphin (*Stenella longirostris*) are the most likely species to be observed within 22 km (12 nm) of the PMRF coastline (U.S. Navy 2008). Other species that are most commonly observed in Main Hawaiian Island waters less than 2,000 m (6,560 ft) deep are short-finned pilot whales (*Globicephala macrorhynchus*), pantropical spotted dolphins (*Stenella attenuata*), common bottlenose dolphins (*Tursiops truncatus*), and rough-toothed dolphins (*Steno bredanensis*; Baird et al. 2013).

The endangered Hawaiian monk seal is known to occur in the waters near PMRF. These seals are known to occur around the Main and Northwest Hawaiian Islands from the shoreline out to waters approximately 500 m (1,640 ft) deep (U.S. Navy 2008). Hawaiian monk seals are found on and near Kauai, especially in shallow waters within 22 km (12 nm) of the PMRF coastline. While critical habitat has been established for the Hawaiian Monk seal on and near Kauai and most other Hawaiian Islands, there is no designated critical habitat for this species offshore of PMRF Main Base.

Spinner dolphins (*Stenella longirostris*) are the most commonly recorded cetaceans observed within 22 km (12 nm) of the PMRF coastline. The spinner dolphin inhabits bays and protected waters, often in waters less than 12 m (40 ft) deep (U.S. Navy 2008). Spinner dolphins are expected to occur in shallow water resting areas (about 50 m or 162 ft deep or less) throughout the middle of the day, moving into deep waters offshore during the night to feed (U.S. Navy 2008).

The humpback whale peak abundance around the Hawaiian Islands is from late February through early April (U.S. Navy 2018b). During the fall-winter period, primary occurrence is expected from the coast to 92 km (50 nm) offshore, including the areas off PMRF (U.S. Navy 2008). There is some ambiguity as to which distinct population segment (DPS) the whales near Hawai`i belong. The Hawai`i DPS of humpback whales is not listed under the ESA. This DPS includes whales that remain near Hawaiian waters throughout the year. There are also humpback whales that winter in Hawaiian waters and migrate north to summer feeding grounds. These whales likely belong to the eastern north Pacific DPS, which is also not listed under the ESA.

Sea Turtles. Of the five sea turtle species that have the potential to occur near PMRF, green and hawksbill turtles are the most common sea turtles in offshore waters around the Main Hawaiian Islands, as they prefer reef-type environments that are less than about 100 m (328 ft) in depth (USASMDC/ARSTRAT 2011). Green turtles have been observed offshore of Nohili Ditch, the only area where basking/haul-out activity on PMRF/Main Base is observed (U.S. Navy 2008). The PMRF Natural Resources Manager monitors sea turtle activity at PMRF. Security patrol reports include a record of the presence and locations of turtles. Any records of green turtle observation are maintained by the PMRF Environmental Office. USFWS and NOAA Fisheries share federal jurisdiction for sea turtles, with USFWS having lead responsibility on the nesting beaches and NOAA Fisheries, the marine environment.

Fish. Fish are vital components of the marine ecosystem. They have great ecological and economic importance. The most commonly harvested coral reef associated species in the Hawaiian Islands include surgeonfishes (Acanthuridae), triggerfishes (Balistidae), jacks (Carangidae), parrotfishes (Scaridae), soldierfishes/squirrelfishes (Holocentridae), wrasses (Labridae), and goatfishes (Mullidae; WPRFMC 2009). To protect this resource, NOAA Fisheries works with the regional fishery management councils to identify the essential habitat for every life stage of each federally managed species using the best available scientific information. EFH has been described for approximately 1,000 managed species to date. EFH may include all types of aquatic habitat such as wetlands, coral reefs, seagrasses, and rivers; and all locations where fish spawn, breed, feed, or grow to maturity.

Essential Fish Habitat. Under the MSA, regional fisheries management councils are responsible for defining EFH and its geographic boundaries. The Western Pacific Regional Fishery Management Council (WPRFMC) has authority over the fisheries and EFH designation in and surrounding the State of Hawai`i, the Territory of American Samoa, the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Pacific Remote Island Areas (Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Atoll; **Figure 3-1**). The flight path for FE-2 crosses over waters designated as EFH near the Hawaiian Islands. Therefore, EFH near the Hawaiian Islands is described in this section of the EA/OEA.

The WPRFMC developed EFH designations for Management Unit Species (MUS) including Bottomfish and Seamount Groundfish, Crustaceans, and Precious Corals (64 FR 19068) as well as for Coral Reef Ecosystem MUS (69 FR 8336; WPRFMC 2009). NMFS has recently implemented a reclassification of EFH that has resulted in many species being moved from MUS to ecosystem components (NMFS 2019b). The current EFH designations for all MUS are summarized in **Table 3-3** (NMFS 2019b). While changes have been made to the MUS categories and the species within those categories, the geographic footprint of EFH has not changed (NMFS 2019b). The EFH designations summarized here are discussed in detail by WPRFMC in the Fishery Ecosystem Plan for the Hawai`i Archipelago (WPRFMC 2009), and the Fishery Ecosystem Plan for Pacific Pelagic Fisheries of the Western Pacific Region (WPRFMC 2005). EFH in the Hawaiian Islands EEZ is summarized in **Table 3-3**.

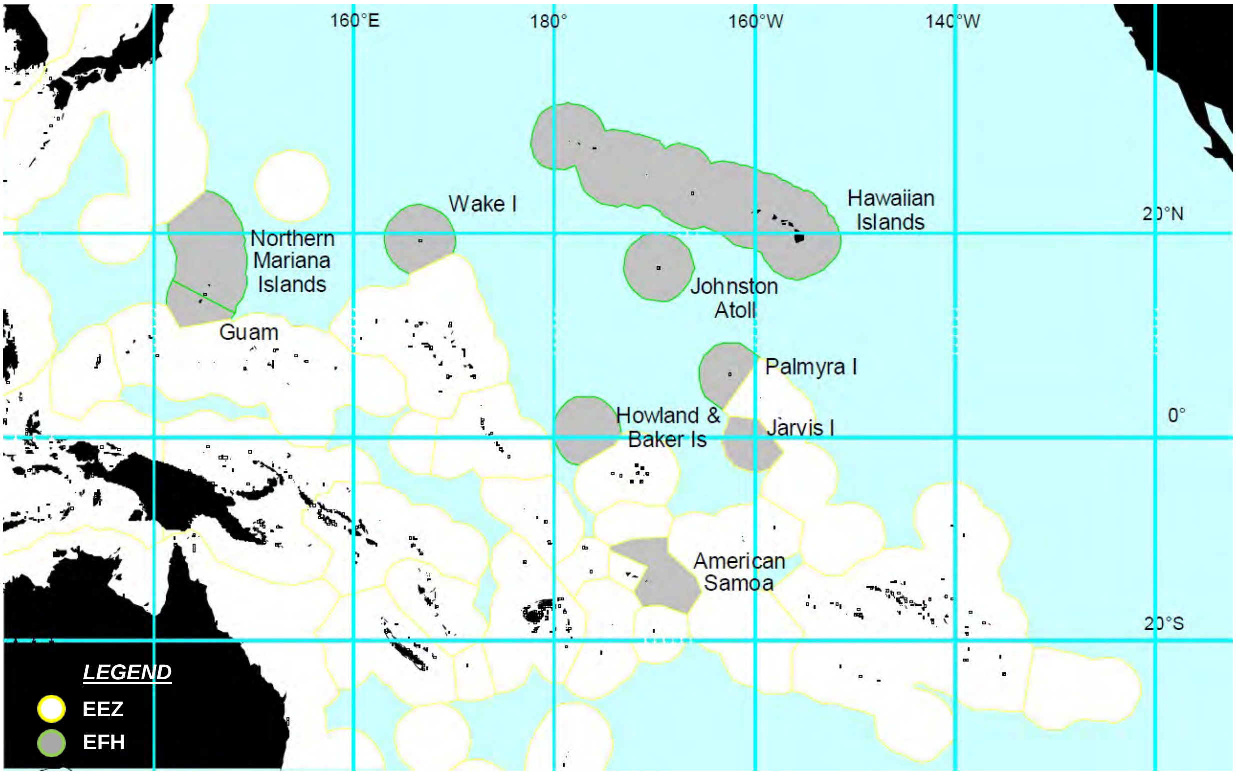


Figure 3-1. Exclusive Economic Zones (EEZ) and Extent of Essential Fish Habitat (EFH) in the Western Pacific Region

Coral. Total coral cover in the Nohili Sector north of PMRF Main Base ranges from 32% to 39% of bottom cover (U.S. Navy 2008). The most abundant coral species are lobe coral (*Porites lobata*, rose or cauliflower coral (*Pocillopora meandrina*), and ringed rice coral (*Montipora patula*). Along the central portion of PMRF, living coral is sparsely distributed, approximately one half of that found in the Nohili area (U.S. Navy 2008). Coral cover further south in the Major's Bay Sector is less than 2% (U.S. Navy 2008).

Further offshore, the predominant coral is antler coral (*Pocillopora eydouxi*), which occurs as single large branching colonies (U.S. Navy 2008). Other corals found in this area are primarily smaller species, which have a collective coverage of about 5% of bottom cover: rose or cauliflower coral, lobe coral, corrugated coral (*Pavona varians*), flat lobe coral (*P. duerdeni*), blue rice coral (*Montipora flabellata*), ringed rice coral, Verrill's ringed rice coral (*M. verrilli*), rice coral (*M. capitata*), crust coral (*Leptastrea purpurea*), and mushroom coral (*Fungia scutaria*; U.S. Navy 2008).

Non-coral Invertebrates. Typical benthic invertebrates found near PMRF include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more (U.S. Navy 2008). Common animals found in rocky intertidal habitats include limpets, periwinkles, littorine snails, rock crabs, gastropods, and rock urchins (USASMDC/ARSTRAT 2011). Further offshore in coral reef habitats, macroinvertebrates include the rock oyster (*Spondylus tenebrosus*), cone shells (*Conus* spp.), sea urchins (*Echinometra mathaei*), and sea cucumbers (*Holothuria atra*; U.S. Navy 2008).

Table 3-3. Essential Fish Habitat (EFH) for Management Unit Species with the Potential to Occur in the Action Area [1]

Fishery	Stock or Stock Complex	Life Stage(s)	EFH Designation
Crustaceans	Kona crab	Egg/larval	The water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m
		Juvenile/adult	All of the bottom habitat from the shoreline to a depth of 100 m
	Deepwater shrimp	Egg/larval	The water column and associated outer reef slopes between 550 and 700 m
		Juvenile/adult	The outer reef slopes at depths between 300-700 m
Bottomfish	Shallow stocks: *Aprion virescens*	Egg	Pelagic zone of the water column in depths from the surface to 240 m, extending from the official US baseline to a line on which each point is 50 miles from the baseline
		Post-hatch pelagic	Pelagic zone of the water column in depths from the surface to 240 m, extending from the official US baseline to the EEZ boundary
	Shallow stocks: *Aprion virescens*	Post-settlement	Benthic or benthopelagic zones, including all bottom habitats, in depths from the surface to 240 m bounded by the official US baseline and 240 m isobath
		Sub-adult/adult	Benthopelagic zone, including all bottom habitats, in depths from the surface to 240 m bounded by the official US baseline and 240 m isobath.
	Intermediate stocks: *Aphareus rutilans, Pristipomoides filamentosus, Hyporthodus quernus*	Eggs	Pelagic zone of the water column in depths from the surface to 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*) extending from the official US baseline to a line on which each point is 50 miles from the baseline
		Post-hatch pelagic	Pelagic zone of the water column in depths from the surface 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*), extending from the official US baseline to the EEZ boundary
		Post-settlement	Benthic (*H. quernus* and *A. rutilans*) or benthopelagic (*A. rutilans* and *P. filamentosus)* zones, including all bottom habitats, in depths from the surface to 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*) bounded by the 40 m isobath and 100 m (*P. filamentosus),* 280 m (*A. rutilans*) or 320 m (*H. quernus*) isobaths
		Sub-adult/adult	Benthic (*H. quernus*) or benthopelagic (*A. rutilans* and *P. filamentosus)* zones, including all bottom habitats, in depths from the surface to 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*) bounded by the 40 m isobath and 280 m (*A. rutilans and P. filamentosus*) or 320 m (*H. quernus*) isobaths
	Deep stocks: *Etelis carbunculus, Etelis coruscans, Pristipomoides seiboldii, Pristipomoides zonatus*	Eggs	Pelagic zone of the water column in depths from the surface to 400 m, extending from the official US baseline to a line on which each point is 50 miles from the baseline
		Post-hatch pelagic	Pelagic zone of the water column in depths from the surface to 400 m, extending from the official US baseline to the EEZ boundary
		Post-settlement	Benthic zone, including all bottom habitats, in depths from 80 to 400 m bounded by the official US baseline and 400 m isobath
		Sub-adult/adult	Benthic (*E. carbunculus* and *P. zonatus*) or benthopelagic (*E. coruscans*) zones, including all bottom habitats, in depths from 80 to 400 m bounded by the official US baseline and 400 m isobaths

[1]Source: NMFS 2019b

3.1.4 Airspace (PMRF/KTF)

This discussion of airspace includes current uses and controls of the airspace. The Federal Aviation Administration (FAA) manages all airspace within the United States and the U.S. territories. Airspace, which is defined in vertical and horizontal dimensions and also by time, is considered to be a finite resource that must be managed for the benefit of all aviation sectors including commercial, general, and military aviation.

3.1.4.1 Regulatory Setting

Airspace, or that space which lies above a nation and comes under its jurisdiction, is generally viewed as being unlimited. However, it is a finite resource that can be defined vertically and horizontally, as well as temporally, when describing its use for aviation purposes. The time dimension is a very important factor in airspace management and air traffic control.

Under Public Law 85-725, Federal Aviation Act of 1958, the FAA is charged with the safe and efficient use of our nation's airspace and has established certain criteria and limits to its use. The method used to provide this service is the National Airspace System. This system is "…a common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information and manpower and material."

Specific aviation and airspace management procedures and policies to be used by the Navy are provided by OPNAVINST 3710.7, *Naval Aviation Training and Operating Procedure Standardization*. Other applicable regulations regarding special use airspace management include FAA Order 7490, "*Policies and Procedures for Air Traffic Environmental Actions*;" FAA Order 7610.4H, "*Special Military Operations*;" and the Memorandum of Understanding Between the FAA and the Department of the Defense Concerning Special Use Airspace Environmental Actions (January 26, 1998).

3.1.4.2 Region of Influence

The affected airspace use environment in the PMRF/KTF ROI is described below in terms of its principal attributes: controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, airports and airfields, and air traffic control. There are no military training routes in the ROI.

The ROI for airspace includes the airspace over and surrounding the islands of Kauai and Niihau. **Figure 3-2** shows a view of the airspace within the PMRF/Main Base ROI, including the PMRF Aircraft Operational Areas, the R-3101 Restricted Area, and surrounding airspace off the western and northwestern coast of Kauai.

The affected airspace use environment in the PMRF/KTF ROI is described below in terms of its principal attributes: controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, airports and airfields, and air traffic control. There are no military training routes in the ROI.

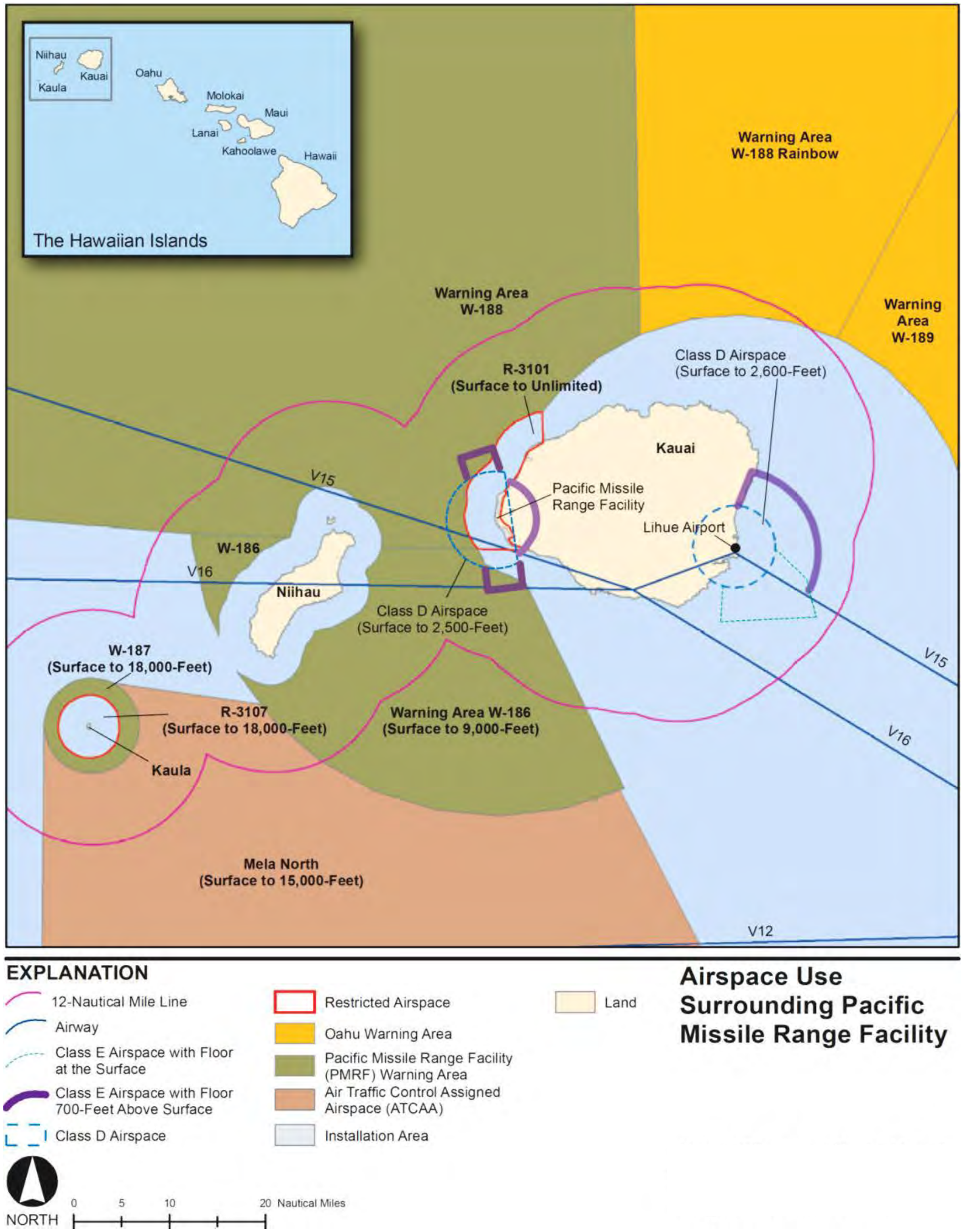


Figure 3-2. Airspace Use Surrounding Pacific Missile Range Facility

Controlled and Uncontrolled Airspace

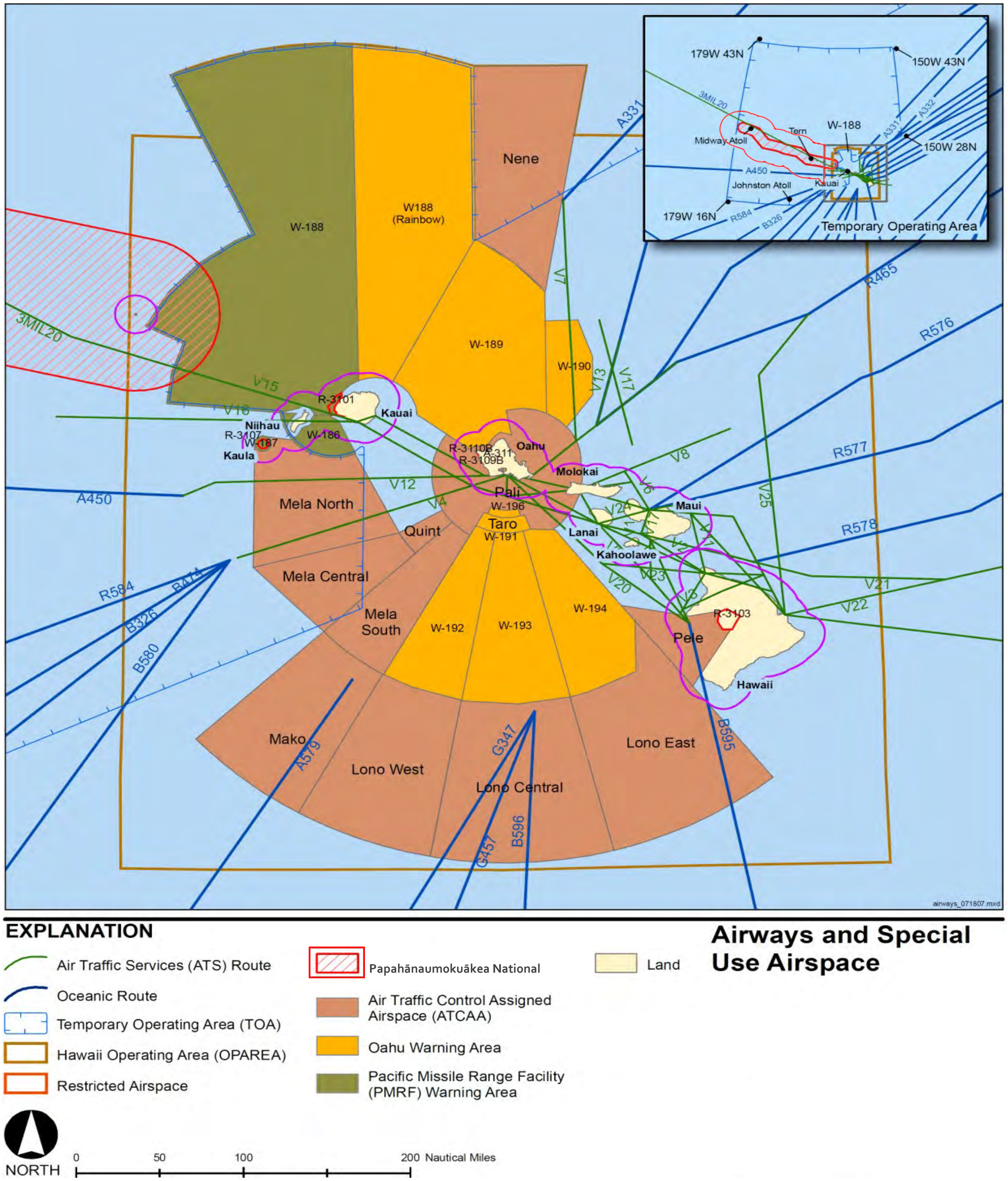
The airspace outside the special use airspace identified below is essentially international airspace controlled by the Honolulu Control Facility and Oakland Air Route Traffic Control Center (ARTCC). Class D airspace (generally that airspace surrounding those airports that have an operational control tower) surrounds the PMRF/Main Base airfield with a ceiling of 762 m (2,500 ft). It is surrounded to the north, south, and east by Class E airspace with a floor 213 m (700 ft) above the surface (**Figure 3-2**). Lihue Airport, located approximately 27.8 km (15 nm) east of PMRF, includes Class D, surface Class E (controlled airspace not in the other classes), and additional Class E airspace with a floor 213 m (700 ft) above the surface. There is no Class B (U.S. terminal control areas) airspace (which usually surrounds the nation's busiest airports) or Class C (operational control tower and radar approach control) airspace in the ROI.

Special Use Airspace

A restricted area is airspace designated under Part 73 within which the flight of aircraft, while not wholly prohibited, is subject to restriction. A warning area is airspace of defined dimensions, extending from 5.6 km (3 nm) outward from the coast of the United States that contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both. (14 CFR Title 14 Part 1.1, 2006)

The special use airspace in the ROI (**Figure 3-3**) consists of Restricted Area R-3101, which lies immediately above PMRF/Main Base and to the west of Kauai, portions of Warning Area W-188 north of Kauai, and Warning Area W-186 southwest of Kauai, all controlled by PMRF. Restricted Area R-3107 over Kaula, a small uninhabited rocky islet 35 km (19 nm) southwest of Niihau that is used for fixed- and rotary-wing aircraft gunnery practice, and which lies within the W-187 Warning Area, is also special use airspace within the ROI.

Restricted Area R-3107 and Warning Area W-187 are scheduled through the Navy Fleet and Area Control and Surveillance Facility Pearl Harbor (FACSFACPH). PMRF and FACSFACPH each coordinate with the FAA Honolulu Control Facility regarding special use airspace. The Honolulu Control Facility is the location in which the ARTCC, the Honolulu control tower, and the Combined Radar Approach Control are collocated.



Source: U.S. Navy 2008

Note: Area of Papahanaumokuakea Marine National Monument was expanded in August 2016.

Figure 3-3. Airways and Special Use Airspace

Table 3-4 lists the affected Restricted Areas and Warning Areas and their effective altitudes, times used, and their manager or scheduler. There are no Prohibited or Alert special use airspace areas in the PMRF airspace use ROI.

Table 3-4. Special Use Airspace in the PMRF/Main Base Airspace Use Region of Influence

Number	Location	Altitude	Time of Use		Controlling Airspace
			Days	Hours	
R-3101	PMRF	To Unlimited	M-F	0600-1800	PMRF
W-186	Southwest of PMRF	To 9,000	Continuous	Continuous	PMRF
W-188	Northwest of PMRF	To Unlimited	Continuous	Continuous	PMRF/HCF

Source: Advanced Hypersonic Weapon Program EA (USASMDC/ARSTRAT 2011)

Abbreviations: R=Restricted; W=Warning; PMRF = Pacific Missile Range Facility; HCF = Honolulu Combined Facility, the location in which the Air Route Traffic Control Center (ARTCC), the Honolulu control tower, and the Combined Radar Approach Control are co-located.

Other types of airspace, and special airspace use procedures used by the military to meet its particular needs, include Air Traffic Control Assigned Airspace (ATCAA) and Altitude Reservation (ALTRV) procedures:

(1) ATCAA, or airspace of defined vertical and lateral limits, is assigned by air traffic control to provide air traffic segregation between specified activities being conducted within the assigned airspace and other instrument flight rules (IFR) air traffic. ATCAAs are usually established in conjunction with Military Operations Areas and serve as an extension of Military Operations Area airspace to the higher altitudes required. These airspace areas support high altitude operations such as intercepts, certain flight test operations, and air refueling operations.

(2) ALTRV Procedures are used as authorized by the Central Altitude Reservation Function, an air traffic service facility, or appropriate ARTCC, under certain circumstances, for airspace utilization under prescribed conditions. An ALTRV receives special handling from FAA facilities. According to FAA Handbook 7610.4H, Chapter 3, ALTRVs are classified as either moving or stationary, with the latter normally defining the fixed airspace area to be occupied as well as the specific altitude(s) and time period(s) the area will be in use. ALTRVs may encompass certain rocket and missile activities and other special operations as may be authorized by FAA approval procedures.

To ensure safe operations, PMRF requests use of specific areas of airspace from the FAA during missile defense testing. The FAA issues a NOTAM to avoid specific areas of airspace until testing is complete. The NOTAM System is a telecommunication system designed to distribute unanticipated or temporary changes in the National Airspace System or until aeronautical charts and other publications can be amended. This information is distributed in the NOTAM.

To further ensure aircraft safety, if aircraft are seen in an impact area, safety regulations dictate that hazardous activities will be suspended when it is known that any non-participating aircraft has entered any part of the danger zone until the non-participating entrant has left the area or a thorough check of the suspected area has been performed. Models run sequentially or in parallel are designed to compute risks based on estimating both the probabilities and consequences of launch failures as a function of time into the mission. Databases include data on mission profile, launch vehicle specifics, local weather conditions, and the surrounding population distribution. Given a mission profile, the risks would vary in time and space. Therefore, a launch trajectory optimization is performed by the range for each proposed launch, subject to risk minimization and mission objectives constraints. The debris impact probabilities and lethality are then estimated for each launch considering the geographic setting, normal jettisons, failure debris, and demographic data to define destruct lines to confine and/or minimize the potential risk of injury to humans or property damage.

En Route Airways and Jet Routes

Although relatively remote from the majority of jet routes that crisscross the Pacific, the airspace use ROI has two IFR en route low altitude airways used by commercial air traffic that pass through the ROI: V15, which passes east to west through the southernmost part of Warning Area W-188, and V16, which passes east to west through the northern part of Warning Area W-186 and over Niihau (**Figure 3-2**). An accounting of the number of flights using each airway is not maintained.

The airspace use ROI, located to the west, northwest, and north of Kauai, is far removed from the low altitude airways carrying commercial traffic between Kauai and Oahu and the other Hawaiian Islands, all of which lie to the southeast of Kauai. There is a high volume of island helicopter sightseeing flights along the Na Pali coastline and over the Waimea Canyon, inland and to the east of PMRF, particularly out of Port Allen near Hanapepe on Kauai’s southern coastline and other tourist and resort towns on the island. However, these do not fly over PMRF or into Restricted Area R-3101.

Airports and Airfields

Except for the airfield at PMRF and the Kekaha airstrip approximately 5 km (3 mi) to the southeast of PMRF and 3 km (2 mi) northwest of Kekaha, there are no airfields or airports in the airspace use ROI. Lihue Airport is located 20 nm east of PMRF, outside the ROI. In addition to helicopter and fixed-wing aircraft landings associated with PMRF’s mission, the PMRF airfield serves as a training facility for landings and takeoffs. The overall number of air operations was 13,395 for 2004. The 2009 air operations were estimated to be 25,486, an increase of about 90%.

Air Traffic Control

Use of the airspace by the FAA and PMRF is established by a Letter of Agreement between the two agencies. Under this agreement, PMRF is required to notify the FAA by 2:00 p.m. the day before range operations would infringe on the designated airspace. Range Control and the FAA are in direct real-time communication to ensure safety of all aircraft using the airways and jet routes and the special use airspace. Within the special use airspace, military activities in Warning

Areas W-186 and W-188 are under PMRF control, and the PMRF Range Control Officer is solely authorized and responsible for administering range safety criteria, the surveillance and clearance of the range, and the issuance of range RED (no firing) and GREEN (clearance to fire) status. Warning Area W-187 is scheduled through the FACSFACPH.

As Warning Areas are located in international airspace, the procedures of the International Civil Aviation Organization (ICAO), outlined in ICAO Document 444, Rules of the Air and Air Traffic Services, are followed. ICAO Document 444 is the equivalent air traffic control manual to FAA Handbook 7110.65, Air Traffic Control. The FAA acts as the U.S. agent for aeronautical information to the ICAO, and air traffic in the ROI is managed by the Honolulu ARTCCs.

3.1.5 Noise (PMRF/KTF)

This discussion of noise includes the types or sources of noise and the associated sensitive receptors in the human environment. Noise in relation to biological resources and wildlife species is discussed in the biological resources section (**Section 4.1.3**).

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. The perception and evaluation of sound involves three basic physical characteristics:

- Intensity – the acoustic energy, which is expressed in terms of sound pressure, in decibels (dB)
- Frequency – the number of cycles per second the air vibrates, in hertz (Hz)
- Duration – the length of time the sound can be detected

Noise is defined as unwanted or annoying sound that interferes with or disrupts normal human activities. Although continuous and extended exposure to high noise levels (e.g., through occupational exposure) can cause hearing loss, the principal human response to noise is annoyance. The response of different individuals to similar noise events is diverse and is influenced by the type of noise, perceived importance of the noise, its appropriateness in the setting, time of day, type of activity during which the noise occurs, and sensitivity of the individual.

Basics of Sound and A-weighted Sound Level

The dB is a logarithmic unit used to represent the intensity of a sound, also referred to as the sound level. Environmental noise measurements are usually on an "A-weighted" scale that filters out very low and very high frequencies to replicate human sensitivity. It is common to add the "A" to the measurement unit to identify that the measurement has been made with this filtering process (dBA). In this document, the dB unit refers to A-weighted sound levels. A sound level of 0 dBA is the approximate threshold of human hearing and is barely audible under extremely quiet conditions. Normal speech has a sound level of approximately 60 dBA. Sound levels above 100 dBA begin to be felt inside the human ear as discomfort. Sound levels between 110 and 130 dBA are felt as pain; levels exceeding 140 dBA could involve tissue damage to the ear (Berglund and

Lindvall 1995). On average, a person perceives a doubling (or halving) of a sound's loudness when there is a 10 dB change in sound level.

Table 3-5 provides a chart of A-weighted sound levels from typical noise sources. Some noise sources (e.g., air conditioner) are continuous sounds that maintain a constant sound level for some period of time. Other sources (e.g., automobile, heavy truck) are the maximum sound produced during an event like a vehicle pass-by. Other sounds (e.g., urban daytime, urban nighttime) are averages taken over extended periods of time. A variety of noise metrics have been developed to describe noise over different time periods, as discussed below.

Table 3-5. Typical Noise Levels of Familiar Noise Sources and Public Responses

Thresholds/Noise Sources	Sound Level (dBA)	Subjective Evaluation[1]	Possible Effects on Humans[1]
Human threshold of pain	140	Deafening	Continuous exposure to levels above 70 dBA can cause hearing loss in the majority of the population
Siren at 30 m (100 ft)	130		
Jet takeoff at 61 m (200 ft) Auto horn at 1 m (3 ft)	120		
Chain saw or noisy snowmobile	110		
Lawn mower at 1 m (3 ft) Noisy motorcycle at 15 m (50 ft)	100	Very Loud	
Heavy truck at 15 m (50 ft)	90		
Pneumatic drill at 15 m (50 ft) Busy urban street, daytime	80	Loud	
Normal automobile at 80 km per hour (50 mi per hour) Vacuum cleaner at 1 m (3 ft)	70		Speech interference
Air conditioning unit at 6 m (20 ft) Conversation at 1 m (3 ft)	60	Moderate	
Quiet residential area Light auto traffic at 30 m (100 ft)	50		Sleep interference
Library or quiet home	40	Faint	
Soft whisper at 5 m (15 ft)	30		None
Slight rustling of leaves	20	Very Faint	
Broadcasting studio	10		
Threshold of human hearing	0		

Source: USEPA 1974

Note: [1] Both the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.

Noise Metrics

The Day Night Average Sound Level (DNL) metric is the energy-averaged sound level measured over a 24-hour period, with a 10-dB penalty assigned to noise events occurring between 10:00 p.m. and 7:00 a.m. (acoustic night). DNL values are average quantities, mathematically representing the continuous sound level that would be present if all the variations in sound level that occur over a 24-hour period were averaged to have the same total sound energy. The DNL metric quantifies the total sound energy received and is therefore a cumulative measure, but it does not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour day. DNL is the standard noise metric used by the U.S. Department of Housing and Urban Development, FAA, USEPA, and DOD. Studies of community annoyance in response to numerous types of environmental noise show that DNL correlates well with impact assessments; there is a consistent relationship between DNL and the level of annoyance. Most people are exposed to sound levels of 50 to 55 DNL or higher on a daily basis.

Research has indicated that about 87% of the population is not highly annoyed by outdoor sound levels below 65 dB DNL (Federal Interagency Committee on Urban Noise 1980). Therefore, the 65 dB DNL noise contour is used to help determine compatibility of military operations with local land use, particularly for land use associated with airfields.

Equivalent Sound Level (L_{eq}) is the continuous sound level that would be present if all the variations in sound level occurring over a specified time period were smoothed out as to contain the same total sound energy. The same calculation for a daily average time period such as DNL but without the penalties is a 24-hour equivalent sound level, abbreviated $L_{eq(24)}$. Other typical time periods for L_{eq} are 1 hour and 8 hours.

The Sound Exposure Level (SEL) metric is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of total sound energy of the entire acoustic event, but it does not directly represent the sound level heard at any given time. SEL captures the total sound energy from the beginning of the acoustic event to the point when the receiver no longer hears the sound. It then condenses that energy into a 1-second period of time, and the metric represents the total sound exposure received.

The highest A-weighted sound level measured during a single event where the sound level changes value with time is called the maximum A-weighted sound level or L_{max}. During a missile launch, the noise level starts at the ambient or background noise level, rises to the maximum level and returns to the background level as the missile goes into the distance. L_{max} defines the maximum sound level occurring for a fraction of a second.

Noise Effects

An extensive amount of research has been conducted regarding noise effects including annoyance, speech interference, sleep disturbance, noise-induced hearing impairment, non-auditory health effects, performance effects, noise effects on children, effects on domestic animals and wildlife, property values, structures, terrain, and archaeological sites. These effects are summarized below.

As previously noted, the primary effect of missile launches on exposed communities is long-term annoyance, defined by USEPA as any negative subjective reaction on the part of an individual or group. The scientific community has adopted the use of long-term annoyance as a primary indicator of community response, and there is a consistent relationship between DNL and the level of community annoyance.

The disturbance of sleep is a major concern for communities exposed to nighttime noise. In this EA/OEA, sleep disturbance uses the SEL noise metric and calculates the probability of awakening from single aircraft overflights. These are based on the particular type of aircraft, flight profile, power setting, speed, and altitude relative to the receptor. The results are then presented as a percent probability of people awakening (USEPA 1974).

For workplace noise the National Institute for Occupational Safety and Health (NIOSH) published a criteria document with a recommended exposure limit of 85 dBA as an 8-hour time-weighted average. This exposure limit was reevaluated in 1998 when NIOSH made recommendations that went beyond conserving hearing by focusing on the prevention of occupational hearing loss. Following the reevaluation using a new risk assessment technique, NIOSH published another criteria document in 1998, which reaffirmed the 85 dB recommended exposure limit (National Institute for Occupational Health and Safety 1998).

Studies have been conducted to examine the nonauditory health effects of aircraft noise exposure, focusing primarily on stress response, blood pressure, birth weight, mortality rates, and cardiovascular health. Exposure to noise levels higher than those normally produced by aircraft in the community can elevate blood pressure and also stress hormone levels. However, the response to such loud noise is typically short in duration: after the noise goes away, the physiological effects reverse and levels return to normal.

3.1.5.1 Regulatory Setting

Under the Noise Control Act of 1972, the Occupational Safety and Health Administration (OSHA) established workplace standards for noise. The minimum requirement states that constant noise exposure must not exceed 90 dBA over an 8-hour period. The highest allowable sound level to which workers can be constantly exposed is 115 dBA, and exposure to this level must not exceed 15 minutes within an 8-hour period. The standards limit instantaneous exposure, such as impact noise, to 140 dBA. If noise levels exceed these standards, employers are required to provide hearing protection equipment that will reduce sound levels to acceptable limits.

3.1.5.2 Region of Influence

The ROI for noise analysis is the area within and surrounding PMRF/Main Base in which humans and wildlife may suffer annoyance or disturbance from noise sources at KTF. This would include areas on PMRF, KTF, and the town of Kekaha.

Primary sources of noise on PMRF/Main Base include airfield and range operations and missile, rocket, and drone launches. Airfield operations include take-offs and landings of high performance and cargo/passenger aircraft, as well as helicopter operations. Range operations include training and research and development activities support. Ambient noise levels from natural sources include wind, surf, and birds.

Noise generated at the PMRF airfield stem from one active runway, four helicopter operating spots, and maintenance operations. Noise levels produced by airfield operations tend to have a continuous impact on PMRF/Main Base. Existing noise levels near the runway may average as high as 75 dBA. Buildings in this area are insulated to achieve a noise reduction of up to 35 dBA. Noise levels farther away from the runway are more characteristic of a commercial park, with levels not exceeding 65 dBA.

Range operations that may impact the sound environment include, but are not limited to, power generation, training and research and development activities support, maintenance operations, and construction or renovation.

The activity with the most noticeable sound events is the launch of missiles, rockets, and drones. These launches result in high-intensity, short-duration sound events. Typical launches at PMRF/Main Base (including KTF launch sites) include the STARS, Terminal High Altitude Area Defense, and Strypi missile launches and have resulted in no public noise complaints. **Table 3-6** lists the noise levels monitored for previous STARS launches at PMRF/Main Base.

Table 3-6. Noise Levels Monitored for STARS Launches at PMRF/Main Base

Distance m (ft)	Measured Average Peak (decibel)
175.3 (575)	125.3
243.8 (800)	123.0
268.5 (881)	121.8
372.5 (1,222)	118.2
482.8 (1,584)	115.3
3,048 (10,000; approx. 2 miles)	97.1
10,668 (35,000; approx. 6.5 miles)	54.0

Source: USASDC 1992

In addition to the noise from the rocket engine, launch vehicles can also generate sonic booms during flight. A sonic boom is a sound that resembles rolling thunder and is produced by a shock wave that forms at the nose and at the exhaust plume of a missile that is traveling faster than the speed of sound. Shock waves that form at the nose and at the exhaust plume of a missile travelling faster than the speed of sound produce an audible sonic boom when they reach the ground. The sonic boom occurs some distance downrange of the launch site. The up-range boundary of the sonic boom carpet forms a parabola pointing downrange. Most of the region subjected to any sonic boom from launches at PMRF is the surface of the ocean so population centers are not affected. Under suitable atmospheric conditions and depending on the trajectory of the missile, low level sonic booms may reach the northern portion of Niihau, as is the case for current operations from PMRF.

Noise impacts on wildlife receptors at the KTF and PMRF/Main Base area are discussed in the biological resources section (**Section 4.1.3**).

3.1.6 Public Health and Safety (PMRF/KTF)

This discussion of public health and safety includes consideration for any activities, occurrences, or operations that have the potential to affect the safety, well-being, or health of members of the public. The primary goal is to identify and prevent potential accidents or impacts on the general public.

A safe environment is one in which there is no, or optimally reduced, potential for death, serious bodily injury or illness, or property damage. Human health and safety addresses public safety during construction, demolition, and renovation activities; and during subsequent operations of those facilities. Various stressors in the environment can adversely affect human health and safety. Identification and control or elimination of these stressors can reduce risks to health and safety to acceptable levels or eliminate risk entirely. Emergency services are organizations which ensure public safety and health by addressing different emergencies. The three main emergency service functions include police, fire and rescue service, and emergency medical service.

The U.S. NTM provides timely marine safety information for the correction of all U.S. Government navigation charts and publications from a wide variety of sources, both foreign and domestic. To ensure the safety of life at sea, the information published in the NTM is designed to provide for the correction of unclassified nautical charts, the unclassified National Geospatial-Intelligence Agency (NGA)/Defense Logistics Information Service (DLIS) Catalog of Hydrographic Products, United States Coast Pilots, NGA List of Lights, U.S. Coast Guard (USCG) Light Lists, and other related nautical publications produced by NGA, National Ocean Service (NOS), and the USCG.

Environmental health and safety risks to children are defined as those that are attributable to products or substances a child is likely to come into contact with or ingest, such as air, food, water, soil, and products that children use or to which they are exposed.

3.1.6.1 Regulatory Setting

Aircraft safety is based on the physical risks associated with aircraft flight. Military aircraft fly in accordance with Federal Aviation Regulations (FAR) Part 91, General Operating and Flight Rules, which govern such things as operating near other aircraft, right-of-way rules, aircraft speed, and minimum safe altitudes. These rules include the use of tactical training and maintenance test flight areas, arrival and departure routes, and airspace restrictions as appropriate to help control air operations. In addition, naval aviators must also adhere to the flight rules, ATC, and safety procedures provided in Navy guidance.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks requires federal agencies to “make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children and shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”

3.1.6.2 Region of Influence

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

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

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

The ROI for potential impacts related to the health and safety of workers includes work areas associated with FE-2 flight test launch operations. The population of concern includes the workers employed at PMRF, including SNL/KTF, but also other personnel directly involved with range operation and training activities currently occurring at PMRF/KTF.

The ROI for potential impact related to public health and safety also includes the areas of Kauai County adjacent to SNL/KTF that could be affected by the proposed launch. These areas include the PMRF overwater training areas. The population of concern consists of visitors to Kauai and permanent residents living in Kauai County.

PMRF takes every reasonable precaution during the planning and execution of the range operations training and test activities to prevent injury to human life or property. In addition to explosive, physical impact, and electromagnetic hazards, potential hazards from chemical contamination, ionizing and non-ionizing radiation, radioactive materials, and lasers are studied by PMRF Range Safety Office to determine safety restrictions.

SNL/KTF Operations

KTF is a launch facility operated by SNL for the DOE on PMRF/Main Base through Inter-Service Support Agreements (U.S. Navy 1998). SNL/KTF notifies PMRF Operations, Security, Fire Department, and Ordnance/Explosive Disposal as required prior to launch and other hazardous operations.

All hazardous operations at SNL/KTF are performed under strict adherence to existing Standard Operating Procedures (SOPs). A site SOP provides general requirements and guidance for all range operations at SNL/KTF, including ordnance safety, pre-launch and hazardous operations control, ordnance handling and storage facilities, liquid fuels storage and handling, and launch pad operations.

KTF rocket motors and other ordnance components are stored in explosive storage magazines by PMRF, except when needed by SNL/KTF for processing, assembly, and launch. The movement of explosives and other hazardous materials between PMRF and SNL/KTF is conducted in accordance with PMRF procedures and DOD Explosives Safety Standards.

PMRF provides fire protection and firefighting services to SNL/KTF and enforces base safety regulations and programs on SNL/KTF.

Range Safety. Range Safety at PMRF is controlled by Range Control, which is responsible for hazard area surveillance and clearance and control of all PMRF operational areas. Range Control maintains real time surveillance, clearance, and safety at all PMRF areas including SNL/KTF. PMRF sets requirements for minimally acceptable risk criteria to occupational and non-occupational personnel, test facilities, and non-military assets during range operations. For all range operations at PMRF, the Range Control Officer requires a safety plan. A Range Safety Operation Plan is generated by PMRF Range Safety personnel prior to range operations.

The PMRF Range Safety Office is responsible for establishing Ground Hazard Areas and Launch Hazard Areas over water beyond which no debris from early flight termination is expected to fall. The Ground and Launch Hazard Areas for missile launches are determined by size and flight characteristics of the missile, as well as individual flight profiles of each flight test. Data processed by ground-based or onboard missile computer systems may be used to recognize malfunctions and terminate missile flight. Before a launch is allowed to proceed, the range is determined cleared using input from ship sensors, visual surveillance from aircraft and range safety boats, radar data, and acoustic information.

All range users must: (1) provide a list of project materials, items, or test conditions that could present hazards to personnel or material through toxicity, combustion, blast, acoustics, fragmentation, electromagnetic radiation, radioactivity, ionization, or other means; (2) describe radiation, toxic, explosive, or ionization problems that could accumulate as a result of their tests; (3) provide aerodynamic and flight control information, and destruct system information and parameters; (4) submit plans, specifications, and procedural or functional steps for events and activities involving explosives to conform to criteria in the PMRF instruction; and (5) provide complete operational specifications of any laser to be used and a detailed description of its planned use. (U.S. Navy 2008)

*Missile Flight Analysis***.** PMRF conducts missile flight safety in accordance with Naval Air Warfare Center Weapons Division Instruction. Missile flight safety includes analysis of missile performance capabilities and limitations, of hazards inherent in missile operations and destruct systems, and of the electronic characteristics of missiles and instrumentation. It also includes computation and review of missile trajectories, launch azimuths, kinetic energy intercept debris impact areas, and hazard area dimensions, review and approval of destruct systems proposals, and preparation of the Range Safety Operation Plan required of all programs at PMRF. These plans are prepared by the PMRF Safety Office for each mission and must be approved by the Commanding Officer prior to any launch. Launch is only allowed when the risk levels are less than the acceptable risk criteria in PMRF Instruction 8020.16, which are equivalent to the criteria developed by the RCC (e.g., RCC 321).

Ground Safety. The Range Control Officer using PMRF assets is solely responsible for determining range status and setting RED (no firing – unsafe condition due to a fouled firing area) and GREEN (range is clear and support units are ready to begin the event) range firing conditions. The Range Safety Approval and the Range Safety Operation Plan documents are required for all weapons systems using PMRF (U.S. Navy 1998). PMRF uses RCC 321, Common Risk Criteria for National Test Ranges. RCC 321 sets requirements for minimally acceptable risk criteria to occupational and non-occupational personnel, test facilities, and nonmilitary assets during range operations. Under RCC 321, the general public shall not be exposed to a probability of casualty greater than 1 in 1 million for each individual during any single mission, and a total expectation of casualty must be less than 100 in 1 million. (Range Commanders Council 2017)

To ensure the protection of all persons and property, SOPs have been established and implemented for the Ground Hazard Areas. These SOPs include establishing road control points and clearing the area using vehicles and helicopters (if necessary). Road control points are established 3 hours prior to launches. This allows security forces to monitor traffic that passes through the Ground Hazard Areas. At 20 minutes before a launch, the Ground Hazard Area is cleared of the public to ensure that, in the unlikely event of early flight termination, no injuries or damage to persons or property would occur.

After the Range Safety Officer declares the area safe, the security force gives the all-clear signal, and the public can reenter the area. (U.S. Navy 1998) No inhabited structures are located within the off-base sections of the Ground Hazard Area. The potential for launch-associated hazards are further minimized by the PMRF Missile Accident Emergency Team. This team is assembled for all launches from PMRF facilities and on-call for all PMRF launches in accordance with PMRF Instruction 5100.1F.

Ordnance Management and Safety. Ordnance safety includes procedures to prevent premature, unintentional, or unauthorized detonation of ordnance. Any program using a new type of ordnance device for which proven safety procedures have not been established requires an Explosive

Safety Approval before the ordnance is allowed on PMRF or used on a test range. This approval involves a detailed analysis of the explosives and of the proposed test activities, procedures, and facilities for surveillance and control, an adequacy analysis of movement and control procedures, and a design review of the facilities where the ordnance items would be handled.

Ordnance management procedures are found in Pacific Missile Range Facility Instruction (PMRFINST) 8020.5, Explosive Safety Criteria for Range Users Ordnance Operations. The Range Control Branch of the Range Programs Division is responsible for: (1) providing detailed analysis of all proposals concerning missiles or explosives and their proposed operation on the range; (2) establishing procedures for surveillance and control of traffic within and entering hazard areas; (3) reviewing the design of facilities in which ordnance items are to be handled to ensure that safety protection meets the requirements of Naval Sea System Command Publication (NAVSEAOP) -5, Ammunition and Explosives Ashore; Safety Regulations for Handling, Storing, Production, Renovation, and Shipping, Chapter 4; (4) training, certifying, and providing Launch Control Officers, Safety Monitors, and Ordnance personnel for activities involving explosive ordnance; (5) assuming responsibility for the control of all emergency facilities, equipment, and personnel required in the event of a hazardous situation from a missile inadvertently impacting on a land area; (6) providing positive control of the ordering, receipt, issue, transport, and storage of all ordnance items; and (7) ensuring that only properly certified handling personnel are employed in any handling of ordnance.

Ordnance is either delivered to PMRF/Main Base by aircraft to the on-base airfield or by ship to Nawiliwili Harbor, and then over land by truck transport along Highway 50 to the base. The barges carrying explosives are met at Nawiliwili Harbor by trained ordnance personnel and special vehicles for transit to and delivery at PMRF/Main Base. All ordnance is transported in accordance with U.S. DOT regulations. The STARS is stored in a specially constructed facility on KTF. No mishaps involving the use or handling of ordnance have occurred at PMRF.

PMRF/Main Base has defined explosive safety-quantity distance (ESQD) arcs. The arcs are generated by launch pads, the Kamokala Magazine ordnance storage area, the Interim Ordnance Handling Pad, and the Missile Assembly/Test Buildings 573, 590, and 685. Only the ESQD arcs generated by the Interim Ordnance Handling Pad and Building 573 are covered by a waiver or exemption. The SNL Launcher site and Missile Assembly Buildings (647 and 685) can accommodate a 380-m (1,250-ft) ESQD arc.

__Ocean Area Clearance__. Range Safety officials manage operational safety for projectiles, targets, missiles, and other hazardous activities into PMRF operational areas. The operational areas consist of two Warning Areas (W-186 and W-188) and one Restricted Area (R-3101) under the local control of PMRF. The Warning Areas are in international waters and are not restricted; however, the surface area of the Warning Areas is listed as “HOT” (actively in use) 24 hours a day. PMRF publishes dedicated warning NTM and NOTAMs 1 week before hazardous operations. In addition, a 24-hour recorded message is updated on the hotline daily by Range Operations to inform the public when and where hazardous operations would take place.

Prior to a hazardous operation proceeding, the range is determined to be cleared using inputs from ship sensors, visual surveillance of the range from aircraft and range safety boats, radar data, and acoustic information from a comprehensive system of sensors and surveillance from shore.

Transportation Safety. PMRF transports ordnance by truck from Nawiliwili Harbor to PMRF along Highway 50. The barges carrying explosives are met at Nawiliwili Harbor by trained ordnance personnel and special vehicles for transit to and delivery at PMRF. All ordnance is transported in accordance with U.S. DOT regulations. PMRF has established PMRFINST 8023.G, which covers the handling and transportation of ammunition, explosives, and hazardous materials on the facility.

In addition, liquid fuels (e.g., nitrogen tetroxide and unsymmetrical dimethylhydrazine) are transported to KTF. These fuels can be shipped to the site by truck, aircraft or barge, which do not affect transportation routes on the island of Kauai. Transportation of these materials is conducted in accordance with U.S. DOT regulations and specific safety procedures developed for the location. Range Control and the FAA are in direct communication in real time to ensure the safety of all aircraft using the airways and the Warning Areas. Within the Special Use Airspace, military activities in Warning Areas W-186 and W-188 are under PMRF control. Warning Areas W-189, W-187, and W-190 are scheduled through the Fleet Area Control and Surveillance Facility.

Because the Warning Areas are located in international airspace, the procedures of the ICAO are followed. The FAA acts as the U.S. agent for aeronautical information to the ICAO, and air traffic in the ROI is managed by the Honolulu Control Facility and Oakland ARTCC.

Fire and Crash Safety. The Navy has developed standards that dictate the amount of fire/crash equipment and staffing that must be present based on the number and types of aircraft stationed on base, and the types and total square footage of base structures and housing. PMRF Crash/Fire is located in the base of the Air Traffic Control Tower, Building 300. Personnel are trained to respond to activities such as aircraft fire fighting and rescue in support of airfield operations, hazardous material incidents, confined space rescue, and hypergolic fuel releases, plus structure and brush fire fighting, fire prevention instruction, and fire inspections.

Ambulance and Class II Emergency Medical Technician services are provided by Emergency Medical Technicians assigned to Crash/Fire. These contractor-operated services are available to military, civil service, and non-government personnel at PMRF, 24 hours a day, 7 days a week. More extensive emergency medical services are available from the West Kauai Medical Center in Waimea, 16 km (10 mi) from the Main Gate at Barking Sands.

3.1.7 Hazardous Materials and Wastes (PMRF/KTF)

This section discusses hazardous materials, hazardous waste, toxic substances, and contaminated sites.

In general, hazardous materials and wastes are defined as those substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, would present substantial danger to public health and welfare or to the environment when released into the environment. The terms hazardous materials, toxic substances, and hazardous waste are often used interchangeably when used informally to refer to contaminants, industrial wastes, dangerous goods, and petroleum products. Each of these terms, however, has a specific technical meaning based on the relevant regulations.

3.1.7.1 Regulatory Setting

Hazardous materials are defined by 49 CFR Section 171.8 as "hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table, and materials that meet the defining criteria for hazard classes and divisions" in 49 CFR Part 173. Transportation of hazardous materials is regulated by the U.S. DOT regulations.

Hazardous wastes are defined by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments, as: "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed." Certain types of hazardous wastes are subject to special management provisions intended to ease the management burden and facilitate the recycling of such materials. These are called universal wastes, and their associated regulatory requirements are specified in 40 CFR Part 273. Four types of waste are currently covered under the universal wastes regulations: hazardous waste batteries, hazardous waste pesticides that are either recalled or collected in waste pesticide collection programs, hazardous waste thermostats, and hazardous waste lamps.

Special hazards are those substances that might pose a risk to human health and are addressed separately from other hazardous substances. Special hazards include asbestos-containing material (ACM), polychlorinated biphenyls (PCBs), and lead-based paint. The USEPA is given authority to regulate special hazard substances by the Toxic Substances Control Act (TSCA). Asbestos is also regulated by USEPA under the CAA, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The DOD established the Defense Environmental Restoration Program (DERP) to facilitate thorough investigation and cleanup of contaminated sites on military installations (active installations, installations subject to Base Realignment and Closure, and formerly used defense sites). The Installation Restoration Program and the Military Munitions Response Program are components of the DERP. The Installation Restoration Program requires each DOD installation to identify, investigate, and clean up hazardous waste disposal or release sites. The Military Munitions Response Program addresses nonoperational rangelands that are suspected or known to contain unexploded ordnance, discarded military munitions, or munitions constituent contamination. The Environmental Restoration Program is the Navy's initiative to address DERP.

3.1.7.2 Region of Influence

The Navy has implemented a strict Hazardous Material Control and Management Program and a Hazardous Waste Minimization Program for all activities. These programs are governed Navy-wide by applicable OPNAVINST and at the installation by specific instructions issued by the Base Commander. The Navy continuously monitors its operations to find ways to minimize the use of hazardous materials and to reduce the generation of hazardous wastes.

The ROI for hazardous materials and hazardous waste would be limited to areas of PMRF, including KTF, to be used for launch preparation, launch, and post-launch activities and in areas where hazardous materials are stored and handled.

Hazardous Materials

PMRF manages hazardous materials through the Navy's Consolidated Hazardous Materials Reutilization and Inventory Management Program (CHRIMP). CHRIMP mandates procedures to control, track, and reduce the variety and quantities of hazardous materials in use at facilities. The CHRIMP concept established Hazardous Materials Minimization Centers as the inventory controllers for Navy facilities. All departments, tenant commands, and work centers must order hazardous materials from the Hazardous Materials Minimization Centers, where all such transactions are recorded and tracked. The exception to this is KTF, which obtains its hazardous materials through DOE channels. Hazardous materials on PMRF are managed by the operations and maintenance contractor through CHRIMP. Hazardous materials managed through the CHRIMP program other than fuels are stored in Building 338. Typical materials used on PMRF/Main Base and stored at Building 338 include cleaning agents, solvents, and lubricating oils.

PMRF has developed programs to comply with the requirements of the Superfund Amendments and Reauthorization Act Title III and Emergency Planning and Community Right-to-Know Act (EPCRA). This effort has included submission to the state and local emergency planning committees of annual Tier II forms, which are an updated inventory of chemicals or extremely hazardous substances in excess of threshold limits. These chemicals at PMRF include jet fuel, diesel fuel, propane, gasoline, aqueous firefighting foam, chlorine, used oil, paint/oils, and paint.

Hazardous Waste

PMRF/Main Base is a large-quantity hazardous waste generator with a USEPA identification number. Hazardous waste on PMRF is not stored beyond the 90-day collection period. PMRF/Main Base has two storage areas on base for hazardous wastes: Building 392 and Building

419. Building 392 stores all base waste except for OTTO (torpedo) fuel, a liquid monopropellant. Building 419 is the torpedo repair shop. At present, both buildings are not used at their maximum hazardous waste storage capacity.

KTF is a small-quantity hazardous waste generator and has a USEPA identification number. There is one hazardous waste storage area on KTF.

PMRF outlines management and disposal procedures for used oils and fuels in the Hazardous Waste Management Plan. PMRF maintains a Used Oil transporter/Processor Permit through the Hawai`i Department of Health. Additionally, degraded jet fuel is used in crash-fire training events. The majority of wastes are collected and containerized at PMRF/Main Base for direct offsite disposal through the Defense Reutilization and Marketing Office (DRMO) at Pearl Harbor within 90 days. The DRMO provides for the transportation and disposal of the wastes to the final disposal facility.

Pollution Prevention/Recycling/Waste Minimization

PMRF has a pollution prevention plan in place for the Main Base and all sites on Kauai, which follows CHRIMP procedures for controlling, tracking, and reducing hazardous materials use and waste generation. PMRF/Main Base currently has three hazardous waste elimination programs in place. These involve recycling toner cartridges, mercury from mercury lamps, and acid/lead batteries.

Installation Restoration Program

KTF has no Environmental Restoration sites. Three Environmental Restoration sites were identified in 1995 and were given a No Further Action determination by USEPA in 1996.

Underground and Aboveground Storage Tanks

There is one underground storage tank and one 10,000-gallon aboveground fuel tank at KTF. KTF complies with PMRF's management plans for oil and hazardous materials outlined in the PMRF Spill Prevention Control and Countermeasures Plan and the Installation Spill Contingency Plan.

Asbestos, Lead-Based Paint, and Polychlorinated Biphenyls

PMRF manages asbestos in accordance with the Base Operations Support contractor's asbestos management plan. Prior to any construction projects, areas to be disturbed are surveyed for asbestos, and any asbestos is removed, before disturbance, by a certified asbestos contractor. The handling of hazardous materials and the potential generation and disposal of hazardous wastes follow ongoing, standard, and applicable regulations and procedures at PMRF.

All facilities associated with PMRF follow basic lead management principles and policies. The exception is KTF, which follows DOE plans for the removal of lead-based paint wastes. The transformers on the KTF site have been tested and are free of polychlorinated biphenyls, and there are no asbestos issues at the site.

Liquid Fuels and Other Toxic Fuels

PMRF uses gasoline and diesel fuels to power range trucks and equipment. Aircraft at PMRF use jet fuel and Jet-A. Jet-A is available at the fuel farm near the airfield. Both aircraft fuels are delivered to the flight line in refuelers.

3.2 Pacific Ocean Flight Corridor

This section includes air quality and biological resources within the Pacific BOA along the over-ocean flight corridor for the FE-2 flight test.

The potential impacts to the following resource areas are considered to be negligible or non-existent so they were not analyzed in detail in this EA/OEA:

Water Resources: There are no groundwater or surface water resources along the over-ocean flight corridor that would be affected by the FE-2 flight test. There would be no disturbance to ocean waters beyond the settling of the individual booster stages hundreds of kilometers (miles) apart as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). No impacts would occur to water resources within the over-ocean flight corridor from the FE-2 flight test.

Geological Resources: There would be no drilling, mining, or construction in the open ocean and no sediment disturbance beyond the settling of the individual rocket booster stages hundreds of kilometers (miles) apart as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). There would be no impacts to geological resources in the over-ocean flight corridor from the FE-2 flight test.

Cultural Resources: There are no identified cultural resources along the flight path within the over-ocean flight corridor; therefore, there would be no impacts to cultural resources within that area from the FE-2 flight test.

Land Use: The FE-2 flight path would avoid populated land masses with their associated assigned land uses. There would be no changes, and therefore, no impacts, from the FE-2 flight test to land use along the flight path over the over-ocean flight corridor.

Airspace: The over-ocean flight corridor is located over international airspace and, therefore, has no formal airspace restrictions governing it. Over-ocean flight tests must comply with DOD Instruction 4540.01, *Use of International Airspace by US Military Aircraft and for Missile/Projectile Firings*. Commercial and private aircraft would be notified through NOTAMs issued through the FAA in advance of the FE-2 flight test launch at the request of RTS as part of their routine operations. Test flight operations would be conducted in accordance with Western Range procedures and would not expand or alter currently controlled airspace. There would be no impacts to airspace from the FE-2 flight test.

Noise: The FE-2 flight would occur at high altitude where it would be generally undetected by vessels or aircraft at the ocean's surface. Sonic booms are generated following launch and during terminal flight and impact; these areas are not within the over-ocean flight corridor. Therefore, there would be no impacts to noise within the over-ocean flight corridor from the FE-2 flight test.

Infrastructure: No changes would occur to infrastructure in the over-ocean flight corridor from the FE-2 flight test; therefore, there would be no impacts to infrastructure in the over-ocean flight corridor.

Transportation: Transportation services would be unaffected by the FE-2 flight test over the open ocean. The payload flight would occur at high altitude where it would be generally undetected by vessels or aircraft. Public NOTAMs and NTMs would be issued along the flight path to ensure the safety of both aircraft and vessels. Components would drop over predetermined open ocean areas to ensure, along with the public notices, that there would be no vessels or aircraft in the vicinity. There would be no impacts from the FE-2 flight test to transportation along the flight path over the open ocean.

Public Health and Safety: The FE-2 flight would occur at high altitudes where it would be generally undetected by vessels or aircraft. NOTAMs and NTMs would be issued along the flight path to ensure the safety of personnel on aircraft and vessels. Components would drop over predetermined open ocean areas to ensure, along with the public notices, that there would be no vessels or aircraft in the vicinities. Range Safety at PMRF would monitor the flight until takeover by RTS range safety as the payload comes into USAKA. If the FE-2 flight strays outside its designated corridor, it would be considered to be malfunctioning and to constitute an imminent safety hazard. The destruct package, which is installed in all flight vehicles capable of impacting inhabited areas, would be activated. This effectively halts powered flight, causing the remaining hardware to fall into the ocean along a ballistic trajectory. The low potential for a flight failure, combined with the low density of vessels in the open ocean, makes any potential impact discountable. There would be no impacts from the FE-2 flight test to public health and safety along the flight path over the over-ocean flight corridor.

Hazardous Materials and Wastes: Each of the three rocket motor boosters would exhaust on-board propellant before dropping into the ocean, while fairings would not carry hazardous materials. *De minimus* residual quantities of other materials may remain on the boosters and fairings; these would be carried to the ocean floor by the sinking components. There would be no impacts to hazardous materials and wastes along the over-ocean flight corridor from the FE-2 flight test.

Socioeconomics: The FE-2 flight corridor is at high altitudes where there would be no impacts to socioeconomics from the FE-2 flight test.

Environmental Justice: Range safety regulations and procedures protective of health and safety would be applied throughout the flight corridor. There would be no disproportionate impacts within the over-ocean flight corridor to minority populations or low-income populations under EO 12898 from the FE-2 flight test.

Visual Resources: The FE-2 flight would occur at high altitude where it would be generally undetected by vessels or aircraft. There would be no changes from the FE-2 flight test to visual resources along the flight path over the over-ocean flight corridor.

Marine Sediments: There would be no marine sediment disturbance beyond the settling of the rocket components as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). There would be no impacts to marine sediments in the over-ocean flight corridor from the FE-2 flight test.

3.2.1 Air Quality (Pacific Ocean Flight Corridor)

3.2.1.1 Regulatory Setting

Because of the potential global effects of testing rockets over the ocean and through the Earth's atmosphere, this EA/OEA considers the environmental effects on the global environment in accordance with the requirements of EO 12114, *Environmental Effects of Major Federal Actions*, DODD 6050.7, *Environmental Effects Abroad of Major Department of Defense Actions; and* EO 13693, *Planning for Federal Sustainability in the Next Decade*, which outlines policies to ensure that federal agencies evaluate climate-change risks and vulnerabilities, and to manage the short- and long-term effects of climate change on their operations and mission. This EO specifically requires DOD agencies to measure, report, and reduce their GHG emissions from both their direct and indirect activities. This section describes the baseline conditions within the Pacific BOA over-ocean flight corridor (**Figure 2-5**) that may be affected by the proposed FE-2 flight test.

Air Quality

The stratosphere, which extends from 10 km (6 mi) to approximately 50 km (30 mi) in altitude, contains the Earth's ozone layer. The ozone layer plays a vital role in absorbing harmful ultraviolet radiation from the sun. Over the last 20 years, anthropogenic (human-made) gases released into the atmosphere—primarily chlorine related substances—have threatened ozone concentrations in the stratosphere which filter harmful ultraviolet sunlight. Such materials include chlorofluorocarbons (CFCs), which have been widely used in electronics and refrigeration systems, and the lesser-used halons, which are extremely effective fire extinguishing agents. Once released, the motions of the atmosphere mix the gases worldwide until they reach the stratosphere, where ultraviolet radiation releases their chlorine and bromine components.

Through global compliance with the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer and amendments, the worldwide production of CFCs and other ozone-depleting substances has been drastically reduced and banned in many countries. A continuation of these compliance efforts is expected to allow for a slow recovery of the ozone layer (World Meteorological Organization 2016).

Atomic chlorine produced from emissions of hydrogen chloride during high-temperature afterburning reactions in the exhaust plume of solid propellant rocket motors can contribute to overall global chlorine loading, which contributes to long-term ozone depletion. Stratospheric hydrogen chloride is diffused through the troposphere and dissipates with a half-life of about 2.3 years; however, hydrogen chloride from rocket emissions could have longer lifetimes because part of the emission occurs at atmospheric levels above the stratosphere. Studies have shown that aluminum oxide, which is emitted from the rocket exhaust as solid particles, could contribute to ozone depletion via activation of chlorine in the atmosphere. Emissions of nitrogen oxides produced in the exhaust plume of rockets can also contribute to stratospheric ozone depletion. **Table 3-7** presents typical emissions from a single STARS booster launch.

Table 3-7. Total Emissions from a STARS Booster

Emission Component	First Stage kg (lb)	Second stage kg (lb)	Third Stage kg (lb)
Water (H_2O)	598.16 (1,318.70)	252.02 (555.60)	22.62 (49.87)
Carbon Dioxide	211.34 (465.91)	171.46 (378.00)	9.03 (19.91)
Hydrogen	219.83 (484.63)	58.87 (129.80)	9.48 (20.91)
Nitrogen	894.42 (1,971.82)	741.64 (1635.00)	47.37 (104.44)
Hydrogen Chloride	1,576.55 (3,475.64)	62.05 (136.80)	23.56 (162.18)
Aluminum Oxide	3,558.80 (7,845.67)	1,391.92 (3,068.60)	155.04 (341.82)
Carbon Monoxide	2,355.86 (5,193.70)	1,346.74 (2,969.00)	92.90 (204.80)
Chlorine	19.81 (43.68)	4.03 (8.90)	0.20 (0.45)

Source: USASDC 1990

Impacts of the FE-2 flight test launch on global warming and ozone depletion in the atmosphere have also been considered as part of cumulative impacts in **Chapter 5.0**.

Greenhouse Gases

As described in **Section 3.1.1.1**, under the USEPA rule, suppliers of fossil fuels or industrial GHGs, manufacturers of mobile sources and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions as carbon dioxide equivalent are required to submit annual reports to USEPA. This threshold was carried forward to determine if additional quantitative analysis would be required for the FE-2 flight test within this EA/OEA.

On 26 June 2019 the CEQ issued draft guidance on when and how federal agencies should consider GHG emissions and climate change in NEPA analyses. As stated in the draft CEQ guidance, a projection of a proposed action's direct and reasonably foreseeable indirect GHG emissions may be used as a proxy for assessing potential climate effects. Agencies should attempt to quantify a proposed action's projected direct and reasonably foreseeable indirect GHG emissions when the amount of those emissions is substantial enough to warrant quantification, and when it is practicable to quantify them using available data and GHG quantification tools. The amount of emissions from the FE-2 flight test is not substantial enough to warrant quantification, and GHG impacts will be analyzed qualitatively.

To reduce energy consumption, reduce GHGs, reduce dependence on petroleum, and increase the use of renewable energy resources the Navy has implemented a number of renewable energy projects. The Navy continues to promote and install new renewable energy projects.

Climate Change

Current global climate changes are scientifically attributable to global warming occurring from GHG emissions. The global annual temperature has increased at an average rate of 0.07°C (0.13°F) per decade since 1880 and at an average rate of 0.17°C (0.31°F) per decade since 1970. The warmest global average temperatures on record have all occurred within the past 15 years, with the warmest years being 2010, 2013, 2014, and 2015 (NOAA 2016). With this in mind, the Navy is poised to support climate-changing initiatives globally, while preserving military operations, sustainability, and readiness by working, where possible, to reduce GHG emissions.

Sea level rise from global warming is primarily ascribed to water flowing into the sea from melting freshwater ice on land and the expansion of sea water as it warms. Tracked by satellites (1993-2016) and as measured along coast lines (1870-2000), according to NASA the rate of sea level rise in 2018 was 3.41 millimeters (0.13 inch) per year.

3.2.1.2 Region of Influence – Over-Ocean Flight Corridor

Dominant during much of the year, trade winds effectively disperse air emissions along the over-ocean flight corridor. Studies in Pacific locations have shown seasonal variations in the concentrations of man-made emissions, consisting of sulfate, nitrate, and dust. Each spring, large quantities of pollution, aerosols, and mineral dust are carried eastward out of Asia and transported over a broad region of the northern Pacific Ocean. Although an increasing trend in emission levels was occurring from the early 1980s to the mid-1990s, a more recent downward trend was recorded through 2000. Because of the lack of local air pollution sources, the dispersal of emissions by trade winds, and the lack of topographic features that inhibit dispersion, air quality along the Pacific BOA over-ocean flight corridor is considered good. Unlike the Continental United States, tropospheric ozone is not a concern in this general area. (USAF 2013)

Changes in sea level have occurred throughout history, with the primary influences being global temperatures; Arctic, Antarctic, and glacial ice masses; and changes in the shape of the oceanic basins and land/sea distribution. Generally, with rising global temperatures, less ice is created or maintained throughout the Earth and sea levels rise. Currently, small islands located within the over-ocean flight corridor may be affected by rising sea levels from global climate change.

3.2.2 Biological Resources (Pacific Ocean Flight Corridor)

Biological resources in the Pacific Ocean Flight Corridor are defined as in **Section 3.1.3**. The biological resources described in this section are those within the affected environment of the Pacific Ocean, specifically those areas subject to FE-2 overflight and splashdown of FE-2 vehicle components (**Figure 2-7**). Consultation species including those protected under the ESA and MMPA have been described in detail and environmental consequences of FE-2 have been analyzed in the U.S. Navy FE-2 Biological Assessment (U.S. Navy 2019).

3.2.2.1 Regulatory Setting

For the purposes of this EA/OEA, special status species in the Pacific Ocean Flight Corridor are those species listed as threatened or endangered under the ESA, species protected under the MMPA, and species protected under the MBTA. The regulatory setting under the ESA, MMPA, and MBTA are described in detail in **Section 3.1.3.1** including relevant definitions under these Acts. The MSA as described in **Section 3.1.3.1** also applies to the Pacific Ocean Flight Corridor, and resources regulated by this Act are discussed below.

3.2.2.2 Biological Resources in the Pacific Ocean Flight Corridor Region of Influence

There are no terrestrial habitats in the Pacific Ocean Flight Corridor. Some seabirds that breed on land and forage in the open ocean area of the Pacific have the potential to occur in the ROI. The waters of the Pacific Ocean Flight Corridor consist of deep ocean waters with both pelagic and benthic habitats. Pelagic areas support communities of planktonic (drifting) and nektonic (swimming) organisms. Benthic communities are made up of marine organisms that live on or near the sea floor such as bottom dwelling fish, mollusks, crustaceans, and echinoderms. **Table 3-8** lists all special status species with the potential to occur in the Pacific Ocean Flight Corridor. Threatened, endangered, and other special status species are discussed in their respective categories. No designated critical habitat for any special status species occurs in the over-ocean flight corridor.

Table 3-8. Special Status Species Known to Occur or with the Potential to Occur in the Pacific Ocean Flight Corridor ROI.

Common Name	Scientific Name	Federal Listing Status	Likelihood of Occurrence in Pacific BOA
Marine Mammals			
Minke whale	*Balaenoptera acutorostrata*	MMPA	L
Sei whale	*B. borealis*	E, MMPA	L
Bryde's whale	*B. edeni*	MMPA	L
Blue whale	*B. musculus*	E, MMPA	L
Fin whale	*B. physalus*	E, MMPA	P
Pygmy killer whale	*Feresa attenuata*	MMPA	P
Short-finned pilot whale	*Globicephala macrorhynchus*	MMPA	L
Risso's dolphin	*Grampus griseus*	MMPA	P
Longman's beaked whale	*Indopacetus pacificus*	MMPA	P
Pygmy sperm whale	*Kogia breviceps*	MMPA	P
Dwarf sperm whale	*K. sima*	MMPA	P
Fraser's dolphin	*Lagenodelphis hosei*	MMPA	P
Humpback whale[1]	*Megaptera novaeangliae*	E, MMPA	P

Common Name	Scientific Name	Federal Listing Status	Likelihood of Occurrence in Pacific BOA
Blainville's beaked whale	*Mesoplodon densirostris*	MMPA	P
Hawaiian monk seal	*Neomonachus schauinslandi*	E, MMPA	P
Killer whale	*Orcinus orca*	MMPA	P
Melon-headed whale	*Peponocephala electra*	MMPA	L
Sperm whale	*Physeter macrocephalus*	E, MMPA	L
False killer whale	*Pseudorca crassidens*	E (Insular Hawaiian DPS), MMPA	P
Pantropical spotted dolphin	*Stenella attenuata*	MMPA	L
Striped dolphin	*S. coeruleoalba*	MMPA	L
Spinner dolphin	*S. longirostris*	MMPA	P
Rough-toothed dolphin	*Steno bredanensis*	MMPA	P
Bottlenose dolphin	*Tursiops truncatus*	MMPA	P
Cuvier's beaked whale	*Ziphius cavirostris*	MMPA	P
Birds			
Band-rumped storm petrel	*Oceanodroma castro*	E, MBTA	P
\`A\`o (Newell's Townsend's shearwater)	*Puffinus auricularis newelli*	T, MBTA	P
Sea Turtles			
Loggerhead turtle	*Caretta caretta*	E	P
Green turtle	*Chelonia mydas*	T (Central North Pacific DPS)	L
Leatherback turtle	*Dermochelys coriacea*	E	P
Hawksbill turtle	*Enetmochelys imbricata*	E	L
Olive ridley turtle	*Lepidochelys olivacea*	T	P
Fish			
Bigeye thresher shark	*Alopias superciliosus*	-	L
Oceanic whitetip shark	*Carcharhinus longimanus*	T	L
Oceanic giant manta ray	*Manta birostris*	T	P
Pacific bluefin tuna	*Thunnus orientalis*	-	P

Abbreviations: ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, MBTA = Migratory Bird Treaty Act, E = federal endangered; T = federal threatened; L = Likely; P = Potential; U = Unlikely.
[1] The Hawai\`i distinct population segment (DPS) is not listed under the ESA. The eastern north Pacific DPS is listed as endangered. There is some evidence that eastern north Pacific DPS whales may winter in Hawai\`i.

Marine Wildlife in the Pacific Ocean Flight Corridor

Marine wildlife in the Pacific Ocean Flight Corridor that are considered in this EA/OEA are those that have the potential to be in the area exposed to elevated noise levels from the FE-2 flight or to splashdown of FE-2 vehicle components.

Marine Mammals. Cetaceans and Hawaiian monk seals are the only marine mammals that have been documented in the Pacific Ocean Flight Corridor. All marine mammal species in the ROI are protected under MMPA, and seven species are listed under the ESA. In addition to the seven ESA listed species, which are all considered to have depleted stocks under the MMPA, four other cetacean species also have depleted stocks (U.S. Navy 2019). All of these species have been described in detail and environmental consequences of FE-2 have been analyzed in the U.S. Navy FE-2 Biological Assessment (U.S. Navy 2019). Nine cetacean species are likely to occur in the Pacific Ocean Flight Corridor. Fifteen other cetacean species are considered to have the potential to occur in the ROI as they likely have very low densities or seasonal distributions in this area. Some of these species such as humpback whales, short-finned pilot whales, killer whales (*Orcinus orca*), spinner dolphins, and bottlenose dolphins, have more coastal distributions. They are more likely to occur in the up-range portion of the flight corridor near the Hawaiian Islands. Species with the highest densities in the Pacific Flight Corridor include Fraser's dolphins (*Lagenodelphis hosei*), spinner dolphins, striped dolphins (*Stenella coeruleoalba*), dwarf sperm whales (*Kogia sima*), and pantropical spotted dolphins (U.S. Navy 2019).

Potential threats to cetacean species in the Pacific BOA include ingestion of marine debris, entanglement in fishing nets or other marine debris, collision with vessels, loss of prey species due to new seasonal shifts in prey species or overfishing, excessive noise above baseline levels in a given area, chemical and physical pollution of the marine environment, parasites and diseases, and changing sea surface temperatures due to global climate change. These threats are not particular to ESA or UES listed species, but the death of an individual is a higher cost to populations with low numbers.

There is increasing evidence that loud underwater noise can be lethal, physically damaging, or disruptive to cetaceans (Miller 2007). Cetaceans have been observed altering their vocalizations in the presence of underwater anthropogenic noises and avoiding some underwater sounds, even vacating feeding or mating grounds, changing migratory routes, or suspending feeding (Miller 2007). Certain cetaceans are affected by elevated noise levels more than others. The beaked whales (Ziphiidae) and other deep diving species seem to be particularly susceptible to acoustic damage and anthropogenic noise has been linked to strandings in some species (Miller 2007, Ellis and Mead 2017).

Hawaiian monk seals breed only on the Hawaiian Islands, with the majority of breeding and pupping taking place on the Northwest Hawaiian Islands (NMFS 2011). Monk seals spend the majority of their time close to shore in waters less than 90 m (300 ft) deep; however, seals are known to forage in offshore areas up to 700 km (378 nm) from the Hawaiian Islands and in waters up to 500 m (1,640 ft) deep (NMFS 2011). Critical habitat was designated for the Hawaiian monk seal in 1986 with revisions in 1988 and 2015 (80 FR 50925 [August 21, 2015]). Critical habitat includes terrestrial areas used for pupping, nursing, and haul-out as well as marine habitat within 10 m (33 ft) of the seafloor out to the 200 m (656 ft) depth contour (80 FR 50925 [August 21, 2015]). This critical habitat includes areas around the main Hawaiian Islands and the Northwestern Hawaiian Islands. Critical habitat has been designated on Kauai; however, no Hawaiian monk seal critical habitat was designated immediately adjacent to PMRF. Hawaiian monk seal critical habitat does not occur in the portion of the ROI that would be subject to direct contact effects (**Figure 3-4**). The stage 1 drop zone does not overlap any Hawaiian monk seal critical habitat. No adverse effects to Hawaiian monk seal critical habitat are anticipated from the FE-2 Proposed Action.

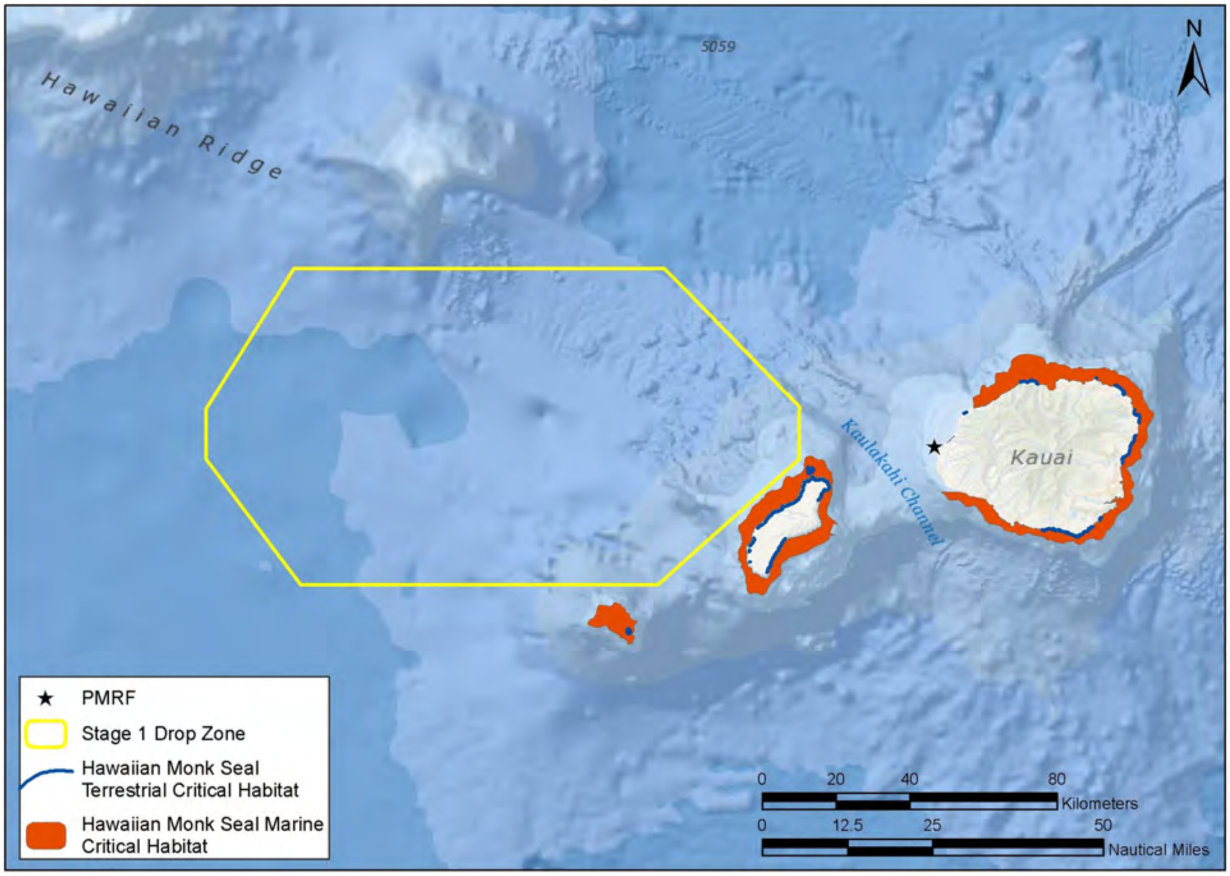


Figure 3-4. Hawaiian Monk Seal Critical Habitat in Relation to the FE-2 ROI near the Hawaiian Islands.

Birds. While no terrestrial habitat occurs in the Pacific Ocean Flight Corridor ROI, many seabirds have wide ranging foraging and non-nesting season distributions. It is possible that some seabird species may forage or rest at sea in the ROI. Two special status species have the potential to occur in the ROI: Newell's shearwater and band-rumped storm petrel (*Oceanodroma castro*). Both species are protected under the ESA and MBTA. No critical habitat for any bird species occurs in the ROI.

Band-rumped storm petrels have a wide distribution with breeding sites in the Pacific and the Atlantic Oceans (USFWS 2005). In the Pacific, breeding sites are found in Japan, the Galapagos, and Hawai`i. These birds are highly pelagic, spending large amounts of time foraging at-sea both during and outside of their breeding season (USFWS 2005). At-sea, these birds feed on small fish, squid, and crustaceans that they take from the ocean surface (USFWS 2005, USFWS 2015). Little information is available for the pelagic distribution of band-rumped storm petrels in the

Pacific. Birds from the Hawaiian population are regularly observed at-sea off Kauai and Hawai`i during the breeding season (USFWS 2005). The marine range of Hawaiian band-rumped storm petrels is believed to extend through the Northwestern Hawaiian Islands and tropical Pacific, especially near the Equatorial Counter Current (USFWS 2005). There are no known at-sea densities for band-rumped storm petrel; however, their densities are likely to be low in the ROI and their distributions patchy and seasonal.

Newell's shearwaters breed only in the southeastern Hawaiian Islands where they nest in burrows on steep forested mountain slopes (Pyle and Pyle 2009). Adults return to Hawai`i to breed in April and depart in early fall (Pyle and Pyle 2009). Little is known about their winter range or about their pelagic foraging distribution; researchers have recorded Newell's shearwaters in low numbers in offshore waters near Hawai`i (Pyle and Pyle 2009). Newell's shearwaters have been primarily recorded in the tropical Pacific between 9–12°N and 160–120°W. However, these birds have been observed and collected at Guam, Saipan, Wake Island, Johnston Atoll, and American Samoa (Pyle and Pyle 2009). While little is known about the abundance and distribution of these birds in the open ocean, it is likely that the distribution and abundance of the pelagic food supply determines the marine distribution of seabirds.

Sea Turtles. Five species of sea turtle—green, hawksbill, leatherback, loggerhead, and olive ridley, all of which are listed under the ESA (**Table 3-8**)—have the potential to occur in the Pacific Ocean Flight Corridor ROI. Green turtles and hawksbill turtles are the most abundant species in the ROI; however, the other species are likely to occur at very low densities. Much of the sea turtle research in the ROI has been conducted on the beaches and nearshore waters of Hawai`i; thus, much of the data documenting the species' occurrence in the BOA is limited to that region. All of these species have been described in detail and environmental consequences of FE-2 have been analyzed in the U.S. Navy FE-2 Biological Assessment (U.S. Navy 2019).

Each sea turtle species has unique life history characteristics that result in different patterns of distribution and abundance in the Pacific. Green turtles are likely to occur in the BOA of the ROI. While green turtles spend much of their time resting and foraging in shallow, nearshore waters, individuals are also known to migrate through deeper waters of the Pacific (Hanser et al. 2017). Studies also suggest that after hatching, juveniles are pelagic (Dutton et al. 2008). Hawksbill turtle hatchlings and small juveniles live in the open ocean where water depths are greater than 200 m (656 ft) before settling into nearshore coral reef habitats as older juveniles (NMFS and USFWS 2013b). Hawksbills are thought to have a mixed migration strategy where some turtles remain close to their rookery and other are highly mobile, traveling thousands of kilometers to foraging areas (NMFS and USFWS 2013b). Similarly, loggerhead turtle hatchlings and early juveniles live in the open ocean before moving to nearshore foraging habitats close to their birth area (Musick and Limpus 1997). They may use the same nearshore habitat as juveniles or may move among different areas before settling in an adult coastal foraging habitat (Godley et al. 2003). Leatherback turtles occur mostly in the open ocean and are only occasionally found in coastal areas. While hatchlings distribution is likely determined by passive drift, juveniles begin to actively swim toward warmer latitudes during winter and higher latitudes during spring (NMFS and

USFWS 2013c). Little is known about olive ridley turtles in the ROI, but available information suggests that olive ridleys traverse through the oceanic waters surrounding the Hawaiian Islands during foraging and developmental migrations (Polovina et al. 2004).

The primary threats to sea turtles in the ROI include bycatch in commercial fisheries, ship strikes, and marine debris (Lutcavage et al. 1997). One comprehensive study estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries (Wallace et al. 2010). Precise data are lacking for sea turtle deaths directly caused by ship strikes; however, live and dead turtles are often found with deep cuts and fractures indicative of a collision with a boat hull or propeller (Hazel et al. 2007; Lutcavage et al. 1997). Marine debris can also be a problem for sea turtles through entanglement or ingestion. Sea turtles can mistake debris for prey; one study found 37% of dead leatherbacks to have ingested various types of plastic (Mrosovsky et al. 2009). In another study of loggerhead turtles in the north Atlantic, 83% (n = 24) of juvenile turtles were found to have ingested plastic marine debris (Pham et al. 2017). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown turtles in all life stages.

Fish. Fish are vital components of the marine ecosystem. They have great ecological and economic importance. The major fisheries in the Central Pacific include several tuna species, marlin, swordfish, sharks, dolphinfish, and wahoo (Lawseth 2007). Two ESA listed species have the potential to occur in the Pacific Ocean Flight Corridor ROI: the oceanic whitetip shark (*Carcharhinus longimanus*) and oceanic giant manta ray (*Manta birostris*). No critical habitat for any fish species is found in the ROI.

The oceanic whitetip is a highly migratory species and is one of the most widespread shark species in tropical and subtropical waters of the world (Young et al. 2018). This species is found in waters between 30°N and 35°S latitude; however, the species prefers open ocean waters between 10°N and 10°S (Young et al. 2018). The oceanic whitetip is found throughout the western and central Pacific Ocean including the Hawaiian Islands (Young et al. 2018). While these sharks may occasionally be found in coastal waters, these sharks are usually found far offshore in the open ocean, on the outer continental shelf, or around oceanic islands in deeper waters (Young et al. 2018).

The giant manta ray is commonly sighted along productive coastlines with upwelling, but primarily occurs near offshore pinnacles and seamounts (Marshall et al. 2011). This species is thought to spend the majority of its time in deep water, with occasional visits to coastal areas (Defenders of Wildlife 2015). While oceanic giant manta rays are known to occur in the ROI, densities, distributions, and migratory patterns for this area are poorly known.

Essential Fish Habitat. To protect fisheries resources, NOAA Fisheries works with the regional fishery management councils to identify the essential habitat for every life stage of each federally managed species using the best available scientific information. EFH is only designated for habitats within the EEZ (from the shoreline out to 200 nm or 370 km). The EFH designations and descriptions for the Hawaiian Archipelago and Pelagics in **Section 3.1.3** and **Table 3-3** apply to the up-range portion of the Pacific Ocean Flight Corridor that is within the Hawaiian Island EEZ and to the stage 1 spent motor drop zone.

Invertebrates. Deepwater coral do occur around the Hawaiian Islands (**Section 3.1.3**; Parrish and Baco 2007). Anthozoan stony corals are known to occur at depths of 500 to 600 m (1,640 to 1,969 ft) in Hawai`i, gold (*Gerardia* spp.) and pink (*Corallium* spp.) corals at depths of 350 to 600 m (1,148 to 1,969 ft), and black corals at depths of 30 to 100 m (98 to 328 ft; Parrish and Baco 2007). The stage 1 drop zone is the area within the ROI that has the shallowest waters, and depths in the stage 1 drop zone are approximately 1,000 to 4,500 m (3,300 to 14,800 ft). Therefore, deepwater corals would not occur in the areas affected by vehicle component splashdown.

While some species of adult deepwater benthic and pelagic invertebrates are likely to occur in the Pacific Ocean Flight Corridor ROI, these organisms likely have low densities within the three spent motor drop zones of the ROI.

At various times of the year the gametes (eggs and sperm) and larvae of marine invertebrates may also occur in the BOA portion of the ROI. The densities of these larvae are difficult to predict, but because of the relatively large distances between reefs and the BOA, larval density in the BOA is likely to be low. It is extremely unlikely that these shallow-water reef-associated larvae would occur in spent motor drop zones in the BOA because they are so far up current from sources of larvae.

3.3 U.S. Army Kwajalein Atoll – Illeginni Islet

This section includes detailed descriptions of cultural resources, biological resources, noise, public health and safety, and hazardous materials and wastes.

The potential impacts to the following resource areas within this geographical area are considered to be negligible or non-existent so they were not analyzed in detail in this EA/OEA:

Air Quality, Greenhouse Gases, and Climate Change: Because of the relatively small numbers and types of local air-pollution sources, the dispersion caused by trade winds, and the lack of topographic features that inhibit dispersion, air quality at USAKA is considered good. The primary activities at USAKA contributing to air pollution are combustion sources that produce particulates, nitrous oxide, sulfur dioxide, carbon monoxide, and hydrocarbon emissions. (UES§1-5.3, 2016) Most of these sources are located on Kwajalein Islet and are regulated under the current version Air Emissions from Major, Synthetic Minor, and Industrial Boiler Stationary Sources Document of Environmental Protection 2013 (Air DEP). There are no ongoing, regulated primary air emission activities at Illeginni Islet or in the BOA proposed impact locations, and there would be no change to air emissions on Kwajalein from the Proposed Action.

The developmental payload would not emit HAPs during flight or impact in USAKA, and no major stationary emission sources would be involved or affected. Fugitive dust from a land impact would be temporary and quickly dispersed by trade winds. Prior to debris recovery at Illeginni Islet, the area would be wetted with freshwater to minimize fugitive dust. Although global sea level is documented to be rising based on climate change and the islands within USAKA are of low elevations, the subtle effects of rising sea level and climate change would not affect the single flight test within a year after signing of the FONSI/FONSH, if approved, nor would the FE-2 flight test affect climate change. No impacts to air quality, GHGs, or climate change would be expected from the FE-2 flight test.

Water Resources: Illeginni Islet has no surface water; groundwater is very limited in quantity and is saline and non-potable. Fresh water used to minimize fugitive dust following impact would not be allowed to flow to the lagoon or ocean and would evaporate in place. In the unlikely event of an accidental release of a hazardous material or petroleum product at the impact site, emergency response personnel would comply with the UES Kwajalein Environmental Emergency Plan (KEEP). No impacts to water resources would be expected.

Geological Resources: There would be no mining or quarrying and little, if any, surface disturbance during the placement of equipment prior to the flight test. While a temporary crater would be created at impact on Illeginni Islet, the crater would be refilled with ejecta and the site topography restored. No impact would occur to geological resources from the FE-2 flight test.

Land Use: No changes to land use would occur from the FE-2 flight test. Illeginni Islet has served as the flight termination site for numerous ballistic and target test flights. The FE-2 flight test activities are consistent with the RTS mission and are well within the limits of current operations of RTS and USAG-KA.

Airspace: Illeginni Islet and the two BOA locations are located under international airspace and, therefore, have no formal airspace restrictions governing them. No new special use airspace would be required, expanded, or altered for the FE-2 flight test. Local airport operations would not be affected. Commercial and private aircraft would be notified through FAA NOTAMs in advance of the launch at the request of RTS as part of their routine operations. Flight operations would be conducted in accordance with Western Range and RTS procedures. There would be no impacts to airspace from the FE-2 flight test.

Infrastructure: There would be no changes and, therefore, no impacts to infrastructure at USAKA. The Proposed Action represents activities that are consistent with the mission and well within the limits of current operations of RTS and USAG-KA.

Transportation: Transportation services would be unaffected by the FE-2 flight test at Kwajalein Atoll. Public NOTAMs and NTMs would be issued along the flight path, to include Kwajalein Atoll, to protect the safety of aircraft and vessels. The payload would impact at Illeginni Islet where there is no resident population, to ensure, along with the public notices, that there would be no unauthorized vessels or aircraft in the vicinity. Transport of FE-2 flight test materials, equipment and personnel to and from USAKA and the impact site would occur using existing transportation methods. The flight test activities are consistent with the mission and well within the limits of current operations of RTS and USAG-KA. There would be no impacts from the FE-2 flight test to transportation at Kwajalein Atoll.

Socioeconomics: Use of USAKA by the U.S. Army is maintained under the Military Use and Operating Rights Agreement and Compact of Free Association, with lease payments made to the Marshallese landowners. The current lease is valid through 2066 with an additional option through 2086. Personnel conducting the FE-2 flight test would reside only temporarily at USAKA, and the flight test would not employ any Marshallese citizens or contribute to the local Marshallese economy. There currently is no resident population at Illeginni Islet. Therefore, there would be no impacts to socioeconomics from the FE-2 flight test.

Environmental Justice: Illeginni Islet does not include any population centers; there currently is no resident population at Illeginni Islet. Therefore, there would be no disproportionate impacts from the FE-2 flight test Flight Test to minority populations and low-income populations as defined under EO 12898.

Visual Resources: There would be no changes to and, therefore, no impacts to the visual aesthetics at USAKA from the FE-2 flight test.

Marine Sediments: For a deep-water impact, there would be no marine sediment disturbance beyond the settling of the payload as it comes to rest on the sea floor after splashing into the ocean at impact and sinking thousands of meters (feet). For an Illeginni Islet impact, which is the

Preferred Alternative, some ejecta may be thrown into shallow waters. There would be no impacts to marine sediments in USAKA from the FE-2 flight test**.**

3.3.1 Biological Resources (USAKA Illeginni Islet)

Biological resources at USAKA are defined as in **Section 3.1.3**. The biological resources described in this section are those within the affected environment of USAKA, specifically those areas subject to pre- and post-flight operations, FE-2 payload overflight, and payload impact. The biological resources are described separately for Illeginni Islet and for the deep-water impact locations southwest and northeast of Illeginni Islet. Consultation species on or near Illeginni Islet and in USAKA waters, including those protected under the ESA, MMPA, and UES, have been described in detail and analyzed in the U.S. Navy FE-2 Biological Assessment (U.S. Navy 2019).

3.3.1.1 Regulatory Setting

The Compact of Free Association between the RMI and the United States (48 USC § 1921) requires all U.S. Government activities at USAKA and all DOD and RTS activities in the RMI to conform to specific compliance requirements, coordination procedures, and environmental standards identified in the UES. As specified in Section 2-2 of the UES, these standards also apply to all activities occurring in the territorial waters of the RMI. The proposed Navy developmental payload test, which could affect Illeginni Islet, the deep-water region southwest of Illeginni Islet, or the deep ocean waters northeast of Kwajalein Atoll, must comply with the UES (USASMDC/ARSTRAT 2018).

For the purposes of this EA/OEA, special status species at USAKA are those species protected under the UES in Section 3-4. The standards in Section 3-4 of the UES were derived primarily from 50 CFR, Sections (§§) 17, 23, 402, 424, and 450-452, which includes species listed as threatened or endangered under the ESA, species protected under the MMPA, and species protected under the MBTA. The regulatory setting under the ESA, MMPA, and MBTA are described in detail in **Section 3.1.3.1** including relevant definitions under these Acts. The Marshall Islands Marine Resources Authority manages marine resources in the RMI.

The UES provides protection for a wide variety of marine mammals, sea turtles, fish, mollusks, coral species, birds, and other terrestrial and marine species, which are listed in Section 3-4 of the UES. This protection applies to all of the following categories of biological resources occurring within the Marshall Islands, including RMI territorial waters:

- Any threatened or endangered species listed under the U.S. ESA;
- Any species proposed for designation or candidates for designation to the endangered species list in accordance with the U.S. ESA;
- All species designated by the RMI under applicable RMI statutes, such as the RMI Endangered Species Act of 1975, Marine Mammal Protection Act of 1990, Marine Resources (Trochus) Act of 1983, and the Marine Resources Authority Act of 1989;

- Marine mammals designated under the U.S. Marine Mammal Protection Act of 1972;
- Bird species pursuant to the Migratory Bird Treaty Act (MBTA); and
- Species protected by the Convention on International Trade in Endangered Species (CITES), or mutually agreed on by USAG-KA, USFWS, NMFS, and the RMI Government as being designated as protected species.

Under the UES, any action carried out at USAKA must be reviewed to determine if the action may affect UES listed species. If consultation is necessary, USFWS and NMFS are responsible for completing consultations. In compliance with Section 3-4 of the UES, a Biological Assessment has been prepared for FE-2 (U.S. Navy 2019). On 27 September 2019, NMFS issued a Final Biological Opinion for the FE-2 Action (NMFS 2019a, **Appendix C**), and USFWS issued a Letter of Concurrence on 29 July 2019 (**Appendix A**).

3.3.1.2 Biological Resources in the Illeginni Islet Region of Influence (Preferred Impact Location)

For the purposes of this EA/OEA, biological resources at Illeginni Islet are those that have the potential to be in the area subject to direct contact, exposure to hazardous chemicals, or exposure to elevated noise levels, or exposed to human activity or equipment operation during FE-2 activities. Special status species at Illeginni Islet are discussed in the appropriate sections below. All species requiring consultation under the UES, including those protected under the ESA and MMPA, have been described in detail and environmental consequences of FE-2 have been analyzed in the U.S. Navy FE-2 Biological Assessment (U.S. Navy 2019).

Terrestrial Vegetation at Illeginni Islet

Vegetation on Illeginni Islet is previously disturbed and managed on much of the western end of the islet, including the payload impact zone, and around buildings/facilities. Native vegetation present on the islet consists of one patch of herbaceous vegetation and three patches of littoral (near shore) forest (**Figure 3-5**). The forest areas are made up primarily of *Pisonia*, *Intsia*, *Tournefortia*, and *Guettarda* trees. Some littoral shrub habitat can also be found, mostly on the western end of the islet (USAF 2010, USFWS 2011). No vegetation species of special status occur on Illeginni Islet.

Marine Vegetation at Illeginni Islet

Marine habitats of the neritic zone around Illeginni Islet include both lagoon-side and ocean-side reef flats, crests, and slopes with diverse communities of organisms as well as areas of pavement and cobbles. These areas provide habitat for several macroalgae species. Surveys of Illeginni Harbor in 2014 (NMFS and USFWS 2017) included observations of blue-green (*Lungbya*), green (*Boodlea, Caulerpa, Neomeris, Halimeda, Rhipilia, Rhipidosiphon,* and *Udotea*), brown (*Dictyota*), and red (*Acrochaetium, Amphiroa, Hydrolithon, Dichotomaria, Gelidiopsis, Sporolithon,* and *Anotrichium*) algae. Seagrass (*Halophila gaudichaudii*) was also in the Illeginni Harbor where it forms dense and relatively extensive beds (NMFS and USFWS 2017). At Kwajalein Atoll, seagrass is listed as a coordination species under the UES. Seagrass beds are important foraging areas for green sea turtles and at Illeginni Islet, seagrass beds are known to occur in the harbor as well as down the slopes in and near the harbor entrance.

Figure 3-5. Terrestrial Habitats, Notional Payload Impact Zone, and Nearshore Direct Contact Affect Areas at Illeginni Islet, Kwajalein Atoll, Republic of the Marshall Islands.

Terrestrial Wildlife at Illeginni Islet

Terrestrial wildlife on Illeginni Islet is limited to seabirds, shorebirds, and potentially nesting sea turtles.

<u>*Sea Turtles*</u>. Suitable sea turtle haulout and nesting habitat exists on the northwestern and eastern beaches of Illeginni Islet (**Figure 3-5**). In a 2008 survey of Illeginni Islet, suitable nesting habitat for sea turtles was identified, consisting or relatively open sandy beaches and seaward margins of herbaceous strand above tidal influence (**Figure 3-5**; USFWS 2011). These areas were thoroughly surveyed on foot for nesting pits and tracks, but none were found. These nesting and haulout habitats were reevaluated during the 2010 inventory (USFWS and NMFS 2012) and were determined to still be suitable habitat. However, the last known sea turtle nest pits on Illeginni Islet were recorded in 1996 on the northern tip of the islet. No sea turtle nests or nesting activity have

been observed on Illeginni Islet in over 20 years. While green and hawksbill turtles are known to use the nearshore waters of Illeginni Islet it is unlikely that sea turtles will haul out or nest on Illeginni Islet.

While sea turtles are unlikely to nest on Illeginni Islet, sea turtles are known to nest throughout the RMI. Based on available information, NMFS and USFWS (2015) estimated 300 nesting green turtle females in the RMI out of a total of 6,500 nesting females in the Central West Pacific DPS (4.6% of known breeding population). Green sea turtles have been observed hauling out and nesting at the northeastern portion of Kwajalein Islet, including the lagoon side at Emon Beach and the sand berm on the ocean side, approximately east of Emon Beach. In May 2009, a hawksbill nested on the lagoon side of Omelek Islet near the harbor area (Malone 2009). The eggs hatched in early July and were inventoried. Thirteen unhatched eggs and 101 hatched eggs were counted. Three sea turtle nests (species unidentified) were found at Kwajalein Islet in September and October 2018. The three nests were excavated after the eggs hatched, and the numbers of hatched and unhatched eggs were estimated as less than 300. Successful sea turtle nesting on Eniwetak was confirmed by video recordings of turtle hatchlings entering the ocean at the islet in May 2011 (Aljure 2016). Successful nesting was also observed on Kwajalein Islet in January 2015 when hatchlings were found and returned to the beach or ocean (Aljure 2016). Observations of potential turtle haul-outs within Kwajalein Atoll include a lagoon-side observation at Legan in May 2013, one at Eniwetak in March 2014, two haul-outs on the ocean-side of Kwajalein Islet in 2014, and two at Eniwetak in December 2014 (Aljure 2016). The most significant green turtle nesting assemblage in RMI is in Bikar Atoll, in the northeastern corner of RMI.

Birds. A number of protected migratory and resident seabirds and shorebirds have been seen breeding, roosting, or foraging on Illeginni Islet (**Table 3-9**). Biological inventories conducted on the islet by USFWS and NMFS have identified at least 14 bird species, including the black noddy (*Anous tenuirostris minutus*), pacific golden plover (*Pluvialis fulva*), wandering tattler (*Heteroscelus incanus*), and ruddy turnstone (*Arenaria interpres*; **Table 3-9**). All of these birds are protected under the MBTA. Birds protected under the MBTA within USAKA receive protection under the UES. None of these species are currently listed under the U.S. ESA.

Surveys have shown shorebirds to use the littoral forest, littoral shrub, and managed vegetation throughout the islet's interior (**Figure 3-5**; USFWS and NMFS 2012). Pooled water on the paved areas attracts both wintering shorebirds and some seabirds (e.g., terns and plovers). White terns have been observed in trees at the northwest corner and southwestern portion of the islet. The shoreline embankment and exposed inner reef provides a roosting habitat for great crested terns and black-naped terns (USFWS and NMFS 2012). Black-naped tern nests with eggs and/or chicks were recorded on Illeginni Islet in 2012 and 2014, and these birds are known to nest in the vicinity of the impact area (Fry 2017). Concentrations of seabirds have also been seen in the littoral forest on the southeast side of the islet, which supports the second largest nesting colony of black noddies recorded on the USAKA islets; 339 nests were identified in 2008. In general, the nesting season for seabirds and shorebirds at Illeginni and other USAKA islets begins in October and continues through April. Exceptions include white terns, which may nest throughout the year (USAF 2010; USFWS 2011) and black-naped terns, which are known to nest in March and

October/November but may nest throughout the year (Fry 2017). These migratory and resident bird species are considered coordination species under the UES. There are no known consultation bird species present on Illeginni Islet.

Table 3-9. Number of Birds Observed on Illeginni Islet During the 1998, 2000, 2002, 2004, 2006, 2008, and 2010 Biological Inventories.

Common Name	Scientific Name	Year						
		1998	2000	2002	2004	2006	2008	2010
Great frigatebird	*Fregata minor*	-	-	-	-	1	-	-
Pacific reef heron	*Egretta sacra*	11	7	3	6	3	3	2
Pacific golden plover	*Pluvialis fulva*	59	39	24	27	41	55	15
Wandering tattler	*Heteroscelus incanus*	6	13	5	7	11	18	7
Gray-tailed tattler	*Heteroscelus brevipes*	-	-	-	-	-	-	1
Tattler spp.	*Heteroscelus* spp.	-	4	1	-	-	-	-
Whimbrel	*Numenius phaeopus*	3	3	4	2	-	4	9
Bristle-thighed curlew	*Numenius tahitiensis*	-	2	-	-	1	2	-
Godwit Sp.	*Limosa*	2	-	-	-	-	-	-
Ruddy turnstone	*Arenaria interpres*	27	3	9	19	57	49	75
Black-naped tern	*Sterna sumatrana*	8	29	24	11	13	31	1
Great crested tern	*Sterna bergii*	5	3	2	1	10	4	3
Brown noddy	*Anous stolidus*	2	4	186	1	36	15	39
Black noddy, adults (nests)	*Anous tenuirostris minutus*	90	292	135	326 (130)	378	- (339)	108 (30)
White tern	*Gygis alba*	14	15	4	5	26	14	-

Source: USFWS and NMFS 2012

Marine Wildlife at Illeginni Islet

The marine environment surrounding Illeginni Islet supports a diverse community of fish, corals, and other invertebrates. In general, coral cover and invertebrate diversity is moderate to high on the lagoon reef slopes and around the eastern seaward reef crest and slopes as well as off the seaward western side. While portions of the western seaward reef area are pavement and cobble with limited diversity and abundance of marine wildlife, much of the area has reef flats and ridges with dense assemblages of corals and other marine organisms. Marine wildlife near Illeginni Islet was evaluated for shallow water habitats in the direct contact affect area and for deeper offshore areas of Kwajalein Atoll which may be subject to elevated sound levels. All special status species described below are protected under the UES.

Marine Mammals. Marine mammals do not occur in the shallow waters of the direct contact area near Illeginni Islet. In the deeper offshore waters near Illeginni Islet, 11 cetacean species are considered likely to occur and four other cetacean species have the potential to occur (**Table 3-10**). These marine mammals (**Table 3-10**) may occur in deeper waters areas subject to increased vessel activity and elevated sound pressure levels (SPLs). All marine mammal species are protected under the MMPA and the UES. These species have been described in detail and environmental consequences of FE-2 have been analyzed in the U.S. Navy FE-2 Biological Assessment (U.S. Navy 2019). The density of most marine mammal species are expected to be very low in the deep waters near Illeginni Islet, although sperm whales have been observed in the vicinity of Illeginni Islet on many occasions (U.S. Navy 2019). Potential threats to cetaceans near Illeginni Islet and hearing ability of these species are the same as for those species in other portions of the ROI (see **Section 3.2.2**).

Table 3-10. Special Status Species Known to Occur or with the Potential to Occur in Shallow Waters Near Illeginni Islet or in Deeper Offshore Waters of Kwajalein Atoll.[1]

Common Name	Scientific Name	Listing Status	Likelihood of Occurrence in Nearshore Waters	Likelihood of Occurrence in Deeper Offshore Waters
Marine Mammals				
Minke whale	*Balaenoptera acutorostrata*	MMPA	-	L
Sei whale	*B. borealis*	E, MMPA	-	P
Bryde's whale	*B. edeni*	MMPA	-	L
Blue whale	*B. musculus*	E, MMPA	-	P
Fin whale	*B. physalus*	E, MMPA	-	P
Short-beaked common dolphin	*Delphinus delphis*	MMPA	-	L
Short-finned pilot whale	*Globicephala macrorhynchus*	MMPA	-	L
Humpback whale	*Megaptera novaeangliae*	E, MMPA	-	P
Killer whale	*Orcinus orca*	MMPA	-	L
Melon-headed whale	*Peponocephala electra*	MMPA	-	L
Sperm whale	*Physeter macrocephalus*	E, MMPA	-	L
Pantropical spotted dolphin	*Stenella attenuata*	MMPA	-	L
Striped dolphin	*S. coeruleoalba*	MMPA	-	L
Spinner dolphin	*S. longirostris*	MMPA	-	L
Bottlenose dolphin	*Tursiops truncatus*	MMPA	-	L
Sea Turtles				
Green turtle	*Chelonia mydas*	T	-	L
Hawksbill turtle	*Enetmochelys imbricata*	E	-	L
Fish				
Bigeye thresher shark	*Alopias superciliosus*	UES	-	P
Oceanic whitetip shark	*Carcharhinus longimanus*	T	-	P
Humphead wrasse	*Cheilinus undulatus*	UES	L	-
Reef manta ray	*Manta alfredi*	UES	P	-
Oceanic giant manta ray	*M. birostris*	T	-	P
Scalloped hammerhead shark	*Sphyrna lewini*	T	-	P
Pacific bluefin tuna	*Thunnus orientalis*	UES	-	P

Abbreviations: MMPA = Marine Mammal Protection Act, E = ESA endangered; T = ESA threatened; L = Likely; P = Potential; U = Unlikely.
Note: [1] All ESA and MMPA listed species are also considered consultation species under the UES.

Sea Turtles. Only the green turtle and hawksbill turtle are known to occur in the waters of the RMI. Green turtles are more common, while hawksbills are considered rare or scarce (Maison et al. 2010). During the 2010 marine inventory at Illeginni Islet, four adult green turtles were observed at three of four survey stations (USFWS and NMFS 2012). During 2012 marine inventories of harbors on Kwajalein Atoll islets, green turtles were only observed in one harbor, and this was at Illeginni Islet (USFWS and NMFS 2017). The 2012 survey recorded dense seagrass beds on the harbor bottom (USFWS and NMFS 2017), which may provide foraging habitat for green turtles. USFWS and NOAA Fisheries share federal jurisdiction for sea turtles, with USFWS having lead responsibility on the nesting beaches and NOAA Fisheries in the marine environment.

In addition to the threats all sea turtle species face throughout their ranges (**Section 3.2.2**), sea turtles near Kwajalein Atoll have the potential to be affected by local threats. In the RMI, sea turtles are an important part of Marshallese culture; they are featured in many myths, legends, and traditions, where they are revered as sacred animals. Eating turtle meat and eggs on special occasions remains a prominent part of the culture. Presently, despite national and international protection as endangered species, marine turtles remain prestigious and a highly desired source of food in the RMI (Kabua and Edwards 2010). Turtles have long been a food source in the RMI, though the level of exploitation is unknown. Direct harvest of eggs and nesting adult females from beaches, as well as direct hunting of turtles in foraging areas, continues in many areas. The harvest of sea turtles in the RMI is regulated by the RMI Marine Resources Act, which sets minimum size limits for greens (86 cm [34-in] carapace length) and hawksbills (69 cm [27 in] carapace length) and closed seasons from June 1 to August 31 and December 1 to January 31. Egg collecting and take of turtles while they are onshore is prohibited (Kabua and Edwards 2010).

Sea turtles' long life expectancy and site fidelity may make them vulnerable to chronic exposure to marine contaminants (Woodrom Rudrud et al. 2007). Sea turtles may also be vulnerable to the bioaccumulation of heavy metals in their tissues (Sakai et al. 2000). At this time, the amount of contaminants in the marine environment at USAKA has not been measured, and sea turtles in the RMI have not been tested for heavy metal levels in blood or tissues. Several studies evaluating sources and contaminants in marine waters, sediments, and organisms have been completed at USAKA for the USAG-KA Environmental Cleanup program. Damage to coral reefs can reduce foraging habitat for hawksbill turtles, and damage to seagrass beds and declines in seagrass distribution can reduce near shore foraging habitat for green turtles in the RMI (NMFS and USFWS 2007, NMFS and USFWS 1991).

Fish. Many species of reef-associated fish are found in the shallow waters of Illeginni Islet. In a 2004 survey of the direct contact affect areas (**Figure 3-5**), NMFS recorded 45 species of fish in the ocean-side direct contact affect area and 40 species in the lagoon-side direct contact affect area (NMFS-PIRO 2017a). The most abundant fish included Atherinid sp., *Chrysiptera brownriggii, Stethojoulis bandanensis, Halichoeres trimuculatus, H. margaritaceus,* and *Thalassoma quinquevittatum* (NMFS-PIRO 2017a). While no UES consultation species were observed during surveys of the affect areas, reef fish can be highly mobile species. Two consultation species, the humphead wrasse (*Cheilinus undulatus*) and a *Manta* sp., have been observed on biological inventories at Illeginni Islet and may occur in the affect areas (**Table 3-11**). One UES coordination species was observed in the ocean-side affect area in 2014 and has also been recorded in reef inventories near Illeginni Islet (**Table 3-11**).

Table 3-11. Consultation and Coordination Fish Species Frequency of Occurrence Since 2010 at Biological Inventory Sites at Illeginni Islet and Throughout Kwajalein Atoll.[1] Consultation species are in Bold.

Common Name	Scientific Name	Listing Status	Frequency at Illeginni Islet (n=5)	Frequency Throughout Kwajalein Atoll (n=125)
Humphead wrasse	*Cheilinus undulatus*	UES	0.2	0.26
Reef manta ray	*Manta alfredi*	UES	0.2	0.03
Giant coral trout	*Plectropomus laevis*	UES	0.8	0.38

[1]Sources: USFWS and NMFS 2012, NMFS and USFWS 2013a, NMFS and USFWS 2017, NMFS and USFWS 2018. Survey sites throughout Kwajalein Atoll include the Mid-Atoll Corridor.

The humphead wrasse is found at low densities (one to eight per acre) where it occurs and is generally observed as solitary male/female pairs or in small groups of two to seven individuals (NMFS 2009). This fish occurs in coral reef regions of the Indo-Pacific in depths from 1 to 100 m (3 to 330 ft; WildEarth Guardians 2012). Both juveniles and adults utilize reef habitats. While juveniles inhabit denser coral reefs closer to shore, adults live in deeper, more open water at the edges of reefs in channels, channel slopes, and lagoon reef slopes (Donaldson and Sadovy 2001). While there is limited knowledge of their movements, it is believed that adults are largely sedentary over a patch of reef and during certain times of the year they move short distances to congregate at spawning sites (NMFS 2009).

Reef manta rays are likely to occur near Illeginni Islet but are not known to occur in the direct contact affect areas. No abundance data is available for reef manta rays in Kwajalein Atoll; however, density data is available for another Pacific island with similar reef ecosystems, Guam. Data from a long-term study of the insular coral reef ecosystem of Guam resulted in an overall density estimate of less than 0.01 individuals per square kilometer (km^2) (Martin et al. 2016). Densities in this study ranged from 0.0 to 0.03 per km^2 with the highest densities in reef habitats predominantly covered by coral, turf, and macroalgae and in Marine Protected Areas around Guam (Martin et al. 2016).

While five special status fish species have the potential to occur in the deep waters of Kwajalein Atoll (**Table 3-10**), only scalloped hammerhead sharks are considered to have the potential to occur in the deep waters near Illeginni Islet. Scalloped hammerhead sharks are found in nearshore areas including bays and estuaries, over continental shelves, and around coral reefs (Defenders of Wildlife 2015). While some reports of scalloped hammerhead sharks in the vicinity of Illeginni Islet are known, this species likely has a sparse and sporadic distribution near Illeginni Islet.

Corals. The marine environment surrounding Illeginni Islet supports a community of corals that is typical of reef ecosystems in the tropical insular Pacific. Within this community are many species of corals that are protected as consultation or coordination species under the UES. In 2014, NMFS surveyed the reef areas adjacent to the impact area at Illeginni Islet (NMFS-PIRO 2017a and 2017b). These surveys encompassed all of the lagoon-side reef area which may be at risk from payload impact and 99% of the ocean-side affect area (**Figure 3-5**). Overall, NMFS recorded 36 coral species that require coordination under the UES and 7 consultation corals (**Table 3-12**). While many other corals species exist in the reefs surrounding Illeginni Islet, these are the only species believed to be in the direct contact affect area. There are 13 additional consultation coral species that occur on the reefs near Illeginni Islet and have the potential to occur in the ROI (*Acropora aculeus, A, aspera, A. dendrum, A. tenella, A. vaughani, Montipora caliculata, Leptoseris incrustans, Pavosna cactua, P. decussata, Turbinaria mesenterina, T. stellulata, Acanthastrea brevis,* and *Alveopora verilliana*; U.S. Navy 2019).

Coral are mostly hermaphroditic broadcast spawners, releasing both male and female gametes into the water in massive numbers (Harrison et al. 1984, NOAA 2017). In many regions, spawning is a mass synchronized event where many coral species release their gametes at the same time (NOAA 2017). After fertilization of the egg, free-floating, or planktonic, larvae form (NOAA 2017). These coral planulae are carried by water currents but are also capable of swimming vertically in the water column (NOAA 2017, Hodgson 1985). Larval duration ranges from a few days to months (reviewed by Jones et al. 2009), but short durations of 3–9 days are much more common (Hughes et al. 2000, Vermeij et al. 2010). Accordingly, dispersal ranges a few tens of meters to 2,000 km (1,080 nm), but local short-distance dispersal occurs much more frequently than long-distance dispersal (Jones et al. 2009, Mumby and Steneck 2008). At certain times of the year, coral gametes, larvae, and planulae may exist in large number over reefs with densities generally decreasing as distance from the reef increases.

There are no known species-specific threats for any particular coral species listed in **Table 3-12**, although it is conceivable that some diseases are species specific. Some groups of corals are more or less susceptible to predation and general threats. For example, the predatory crown of thorns sea star (*Acanthaster planci*) feeds preferentially, but not exclusively, on *Acropora* and *Pocillopora* species (Gulko 1998). A type of “white” disease seems to preferentially affect tabular colonies of *Acropora* (Beger et al. 2008). The aquarium industry has various taxa-specific preferences and, as one of the more profitable industries in the RMI, is a potential contributor to loss of preferred populations (Pinca et al. 2002).

Table 3-12. Coral Species Requiring Consultation (Bold) and Coordination Observed in Direct Contact Affect Areas at Illeginni Islet.[1]

Family	Scientific Name	Ocean-Side Affect Area	Lagoon-Side Affect Area	Number of USAKA Islets Observed on (n=11)
Alcyoniidae				
	Sinularia sp.	x	-	11
Milleporidae				
	Millepora sp.	x	x	11
Helioporidae				
	Heliopora coerulea	**-**	**x**	**11**
Acroporiidae				
	Acropora abrotanoides	x	-	11
	A. austera	x	-	11
	A. digitifera	x	x	11
	A. gemmifera	x	-	11
	A. humilis	x	-	11
	A. latistella	x	-	11
	A. microclados	**x**	**-**	**11**
	A. monticulosa	x	-	11
	A. nana	x	-	10
	A.nasuta	x	-	11
	A. polystoma	**x**	**-**	**6**
	A. robusta	x	x	10
	A. secale	x	-	11
	A. tenuis	x	x	11
	Astreopora myriophthalma	-	x	11
	Montipora aequituberculata	x	-	11
	M. digitata	-	x	9
Agariciidae				
	Gardineroseris planulata	x	x	10
	Pavona duerdeni	x	-	11
	P. varians	x	-	11
	P. venosa	**-**	**x**	**11**
Dendrophylliidae				
	Turbinaria reniformis	**-**	**x**	**11**
Faviidae				
	Cyphastrea agassizi	**-**	**x**	**9**
	Favia matthaii	x	-	11
	Favites abdita	-	x	10
	Favites pentagona	-	x	9
	Goniastrea edwardsi	x	-	11
	G. reniformis	x	-	10
	Leptastrea purpurea	x	x	11
	Platygyra sinesis	x	x	11
Fungiidae				
	Fungia scutaria	x	x	11
Meruliniidae				
	Hydnophora microconis	x	-	11

Family	Scientific Name	Ocean-Side Affect Area	Lagoon-Side Affect Area	Number of USAKA Islets Observed on (n=11)
Mussidae				
	Symphyllia recta	x	-	10
Pocilloporiidae				
	Pocillopora damicornis	-	x	11
	P. eydouxi	x	x	11
	P. meandrina	x	-	11
	P. verrucosa	x	-	11
Poritiidae				
	Porites lobata	x	x	11
	P. lutea	x	x	11
	P. rus	x	-	11

[1] All coordination and consultation coral in this table are protected under the UES. Data Source: NMFS-PIRO 2017a

Factors that can stress or damage coral reefs are coastal development (Risk 2009), impacts from inland pollution and erosion (Cortes and Risk 1985), overexploitation and destructive fishing practices (Jackson et al. 2001, Pandolfi et al. 2003), global climate change and acidification (Hughes et al. 2003), disease (Beger et al. 2008, Galloway et al. 2009), predation (Richmond et al. 2002, Sakashita and Wolf 2009), harvesting by the aquarium trade (Caribbean Fishery Management Council 1994, Richmond et al. 2002), boat anchors (Burke and Maidens 2004), invasive species (Bryant et al. 1998, Galloway et al. 2009, Wilkinson 2002), ship groundings (Sakashita and Wolf 2009), oil spills (NOAA 2001), and possibly human-made noise (Vermeij et al. 2010). These threats can result in coral death from coastal runoff, reduced growth rates caused by a decrease in the pH of the ocean from pollution, reduced tolerance to global climate change, and malnutrition and weakening due to coral bleaching (Carilli et al. 2010, Cohen et al. 2009). The causes of coral bleaching are reasonably well understood and are often tied to unusually high sea temperatures (Brown 1997, Glynn 1993, van Oppen and Lough 2009). Human-made noise may affect coral larvae by masking the natural sounds that orient them toward suitable settlement sites (Vermeij et al. 2010).

Non-Coral Invertebrates. Typical benthic invertebrates include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more. A diverse benthic invertebrate community exists in the shallow waters near Illeginni Islet and has been documented by biennial inventories of Illeginni Islet conducted by NMFS and USFWS. In 2014, NMFS surveyed the reef areas adjacent to the impact area at Illeginni Islet (NMFS-PIRO 2017a and 2017b). These surveys encompassed all of the lagoon-side reef area which may be at risk from payload impact and 99% of the ocean-side affect area (**Figure 3-5**). Overall, NMFS recorded three mollusk species requiring consultation and three coordination mollusk species in the direct contact affect areas (**Table 3-13**). These species are the only species likely to be in the direct contact affect area at Illeginni Islet. Two other consultation species (*Tridacna gigas* and *Pinctada margaritifera*) have been recorded at Illeginni Islet reefs since 2010 and potentially occur in the ROI (**Table 3-13**). Three of these species (*Hippopus hippopus, Tridacna gigas*, and *T. squamosa*) are currently ESA candidate species.

Table 3-13. Mollusk Species Requiring Consultation (Bold) and Coordination Observed in Direct Contact Affect Areas and Biennial Surveys at Illeginni Islet Since 2010.[1]

Family	Scientific Name	Ocean-Side Affect Area	Lagoon-Side Affect Area	Frequency of Occurrence at Illeginni (n=5)	Number of USAKA Islets Observed on (n=11)
Trochiidae					
	Tectus niloticus	-	x	100 %	11
Cardiidae					
	Hippopus hippopus	x	x	40 %	11
	Tridacna gigas	-	-	40 %	11
	T. maxima	-	x	100 %	11
	T. squamosa	-	x	60%	9
Pteriidae					
	Pinctada margaritifera	-	-	20%	8
Strombidae					
	Lambis lambis	-	x	20%	11
	L. c.f. truncata	x	-	60%	11

Data Sources: NMFS-PIRO 2017a, USFWS and NMFS 2012, NMFS and USFWS 2013a, NMFS and USFWS 2017, NMFS and USFWS 2018

[1] All coordination and consultation coral in this table are protected under the UES

All of these special status mollusk species occur on reefs throughout Kwajalein Atoll (**Table 3-13**) and on reefs throughout the Indo-Pacific. Consultation species are described in detail and evaluated with regards to the FE-2 Action in the FE-2 Biological Assessment (U.S. Navy 2019). Major threats for these species include habitat degradation in the form of sedimentation and pollution; harvesting for subsistence, commercial fisheries, the aquarium trade, and the curio trade; and threats from global climate change including shell degradation from ocean acidification and in the giant clams, bleaching of symbiotic zooxanthellae (Meadows 2016).

Reproduction in these mollusk species takes place by broadcast spawning of gametes, usually seasonally. Fertilization generally takes place within hours of spawning, and fertilization success decreases within hours of spawning (Neo et al. 2015); therefore, viable gametes are not likely to be found far from adult clams. Within a few days, fertilized eggs grow into planktonic larvae, which generally metamorphose and settle to the substrate within 3 to 30 days depending on the species (U.S. Navy 2019). In giant clams, larvae are considered the dispersal phase where ambient currents and larval swimming speed influence long-distance dispersal (Neo et al. 2015). This long-distance dispersal is limited by the time period during which larvae are able to survive before settlement/recruitment. For most giant clam species, the period from spawning to settlement is approximately 14 days (Ellis 1997, Neo et al. 2015). Due to the short time between fertilization and settlement in giant clams and their time-limited dispersal capability, the abundance of giant clam larvae (especially viable larvae) is likely very low in the open ocean.

Sponges are ubiquitous on the seafloor at all depths but are most common on hard bottom or reef substrates. The sponges that inhabit coral reefs range from robust species, capable of surviving wave energy and temperature extremes, to specialized species that are delicate and cryptic. The sponges that inhabit coral reefs of the RMI are generally found throughout the tropical Indo-Pacific region. All artificially planted or cultivated sponges (phylum Porifera) within the RMI are afforded protection under the RMI Marine Resources Act. All artificially planted or cultivated sponges are protected under the UES; however, no cultivated sponges are present in the study area. No sponges are regulated by the CITES, and no sponges are protected under the ESA (USAFGSC and USASMDC/ARSTRAT 2015). While there are no consultation or coordination sponges in the ROI, the sponges that inhabit the shallow-water coral reefs of the RMI are generally found throughout the Indo-Pacific, although endemism is possible given that at least 50 other organisms are known to be endemic to the RMI (Beger et al. 2008).

3.3.1.3 Biological Resources in the Offshore Waters of Kwajalein Atoll Region of Influence (Alternative Impact Location)

For the purposes of this EA/OEA, biological resources in the offshore waters southwest and northeast of Kwajalein Atoll are those that have the potential to be in the area subject to direct contact, exposure to hazardous chemicals, or exposure to elevated noise levels, or exposure to human activity or equipment operation during FE-2 activities. The two alternative impact locations are deep water areas with depths between 1,500 and 4,800 m (5,000 and 15,700 ft). Special status species in these two alternative impact locations are discussed in the appropriate sections below.

Marine Wildlife in the Offshore Waters of Kwajalein Atoll

The deepwater marine environment of Kwajalein Atoll likely supports a variety of pelagic and benthic communities. A number of threatened, endangered, and other special status cetacean, sea turtle, and fish species have the potential to occur in these areas. Some of these species occur only seasonally for breeding or because of unique migration patterns.

Marine Mammals. Cetaceans are the only special-status marine mammals that have been documented in the deep offshore waters near Kwajalein Atoll (**Table 3-10**). Eleven cetacean species are considered likely to occur in the deep offshore waters portion of the ROI near Kwajalein Atoll, and four other cetaceans are considered to have the potential to occur in this area (**Table 3-10**). Some of these species occur only seasonally for breeding or during particular points in the migration patterns. Migratory patterns and density of these species were considered when determining the likelihood of occurrence, though little is known about the migratory patterns, distributions, or densities of some cetacean species. Five of these special-status cetacean species are listed under the ESA as endangered. All marine mammals discussed in this section are also protected under the MMPA (16 USC § 1361 et seq.) and the UES.

Potential threats to cetacean species and hearing abilities of cetaceans in the deep offshore waters near Kwajalein Atoll are the same as the general cetacean threats in other portions of the ROI (**Section 3.2.2**).

Sea Turtles. Of the five species of sea turtle species found in the ROI, only the green turtle and hawksbill turtle are known to occur in Kwajalein Atoll offshore waters (**Table 3-10**). Green turtles are more common, while hawksbills are considered rare or scarce (Maison et al. 2010). Sea turtles are highly migratory and may utilize different marine habitats during various life stages (see **Section 3.2.2**). Adult green and hawksbill turtles are known to use nearshore seagrass beds and coral reefs; however, hatchling and juvenile turtles may be found more often in the open ocean. USFWS and NOAA Fisheries share federal jurisdiction for sea turtles with USFWS having lead responsibility on the nesting beaches and NOAA Fisheries, the marine environment.

Fish. Five species of special-status fish have the potential to occur in the deep offshore waters of Kwajalein Atoll (**Table 3-10**). While the bigeye thresher shark, oceanic whitetip shark, and Pacific bluefin tuna are known to occur in the Marshall Islands and have been documented as being caught in local fisheries, little is known about their abundance, distribution, or seasonality in this area. The reef manta ray is not likely to occur in deep offshore waters; however, individuals have been known to migrate further offshore. The oceanic giant manta ray is a more oceanic species and has the potential to occur in these waters. Scalloped hammerhead sharks of the Indo-west Pacific DPS have the potential to occur in the offshore waters of Kwajalein Atoll. The scalloped hammerhead occurs in coastal, warm temperate waters from the surface and intertidal zones to depths of at least 275 m (900 ft). They are highly mobile and partly migratory (Food and Agriculture Organization of the United Nations 2006). Scalloped hammerheads typically remain close to shore during the day and move into deeper waters at night to feed (Bester 1999). Little is known about the abundance, distribution, or migration patterns of scalloped hammerheads in the ROI.

Invertebrates. Habitats in these deep offshore areas may support a variety of pelagic and deep-water benthic invertebrates. Little information is known about species assemblages in the deep offshore waters of Kwajalein Atoll; however, deep water benthic communities have been documented around other island in the central Pacific including the Hawaiian Archipelago, Wake Island, and Johnston Atoll (Parrish and Baco 2007, Kelley et al. 2017, Kelley et al. 2018). Around Wake Atoll, large coral colonies with a diversity of deep-water coral and sponge species have been observed at depths of 1,400 to 1,500 m (4,600 – 5,000 ft; Kelley et al. 2017). In the Hawaiian Archipelago, deep water corals including members of several octocoral Families (Coralliidae, Isididae, Primnoidae, and Chrysogorgiidae) and antipatharian black corals have been observed in waters between 600 and 1,800 m (2,000 – 6,000 ft) deep (Parrish and Baco 2007). A diversity of corals, sponges, and other invertebrates have been found on crust substrate at depth of 1,000 – 2,500 m (3,300 – 8,200 ft) near Johnston Atoll (Kelley et al. 2018). The presence and potential composition of benthic communities in the ROI is unknown; however, if coral species occurred in the deep water impact areas within RMI waters, those species would likely be UES coordination species.

Adults of shallow-water reef associated corals and mollusks do not occur in the deepwater alternative impact sites as their required shallow habitat is absent. As discussed in **Section 3.2.2** and for Illeginni Islet above, coral and other invertebrate gametes and larvae may occur in deep offshore waters at certain times of the year. These may include larvae and gametes of special status species found on the reefs of Kwajalein Atoll. Given the distance from these sites to reef-habitat larval sources and the average time to larval settlement, larval densities in the deep ocean waters near USAG-KA are likely to be very low.

3.3.2 Cultural Resources (USAKA Illeginni Islet)

Cultural resources are material remains of human activity that are significant in the history, prehistory, architecture, or archaeology of the RMI. They include prehistoric resources (produced by preliterate indigenous people) and historic resources (produced since the advent of written records).

3.3.2.1 Regulatory Setting

The UES standards for Cultural Resources (UES§3-7) are derived from the NHPA. The Act establishes federal responsibilities and implementing regulations in 36 CFR 800 and in the U.S. Archaeological and Historic Preservation Act (Public Law 93-291). The regulations for promoting cultural preservation that are in the RMI's Historic Preservation Act 1991 (45 Marshall Islands Revised Code, Chapter 2) was considered in developing UES§3-7. (UES§1-5.9)

The Standards for cultural resources are similar, with a few exceptions, to the U.S. statutes and regulations on which they are based. Under the UES, the U.S. Advisory Council on Historic Preservation (ACHP) does not have a formal role but may be used as a resource by the RMI Historic Preservation Officer (RMIHPO). The RMI ACHP reviews documentation of interaction between USAKA and RMIEPA in certain instances and may be called upon to mediate disagreements between the RMIHPO and the Commander, USAG-KA. Under the Standards, the RMIHPO executes the function of the state historic preservation office. All communication between USAG-KA and the RMIHPO is conducted through RMIEPA. The Standards substitute the RMI National Register of Historic Places and its listing criteria for the corresponding U.S. Register and listing criteria.

A programmatic DEP (current version – Cultural Resources DEP 2006) on protecting cultural resources at USAKA addresses the potential effects of routine operations at USAKA on cultural resources and the procedures for identifying potential cultural resources in areas where they are not known. The programmatic DEP also establishes mitigation procedures for all adverse effects on previously unidentified cultural resources. For proposed activities not covered by the programmatic DEP, a specific DEP that discusses the potential for effects on cultural resources is required. The U.S. Navy SSP has submitted an NPA and will complete the DEP for the FE-2 flight test that addresses all applicable areas of the UES.

3.3.2.2 Region of Influence – Illeginni Islet (Preferred Impact Location)

The ROI includes those areas on Illeginni Islet where FE-2 flight test activities would occur. Surface cover from construction of a helipad, roads, and facilities, and operational disturbances encompass almost the entirety of Illeginni Islet. Vegetative cover is moderate in some areas and represents regrowth since the early 1970s construction occurred.

Limited subsurface testing on the Islet found severe disturbance to the original land surface, especially along the lagoon-facing shoreline; most of which was bulldozed at some time in the past. With the construction of the remote launch site on the east side of the Islet and subsequent use of the Illeginni Islet as a target impact site, any buried traditional or prehistoric remains are likely under significant amounts of modern fill.

Archaeological surveys conducted in 1988 failed to identify any sites on Illeginni Islet. Surveys and subsurface testing in 1994 identified midden-associated (refuse heap) charcoal along the lagoon shoreline that is most likely a modern intrusion; this site was not recommended as eligible for inclusion in the RMI NRHP. No indigenous cultural materials or evidence of subsurface deposits has been found.

In September 1996, a survey of Cold War-era properties at USAKA was completed; a Cold War Historic Context study that built on the 1996 survey was completed in 2012. Several buildings and structures at USAKA are eligible for listing on the RMI NRHP under a Missile Defense Cold War context. Seven potentially eligible buildings are located on Illeginni Islet, and three of those are considered to be significant. These are primarily missile launch facilities and associated buildings. The buildings and other facilities are primarily located in the central and eastern portions of the Islet. Most of them are no longer used and have been abandoned in place. (Mead 2014)

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

There are no cultural resources identified at either of the offshore water impact locations.

3.3.3 Noise (USAKA Illeginni Islet)

This discussion of noise includes the types or sources of noise and the associated sensitive receptors in the human environment. Natural sources of noise on Kwajalein Atoll include the constant wave action along shorelines and the occasional thunderstorm. The sound of thunder is one of the loudest sounds expected at the Atoll and can register up to 120 dB. Within the Atoll communities, other noise sources include a limited number of motor vehicles, motorized equipment, and an occasional fixed- or rotary-wing aircraft. Daytime noise levels within the local communities are expected to typically range between 55 and 65 dBA. Ambient noise levels at Kwajalein Islet are slightly greater because of higher levels of equipment, vehicle, and aircraft operations; there are several aircraft flights per week there, including military and commercial jet aircraft. (USASMDC 2014)

Flight test vehicles can generate sonic booms during flight. The sound of a sonic boom resembles rolling thunder and is produced by a shock wave that forms at the nose and at the exhaust plume of a missile when it travels faster than the speed of sound. These shock waves produce an audible sonic boom when they reach the ground.

3.3.3.1 Regulatory Setting

The UES incorporate provisions and policies for noise management and specify conformance with the U.S. Army's Environmental Noise Management Program and noise monitoring provisions as specified in Army Regulation 200-1 (*Environmental Protection and Enhancement*). As an Army installation, USAG-KA also implements the Army's Hearing Conservation Program as described in Department of the Army Pamphlet 40-501 (*Hearing Conservation Program*). Army standards require hearing protection whenever a person is exposed to steady-state noise greater than 85 dBA, or impulse noise greater than 140 dB, regardless of duration. Army regulations also require personal hearing protection when using noise-hazardous machinery or entering hazardous noise areas.

3.3.3.2 Region of Influence – Illeginni Islet (Preferred Impact Location)

During terminal flight and impact at RTS, the U.S. Navy SSP payload has the potential to affect land areas with sonic booms. The ROI for noise is focused primarily on those RMI atolls and islands closest to a proposed flight path. For the Illeginni Islet land impact scenario, Kwajalein, Likiep, Ailuk, Taka, and Utirik Atolls, as well as Jemo Island, might be affected. Census records from 2011 indicate 401 residents on Likiep Atoll, 339 on Ailuk Atoll, and 435 on Utirik Atoll; and none were reported on Taka Atoll or on Jemo Island. Kwajalein Atoll has the highest population within the ROI with a total population of approximately 11,408, including U.S. personnel and Marshallese residents. (Secretariat of the Pacific Community 2011)

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

During terminal flight and impact at RTS, the developmental payload has the potential to affect open ocean areas with sonic booms. Thus, the ROI for noise for a BOA impact is focused primarily on those RMI atolls and islands closest to the proposed flight path. For a BOA impact scenario, Bikar, Taka, and Utirik Atolls might be affected. Census records from 2011 indicate 435 residents on Utirik Atoll and none were reported on Bikar or Taka Atolls or on Jemo Island.

3.3.4 Public Health and Safety (USAKA Illeginni Islet)

RTS range safety ensures protection to Installation personnel, inhabitants of the Marshall Islands, and ships and aircraft operating in the downrange areas potentially affected by flight tests. Commercial, private, and military air and sea traffic in caution areas designated for specific flight tests or missions, and inhabitants near a flight path, are notified of potentially hazardous operations. An NTM and a NOTAM are transmitted to appropriate authorities to clear traffic from caution areas and to inform the public of impending missions. The warning messages describe the time, the area affected, and safe alternate routes. The GRMI also is informed in advance of rocket launches and reentry payload missions.

3.3.4.1 Regulatory Setting

Specific procedures based on regulations, directives, and flight safety plans are required for all missions at RTS involving aircraft, missile launches, and reentry vehicles. All program operations must first receive approval from the Safety Office at RTS. This is accomplished through presentation of the proposed program to the Safety Office. All safety analyses, SOPs, and other safety documentation applicable to operations affecting the RTS must be provided, along with an overview of mission objectives, support requirements, and schedule. The flight safety plans evaluate risks to inhabitants and property near the flight path, calculate trajectory and debris areas, and specify range clearance and notification procedures. Criteria used at RTS to determine debris hazard risks are in accordance with RCC Standard 321-17, *Common Risk Criteria Standards for National Test Ranges* (Range Commanders Council 2017).

3.3.4.2 Region of Influence – Illeginni Islet (Preferred Impact Location)

The areas of Illeginni Islet where FE-2 flight test activities would occur are the ROI for a land impact scenario. Illeginni Islet is and has been the target impact location for several missile programs, including the MMIII ICBM flights. As part of USAKA, the Islet is not open to the public. A limited number of FE-2 flight test personnel would access the Islet before the flight test to place equipment and after the test to recover the equipment and restore the impact site. There would be no personnel on-island during the impact; project personnel would be located offshore on ships or at other islands at the time of impact.

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

The deep offshore waters to the southwest or northeast of Kwajalein Atoll are the ROI for an FE-2 flight test water impact. These have been previously identified as potential impact locations for several missile programs. Radar and/or visual sweeps of hazard areas are accomplished immediately prior to operations to assist in the clearance of non-mission ships and aircraft. For terminal flight tests, when a point of impact in the Mid-Atoll Corridor at RTS (**Figure 2-2**) is required, additional precautions are taken to protect personnel and the general public, including evacuating nonessential personnel. The FE-2 flight test would not have a Mid-Atoll Corridor impact.

3.3.5 Hazardous Materials and Wastes (USAKA Illeginni Islet)

Hazardous materials are defined by the UES referencing the U.S. DOT definition: a substance or material that is capable of posing an unreasonable risk to health, safety, or property when transported in commerce and has been so designated. Hazardous waste is defined as any solid waste not specifically excluded which meets specified concentrations of chemical constituents or has certain toxicity, ignitability, corrosivity, or reactivity characteristics.

3.3.5.1 Regulatory Setting

The UES for material and waste management (UES §3-6) are derived from a composite of U.S. statutes and regulations addressing the use and management of hazardous material and solid waste and the RMIEPA regulations. (UES §1-5.8)

The UES for hazardous materials and wastes differ from U.S. standards in that the UES classify all materials as either general-use, hazardous, petroleum products, or prohibited. The objective of the Standards for material and waste management is to identify, classify, and manage in an environmentally responsible way all materials imported or introduced for use at USAKA/RTS. Hazardous materials are subject to requirements for security, storage, and inspection at USAKA.

Hazardous wastes must be shipped off the island. Also prohibited are all new uses of PCBs, introduction of new PCBs, and introduction of PCB articles or PCB items.

The USAG-KA base contractor manages hazardous materials and wastes through a Hazardous Materials Management Plan (UES §3-6.4.2), which is incorporated into the KEEP (UES §3-6.4.1). The import, use, handling, and disposal procedures, records, and reporting outlined in the KEEP apply to all tenant activities at USAKA and the RMI as well as to the Garrison.

3.3.5.2 Region of Influence – Illeginni Islet (Preferred Impact Location)

Per the UES requirements, activity-specific Hazardous Materials Procedures are submitted by the project or mission proponents to the Commander, USAG-KA for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials to be used by organizations on the RTS test range and its facilities are under the direct control of the user organization, which is responsible for ensuring that these materials are stored and used in accordance with UES requirements. The use of all hazardous materials is subject to ongoing inspection by USAG-KA environmental compliance and safety offices to ensure the safe use of all materials. The majority of these materials are stored in satellite supply facilities, are distributed through the base supply system, and are consumed in operational processes.

Pollution prevention, recycling, and waste minimization activities are performed at USAKA in accordance with the UES, and established contractor procedures are in place and managed through USAG-KA.

USAG-KA has a contingency plan (the KEEP; UES§3-6.4.1) for responding to releases of oil, hazardous material, pollutants, and contaminants to the environment that is similar to the spill prevention, control, and countermeasures (SPCC) plan required in the United States. The UES also include a process for evaluating and, when called for, remediating sites contaminated from releases. The process is similar to U.S. CERCLA requirements with full participation by the public and UES Appropriate Agencies.

USAG-KA has removed all remaining hazardous materials and wastes (e.g., asbestos, polychlorinated biphenyls in old light ballasts, and cans of paint) from buildings and facilities on Illeginni Islet (USAF 2004). Range personnel, generally using the UXO burn pit on the far west side of the islet, also ensure that any unexploded ordnance or material is consumed with each burn operation. Due to the intermittent nature of flight testing and consequent occupancy of Illeginni Islet, only small quantities of hazardous wastes are generated and managed at Illeginni Islet.

Hazardous waste, whether generated by Installation activities or RTS users, is collected at individual work sites in waste containers. Containers are labeled in accordance with the waste which they contain and are dated the day that the first waste is collected in the container. Containers are kept at the point of generation until full or until a specified time limit is reached. Once full, containers are collected from the generation point within 72 hours and are prepared for transport to the Hazardous Waste Storage Facility (Building 1521) on Kwajalein. Each of the accumulation sites is designed to handle hazardous waste and provide the ability to contain any accidental spills of material, including spills of full containers, until appropriate cleanup can be completed.

Hazardous handling and disposal activities are closely monitored by the USAG-KA Environmental Office in accordance with Standard Practice Instruction 1534 (Management of Materials, Wastes, and Petroleum Products). Waste treatment or disposal is not allowed at the Installation under the UES.

Because of previous reentry vehicle tests on Illeginni Islet, residual concentrations of beryllium and depleted uranium remain in the soil near the helipad on the west side of the Islet. In 2005, LLNL analyzed over 100 soil samples collected around the helipad to determine concentrations of beryllium and depleted uranium in the soil. Soil samples were collected again following subsequent flight tests and results were reported in 2010 and 2013 (Robison et al. 2013). The observed soil concentrations of beryllium and uranium (as a surrogate for depleted uranium) on Illeginni Islet were within compliance with USEPA Region 9 Preliminary Remediation Goals as outlined in the UES. Results from the soil sampling conducted in September 2018 indicated possible beryllium and uranium above the screening levels.

Beryllium was not detected in any of the 20 parent soil samples collected from the Illeginni Islet borings; however, it was detected in one of the duplicate samples with a concentration of 1.9 mg/kg, which exceeded the 1.1 mg/kg screening level for beryllium. This sample was a field duplicate of a sample in which beryllium was not detected above 0.089 mg/kg. This large discrepancy may be due to the heterogeneous nature of the soil matrix (described as gravelly sand), and for conservative interpretation of results, the higher value should be reported. It should be noted that the 20x dilution results did not show this same discrepancy (parent result <0.89 mg/kg, duplicate result < 0.83 mg/kg; see the Data Validation Report in Appendix H); therefore, the elevated results may represent an isolated hotspot within the heterogeneous soil matrix. (LLNL 2018)

Uranium was detected in all 20 of the 20 parent soil samples and the three duplicate soil samples collected from the Illeginni Islet borings, with results ranging from 0.72 mg/kg to 5.1 mg/kg. Six of the detected concentrations in samples collected from the borings and a duplicate sample exceeded the 1.8 mg/kg screening level. Two of the six exceedances were in borings located to represent background locations; therefore, uranium may naturally be present in concentrations above the screening level. (LLNL 2018)

Tungsten was originally considered a stable metal in soil that does not dissolve easily in water. However, tungsten-contaminated environmental media are now a growing concern to USEPA and the DOD because recent research indicates that tungsten may not be as stable as was indicated in earlier studies. Furthermore, varying soil properties such as pH may cause tungsten to dissolve and leach from soil into underlying aquifers (USEPA 2014).

Prior to and following the FE-1 flight test and impact on Illeginni Islet, soil samples were taken to determine the level of tungsten in the soil. Initial results indicate the average level of tungsten in the soil prior to the FE-1 test was 1.3 mg/kg (range of 0.2 to 8.5 mg/kg) and an average of 3.0 mg/kg (range of 0.7 to 9.0 mg/kg) in the soil following the test. The USEPA Regional Screening Levels (RSL) for tungsten is 63 mg/kg for residential areas and 930 mg/kg for industrial areas. Some preliminary computer modeling developed for the FE-1 flight test estimated an average concentration of tungsten in the soil to be 6.5 mg/kg.

Water samples collected in the impact crater shortly after the FE-1 test have tungsten concentrations of 0.65 milligrams per liter (mg/L; range of 0.64 to 0.67 mg/L). These values are well above the USEPA RSL for tapwater (0.016 mg/L tungsten). With respect to predicting tungsten release to groundwater, it was estimated in the original LLNL reactive transport model that the tungsten groundwater concentrations would fall at or below the USEPA RSL of 16 ug/L. This predicted concentration is strongly dependent on the spatial distribution of tungsten, the surface area of the tungsten, and the estimated annual precipitation on the island. We can expect that tungsten concentration in subsurface waters may be higher than the USEPA RSL under certain event conditions. However, because the groundwater at Illeginni Islet is saline and not available year-round, it is not considered a viable source of potable water and the USEPA RSL would not apply. The high concentrations observed in the crater bottom shortly after the FE-1 test may reflect the dissolution of high surface area particulate tungsten in the crater.

The tungsten concentration in water was estimated from a combination of experimental observation (column experiments) and modeling results. Column experiments quantified the rates of tungsten dissolution and degree of tungsten sorption to carbonate material, which were then used to calibrate the CrunchFlow model. The calibrated dissolution rate and sorption affinity were then used in a simple one-dimensional model of the area of tungsten deposition to estimate tungsten concentrations in the freshwater zone just below the zone of tungsten deposition in soil. Shortly after tungsten is deposited in the carbonate soil and rainfall begins the dissolution process, aqueous tungsten concentrations increase; with regular precipitation (assumed at 2.5 m/yr) the concentrations reach a steady state in less than 1 year and remain constant for the following 25 years, the period for which the model was run. The steady state concentration is primarily controlled by the rate of tungsten alloy dissolution and the rate of precipitation on the island. Based on the model parameters estimated aqueous tungsten concentrations will be between 0.006 mg/L (at a dissolution rate of 1.0 mg/m^2/hr) and 0.015 mg/L (at a dissolution rate of 2.6 mg/m^2/hr). These results both fall below the USEPA Residential RSL Level of 0.016 mg/L.

In September 2018 groundwater samples collected from the groundwater monitoring wells were analyzed for tungsten, beryllium, and uranium. Tungsten was detected in seven of the nine groundwater samples collected from the Illeginni Islet wells. Detected concentrations ranged from 55 ug/L to 1,200 ug/L. All detected concentrations exceed the USEPA residential tap water screening level of 16 ug/L, including the sample from a well located as a background well (230 ug/L). Tungsten at this well may be either naturally elevated or present due to past impacts. (LLNL 2018)

Beryllium was not detected in any of the nine groundwater samples collected from the Illeginni Islet wells. Uranium was detected in three of the nine groundwater samples, but concentrations did not exceed the 30 ug/L USEPA MCL screening level. (LLNL 2018)

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

As for a land impact, the UES, KEEP, and Hazardous Materials Management Plan specify procedures relative to hazardous materials and waste. Activity-specific Hazardous Materials Procedures would be submitted by the project or mission proponents to the Commander, USAG-KA for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials would be under the direct control of the user organization to ensure these materials are stored and used in accordance with UES requirements. Identified materials would be expected to be consumed in operational processes associated with the FE-2 flight test.

NASA conducted a thorough study of the seawater quality effects of missile components deposited in ocean waters and concluded that the release of hazardous materials from missiles into seawater will not be significant. The materials will be rapidly diluted and, except in the immediate vicinity of the debris, will not be found at concentrations that produce adverse effects. The payload materials are relatively insoluble and the depth of the Pacific Ocean at either of the proposed BOA impact sites is thousands of feet; where light does not penetrate; levels of oxygen that might interact with materials at the surface are too low for that to occur; and water temperature differences from the upper water layers hamper any mixing between them. Any area on the ocean bottom affected by the slow dissolution of the payload debris would be relatively small, due to the size of the payload debris pieces as compared relative to the volume of surrounding seawater. Therefore, water quality effects from the payload are expected to be minimal. As potential for toxic concentrations is expected to be small and the effects would be very localized, the potential for cumulative impacts is expected to be nil. There are no plans to monitor deep water impacts in the BOA benthic zones of 2,440 m (8,000 ft) depth or greater, where no mixing with upper layers of water occurs.

3.4 NASA Wallops Flight Facility, Virginia

For both institutional support and operational components at WFF, use of an environmental checklist is the procedure by which a proposed project is reviewed to see if that project triggers additional NEPA analysis or falls within the current environmental analysis envelope. Based on the environmental checklist prepared for FE-2, this section includes descriptions of the affected environment for biological resources, airspace, public health and safety, and hazardous materials and wastes at WFF.

Based on the environmental checklist and reviewing the proposed action against each resource in the Final Programmatic EIS (NASA 2019b), the potential impacts to the following resource areas are negligible or non-existent, so they were not analyzed in detail in this EA/OEA:

Air Quality: The Navy FE-2 flight test would result in temporary air emissions during the liftoff of the STARS booster. The quantities of combustion products aluminum oxide, carbon monoxide, carbon dioxide, and hydrogen chloride generated by the entire first stage burn of the STARS booster are 2% to 45% of the liftoff burn (18 seconds) of the Solid-fueled Launch Vehicle (SFHC LV) analyzed in the WFF PEIS. Thus, the minor amounts of combustion products would be well within the limits analyzed in the PEIS and only very minor short-term impacts to air quality would occur. The FE-2 flight test would have the potential to incrementally contribute to global emissions of GHGs. However, no significant impacts are anticipated.

Geological Resources: The Navy FE-2 flight test requires no ground-disturbing activities; thus, no impacts to geological resources would be expected.

Cultural Resources: The Navy FE-2 flight test requires no ground-disturbing activities; thus, no impacts to cultural resources would be expected. Architectural resources that are listed on the NRHP would be within areas subject to noise from FE-2 launches. NASA has developed a Programmatic Agreement with the Virginia Department of Historic Resources and ACHP that would address potential impacts to these structures.

Noise: The Navy FE-2 flight test would result in a short-term noise event during the liftoff of the STARS booster. The noise would be well within the limits analyzed in the PEIS, and only minor short-term impacts to the noise environment would occur.

Land Use: The Navy FE-2 flight test represents activities that are consistent with the mission and well within the limits of current operations at WFF. FE-2 launch activities would not significantly impact parks, recreation areas, wildlife refuges or National Register of Historic Places (NRHP)-eligible structures. Thus, there would be no adverse effects on land use.

Infrastructure: The Navy FE-2 flight test represents activities that are consistent with the mission and well within the limits of current operations and infrastructure capacities at WFF. Thus, there would be no adverse effects on infrastructure.

Transportation: The Navy FE-2 flight test represents activities that are consistent with the mission and well within the limits of current transportation operations at WFF. Any temporary road or waterway closures would be within the limits analyzed in previous NEPA documents. Thus, there would be no adverse effects on transportation.

Socioeconomics: There would be a very small, short-term positive economic impact from expenditures, tax revenue, etc. from the FE-2 program and support staff; thus, no socioeconomic concerns are anticipated. Any increase would be temporary and only for the duration of the Proposed Action.

Environmental Justice: The Navy FE-2 flight test includes a launch trajectory, range safety regulations and procedures, and dispersing of noise over a wide area that precludes disproportionate impacts to minority populations and low-income populations under EO 12898.

Visual Resources: The Navy FE-2 flight test does not require any new construction and the visual aesthetics of WFF would not be changed. Short-term, negligible impacts to recreational resources could occur from temporary closure of Wallops Island beach, Chincoteague inlet, downrange ocean areas, and portions of the Chincoteague National Wildlife Refuge and Assateague Island National Seashore during launch operations.

Marine Sediments: The Navy FE-2 flight test does not require any new construction and the marine sediments of WFF would not be changed.

The following resource areas are analyzed further in this EA.

3.4.1 Biological Resources (WFF)

Biological resources on and near WFF are defined as in **Section 3.1.3**. The biological resources described in this section are those within the affected environment at WFF, specifically those areas subject to FE-2 pre- and post-launch operations as well as launch activities. Launch of the FE-2 vehicle would take place on the Wallops Island area of WFF. Wallops Island is a barrier island on the Virginia Coast which includes beach, maritime grassland, maritime scrub, maritime forest, and wetland habitats along with managed/maintained areas (NASA 2017).

The biological resources at WFF were recently evaluated in an Environmental Resource Document (ERD; NASA 2017). The purpose of the ERD is to provide a baseline description of environmental conditions at WFF against which the effects of proposed actions may be evaluated (NASA 2017). Biological resources were also recently evaluated for impacts of current operations at WFF (including rocket launches) and proposed new operations in the Final WFF Site-wide Programmatic EIS (NASA 2019b).

3.4.1.1 Regulatory Setting

For the purposes of this EA/OEA, special status species at WFF are those species listed as threatened or endangered under the ESA, and species protected under the MMPA, the MBTA, and the Bald and Golden Eagle Protection Act (BGEPA). The regulatory setting under the ESA, MMPA, and MBTA are described in detail in **Section 3.1.3.1** including relevant definitions under these Acts. The MSA as described in **Section 3.1.3.1** also applies to waters offshore of WFF, and resources regulated by this Act are discussed below.

The BGEPA protects bald and golden eagles by prohibiting taking of eagles including disturbing eagles or habitat alterations that would impact eagles (16 USC §§ 668-668c). Under the BGEPA, disturbing eagles is defined as agitating or bothering a bald or golden eagle to a degree that causes or is likely to cause injury to an eagle or is likely to decrease productivity or cause nest abandonment by interfering with breeding, feeding, or sheltering behavior. Any take, including incidental take that is associated with an activity, must be authorized by a permit under the BGEPA (50 CFR § 22.26).

3.4.1.2 Biological Resources at Wallops Region of Influence

Terrestrial Vegetation at Wallops Flight Facility

Wallops Island is dominated by estuarine emergent wetland habitats. These include both non-tidal wetlands in the island interior and tidal wetlands on the western edge (NASA 2017). Predominant vegetation in low marsh tidal wetlands is salt march cordgrass (*Spartina alterniflora*), while high marsh habitats are predominantly salt meadow hay (*Spartina patens*), salt grass (*Distichlis spicata*), common reed (*Phragmites australis*), and groundsel tree (*Baccharis halimifolia*; NASA 2017).

Habitat in the vicinity of the launch facilities at WFF is primarily managed/maintained and estuarine wetland habitats but also includes some scrub-shrub wetlands and maritime grassland habitats (NASA 2017). Managed/maintained areas include meadows of bushy bluestem (*Andropogon glomeratus*), little bluestem (*Schizachyrium scoparium*), thoroughworts and bonesets (*Eupatorium* spp.), and goldenrods (*Solidago* sp.) as well as lawns and roadsides dominated by invasive and introduced plant species (NASA 2017). Vegetation in the maritime grasslands of Wallops Island include American beachgrass (*Ammophila breviligulata*), saltmeadow cordgrass (*Spartina patens*), beach panic grass (*Panicum amarum*), and seaside goldenrod (*Solidago sempervirens*; NASA 2017). Maritime scrub habitats include these maritime grassland species as well as bayberry (*Morella cerifera*), marsh elder (*Iva frutescens*), poison ivy (*Toxicodendron radicans*), winged sumac (*Rhus copallina*), groundsel tree (*Baccharis halimifolia*), stunted black cherry (*Prunus serotina*), and stunted loblolly pine (*Pinus taeda*; NASA 2017).

The only special status plant species known to occur near WFF is seabeach amaranth (*Amaranthus pumilus*; see **Table 3-14**), which occurs on barrier islands and beaches (NASA 2017). Seabeach amaranth is not known to occur on WFF but has been documented on Assateague Island to the north of WFF (NASA 2019b).

Terrestrial Wildlife at Wallops Flight Facility

The terrestrial habitats at WFF support a highly diverse assemblage of terrestrial wildlife including mammals, birds, reptiles, amphibians, and invertebrates. The common wildlife species found on Wallops Island are discussed below as well as special status species (as defined in **Section 3.1.3**) known to occur at WFF.

Mammals. Mammals such as raccoon (*Procyon lotor*), red fox (*Vulpes fulva*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), rice rat (*Oryzomys palustris*), white-tailed deer (*Odocoileus virginianus*), and Eastern cottontail rabbit (*Sylvilagus floridanus*) are all common in the dune and backdune habitats of WFF (NASA 2017).

The only special status terrestrial mammal species with the potential to occur in the ROI is the northern long-eared bat (*Myotis septentrionalis*; **Table 3-14**). This species roosts underneath the bark or in cavities or crevices of trees in the summer and emerges at dusk to feed on insects (NASA 2017). While presence of the northern long-eared bat has not been confirmed on WFF, there have been acoustic detections of bats in the *Myotis* genus at WFF, and it is assumed this species could occur in the vicinity of WFF (NASA 2017).

Birds. Many migratory and resident native bird species are known to occur on WFF. These native bird species are protected under the MBTA including some BCC species (as defined in **Section 3.1.3; Table 3-15**). Bird species known to occur on Wallops Island include several species of shorebirds, marsh birds, grassland species, and shrub-land birds. Some of the most common shorebirds found on Wallops Island beaches include the sanderling (*Calidris alba*), semi-palmated plover (*Charadrius semipalmatus*), short-billed dowitcher (*Limnodromus griseus*), dunlin (*Calidris alpina*). willet (*C. semipalmatus*), royal tern (*Sterna maxima*), least tern (*S. antillarum*), common tern (*S. hirundo*), Forester's tern (*S. foresteri*), laughing gull (*Larus atricilla*), herring gull (*L. argentatus*), and great black-backed gull (*L. marinus*; NASA 2017). Common shrub habitat birds include several species of sparrow, red-winged blackbirds (*Agelaius phoeniceus*), boat-tailed grackles (*Quiscalus major*), fish crows (*Corvus ossifragus*), song sparrows (*Melospiza melodia*), gray catbirds (*Dumetella carolinensis*), yellowthroats (*Geothlypis trichas*), and mourning doves (*Zenaida macroura*; NASA 2017).

Three species of bird listed under the ESA have the potential to occur in the WFF ROI; the red knot (*Calidris canutus rufus*), piping plover (*Charadrius melodus*), and roseate tern (*Sterna dougallii*; **Table 3-14**; NASA 2019b). The red knot are known to occur on Wallops Island beaches during spring migration (NASA 2017). These birds occur mostly during the second half of May when flocks of hundreds to thousands of individuals feed on small mollusks (NASA 2017). Piping plovers use beach and dune habitats and are known to nest on Wallops Island (NASA 2017). These birds feed on invertebrates on beaches and nest in sand or cobbles in low vegetation dune areas (NASA 2017). Piping plovers have been recorded nesting on the north end of Wallops Island since at least 2009 (NASA 2017). Roseate terns are not known to occur on WFF but may transit offshore waters during migration (NASA 2019b).

Several species listed as threatened or endangered by the State of Virginia are also known to occur at or near WFF (**Table 3-14**). Bald eagles, which are no longer listed under the ESA but are still protected under the BGEPA, are known to nest on Wallops Island and other areas of WFF.

Table 3-14. Special Status Species Known to Occur or with the Potential to Occur at or near Wallops Flight Facility and Critical Habitat Presence.

Common Name	Scientific Name	Federal Listing Status	State Listing Status	Area of Occurrence at WFF
Plants				
Seabeach amaranth	*Amaranthus pumilus*	T	T	Nearby Islands
Terrestrial Mammals				
Northern long-eared bat	*Myotis septentrionalis*	T	T	Potentially at WFF
Marine Mammals				
Fin whale	*Balaenoptera physalus*	E, MMPA	E	Nearshore Waters
Humpback whale	*Megaptera novaeangliae*	E, MMPA	E	Nearshore Waters
Harbor seal	*Phoca vitulina*	MMPA		Nearshore Waters
Harbor porpoise	*Phocoena phocoena*	MMPA		Nearshore Waters
Florida manatee	*Trichechus manatus latirostris*	T, MMPA	E	Nearshore Waters
Bottlenose dolphin	*Tursiops truncatus*	MMPA		Nearshore Waters
Birds				
Upland sandpiper	*Bartramia longicauda*	MBTA	T	Wallops Island
Red knot	*Calidris canutus rufus*	T, MBTA	SGCN	Wallops Island
Piping plover	*Charadrius melodus*	T, MBTA	T	Wallops Island
Wilson's plover	*C. wilsonia*	MBTA	E	Nearby Islands
Peregrine falcon	*Falco peregrinus*	MBTA	T	Wallops Island
Gull-billed tern	*Gelochelidon nilotica*	MBTA	T	Nearby Islands
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	T	Wallops Island
Loggerhead shrike	*Lanius ludovicianus*	MBTA	T	Potential in Area
Roseate tern	*Sterna dougallii*	T, MBTA	T	Offshore Waters
Sea Turtles				
Loggerhead turtle	*Caretta caretta*	T	T	Nest at Wallops Island Nearshore Waters
Green turtle	*Chelonia mydas*	T	T	Nearshore Waters
Leatherback turtle	*Dermochelys coriacea*	E	E	Mostly Offshore
Kemp's ridley turtle	*Lepidochelys kempi*	E	E	Nearshore Waters
Fish				
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	E	SGCN	Nearshore Waters

Source: Table 35-5 in NASA 2017
Abbreviations: BGEPA =The Bald and Golden Eagle Protection Act, MMPA = Marine Mammal Protection Act, MBTA = Migratory Bird Treaty Act, E = endangered; T =threatened, SGCN = Species of Greatest Conservation Need, WFF – Wallops Flight Facility

Table 3-15. Birds of Conservation Concern Species That May Occur on or in the Vicinity of Wallops Flight Facility[1].

Common Name	Scientific Name	Habitat	Common Name	Scientific Name	Habitat
Saltmarsh sharp-tailed sparrow	*Ammodramus caudacutus*	marshland	Worm-eating warbler	*Helmitheros vermivorum*	woodland
Seaside sparrow	*Ammodramus maritimus*	marshland	Wood thrush	*Hylocichla mustelina*	woodland
Nelson's sharp-tailed sparrow	*Ammodramus nelsoni*	marshland	Least bittern	*Ixobrychus exilis*	marshland
Short-eared owl	*Asio flammeus*	grassland	Short-billed dowitcher	*Limnodromus griseus*	marshland
Upland sandpiper	*Bartramia longicauda*	grassland	Marbled godwit	*Limosa fedoa*	marshland
American bittern	*Botaurus lentiginosus*	wading	Hudsonian godwit	*Limosa haemastica*	shorebird
Red knot	*Calidris canutus rufa*	shorebird	Red-headed woodpecker	*Nelanerpes erythrocephalus*	woodland
Semipalmated sandpiper	*Calidris pusilla*	shorebird	Whimbrel	*Numenius phaeopus*	shorebird
Wilson's plover	*Charadrius wilsonia*	shorebird	Horned grebe	*Podiceps auritus*	wading
Sedge wren	*Cistothorus stellaris*	marshland	Pied-billed grebe	*Podiymbus podiceps*	wading
Snowy egret	*Egretta thula*	marshland	Black skimmer	*Rynchops niger*	shorebird
Rusty blackbird	*Euphagus carolinus*	woodland	Prairie Warbler	*Setophaga discolor*	woodland
Peregrine falcon	*Falco peregrinus*	woodland	Brown-headed nuthatch	*Sitta pusilla*	woodland
Red-throated loon	*Gavia stellata*	marshland	Least tern	*Sternula antillarum*	shorebird
Gull-billed tern	*Gelochelidon nilotica*	shorebird	Lesser yellowlegs	*Tringa flavipes*	marshland
Kentucky warbler	*Geothlypis formosa*	woodland	Solitary sandpiper	*Tringa solitaria*	marshland
American oystercatcher	*Haematopus palliatus*	shorebird	Buff-breasted sandpiper	*Tryngites subruficollis*	shorebird
Bald eagle	*Haliaeetus leucocephalus*	woodland	Blue-winged warbler	*Vermivora cyanoptera*	woodland

[1] Table 3.9-1 from NASA 2019b. These bird species are also protected under the MBTA.

<u>Reptiles and Amphibians</u>. Several reptile and amphibian species are known to occur on Wallops Island. Common reptiles in the shrub habitats of Wallops Island include the black rat snake (*Elaphe obsoleta*), hognose snake (*Heterodon platyrhinos*), snapping turtle (*Chelydra serpentina*), box turtle (*Terrapene carolina*), and northern fence lizard (*Sceloporus undulatus*; NASA 2017). Diamondback terrapins (*Malaclemys terrapin*) are also known to use the saltmarsh estuaries and tidal flats at WFF (NASA 2017). Amphibian species which are known to use terrestrial and freshwater habitats on Wallops Island include Fowler's toads (*Bufo woodhousei*) and green tree frogs (*Hyla cinerea*; NASA 2017).

Only one species of sea turtle is known to nest at WFF. The loggerhead turtle (*Caretta caretta*) is listed as threatened under the ESA and by the State of Virginia (NASA 2017). Loggerhead turtle nests have been recorded on the beaches of Wallops Island in several years since 2008 (NASA 2017).

<u>Invertebrates</u>. The tidal marshes of Wallops Island support a diversity and abundance of invertebrate species from arthropods such as salt marsh grasshoppers (*Orchelimum fidicinium*), plant hoppers (*Megamelus* spp.), flies, wasps, spiders, and mites to mollusks such as periwinkle snails (*Littorina irrorata*) and mud snails (*Ilyanassa obsoleta*; NASA 2017). The most common

insects at WFF are salt marsh mosquitoes (*Ochlerotatus sollicitans*) and greenhead flies (*Tabanus nigrovittatus*; NASA 2017). Coastal habitats at WFF support a variety of crabs including ghost crabs (*Ocypode quadrata*), calico crabs (*Ovalipes ocellatus*), and fiddler crabs (*Uca* spp.), as well as sand shrimp (*Crangon septemspinosa*) and coffee bean snails (*Melampus bidentatus*; NASA 2017).

Marine Wildlife at Wallops Flight Facility

For the purposes of this EA/OEA, discussion of marine biological resources in the WFF ROI is limited to biological resources in nearshore habitats, within 5.6 km (3.0 nm) of Wallops Island.

Marine Mammals. All marine mammals are protected under the MMPA and as such are considered special status species. Six marine mammal species are known to occur in Wallops Island nearshore waters (**Table 3-14**; NASA 2017). The fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), and Florida manatee (*Trichechus manatus latirostris*) are listed under the ESA. Fin whales are primarily found in deep offshore waters; however, these whales may be found in continental shelf waters and have been documented as close as 2 km (1 mi) offshore (NASA 2017). Humpback whales are primarily found in the North Atlantic during the summer months where they forage on plankton in shallow waters (NASA 2017). Humpback whales may be found in the nearshore waters off Wallops Island, and a juvenile whale was found stranded on north Wallops Island in 2012 (NASA 2017). Florida manatees are known to range north into the mid-Atlantic during the summer and fall where they feed on seagrass and other aquatic vegetation, primarily in rivers and creeks (NASA 2017). Manatees have been observed in nearshore waters in the vicinity of WFF, with the nearest record approximately 12.1 km (7.5 mi) southwest of Wallops Island (NASA 2017).

Sea Turtles. Four species of sea turtles have the potential to occur in Wallops Island nearshore waters (**Table 3-14**; NASA 2017). All four sea turtle species are listed under the ESA and by the State of Virginia. Loggerhead turtles are the most common species of turtles in the nearshore water of WFF (NASA 2017). These turtles forage in offshore and coastal waters where they feed primarily on jellies, crabs, shrimp, sea urchins, sponges, and fish (Bjorndal 1997). Loggerhead turtles are known to nest on the beaches of Wallops Island (NASA 2017), and therefore are likely to be found in nearshore waters. Atlantic green turtles (*Chelonia mydas*) are known to occur in the waters off WFF (NASA 2017). Green turtles forage seasonally on sea grasses and algae in coastal waters and are most likely to be found in the ROI in the summer months (NASA 2017). Leatherback turtles (*Dermochelys coriacea*) forage mainly in offshore waters but are known to forage in coastal waters (NASA 2017). While leatherbacks have not been observed in WFF nearshore waters, a leatherback was found washed up on Wallops Island in 2006 (NASA 2017). The Kemp's ridley turtle (*Lepidochelys kempi*) has never been observed in nearshore waters of WFF (NASA 2017). This turtle has the potential to occur in shallow waters (less than 49 m or 160 ft deep) in the region (NASA 2017).

Fish. The nearshore waters of WFF provide a variety of coastal and estuarine habitats for fish. Common fish near Wallops Island include the Atlantic croaker (*Micropogonias undulatus*), sand shark (*Carcharias taurus*), smooth dogfish (*Mustelus canis*), smooth butterfly ray (*Gymnura* *micrura*), bluefish (*Pomatomidae saltatrix*), spot (*Leiostomus xanthurus*), and summer flounder (*Paralichthys dentatus*; NASA 2017).

One special status fish, the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), has the potential to occur in nearshore waters of WFF (NASA 2017). This species spawns in freshwater rivers in the spring, but they spend the majority of their lives in estuarine and marine waters where they feed on benthic invertebrates (NASA 2017). Atlantic sturgeon are known to occur in the deeper waters off WFF (NASA 2019b) and are most likely to be found in waters less than 50 m (164 ft) deep (NASA 2019b).

Essential Fish Habitat. EFH, as defined in **Section 3.1.3**, has been designated for many species in the vicinity of WFF by the Greater Atlantic Regional Field Office. In this region, EFH is divided into grids. The waters offshore of WFF fall within two of these grid squares. EFH near WFF has been summarized by NASA in their WFF ERD (NASA 2017). Species with designated EFH in the two grid sections are listed in **Table 3-16** (Table 5-4 in NASA 2017).

Table 3-16. Species with Designated Essential Fish Habitat in Waters near WFF[1].

Common Name	Scientific Name	Eggs	Larvae	Juveniles	Adults
Black sea bass	*Centropristus striata*			x	x
Dusky shark	*Charcharinus obscurus*		x	x	
Sandbar shark	*Charcharinus plumbeus*		x	x	x
Atlantic sea herring	*Clupea harengus*				x
Tiger shark	*Galeocerdo cuvieri*		x		
Witch flounder	*Glyptocephalus cynoglossus*	x			
Little skate	*Leucoraja erinacea*			x	x
Winter skate	*Leucoraja ocellata*			x	x
Monkfish	*Lophius americanus*	x	x		
Sand tiger shark	*Odontaspis taurus*		x		x
Summer flounder	*Paralicthys dentatus*			x	x
Atlantic butterfish	*Peprilus triacanthus*			x	x
Winter flounder	*Pleuronectes americanus*	x	x	x	x
Bluefish	*Pomatomus saltatrix*		x	x	x
Cobia	*Rachycentron canadum*	x	x	x	x
Clearnose skate	*Raja eglanteria*			x	x
Atlantic sharpnose shark	*Rhizopriondon terraenovae*				x
Red drum	*Sciaenops occelatus*	x	x	x	x
King mackerel	*Scomberomorus cavalla*	x	x	x	x
Spanish mackerel	*Scomberomorus maculatus*	x	x	x	x
Windowpane flounder	*Scopthalmus aquosus*			x	x
Scalloped hammerhead shark	*Sphyrna lewini*			x	
Surf clam	*Spisula solidissima*			x	
Spiny dogfish	*Squalus acanthias*				x
Scup	*Stenotomus chrysops*			x	x
Red hake	*Urophycis chuss*	x	x	x	

Source: Table 5-4 in NASA 2017
[1] Life stages with an "x" have designated EFH for the corresponding species.

3.4.2 Airspace (WFF)

3.4.2.1 Regulatory Setting

The regulatory setting for airspace is described in **Section 3.1.4**.

3.4.2.2 Region of Influence

The affected airspace use environment in the WFF ROI is described below in terms of its principal attributes: controlled and uncontrolled airspace, special use airspace, en-route airways and jet routes, airports and airfields, and air traffic control, and military training routes.

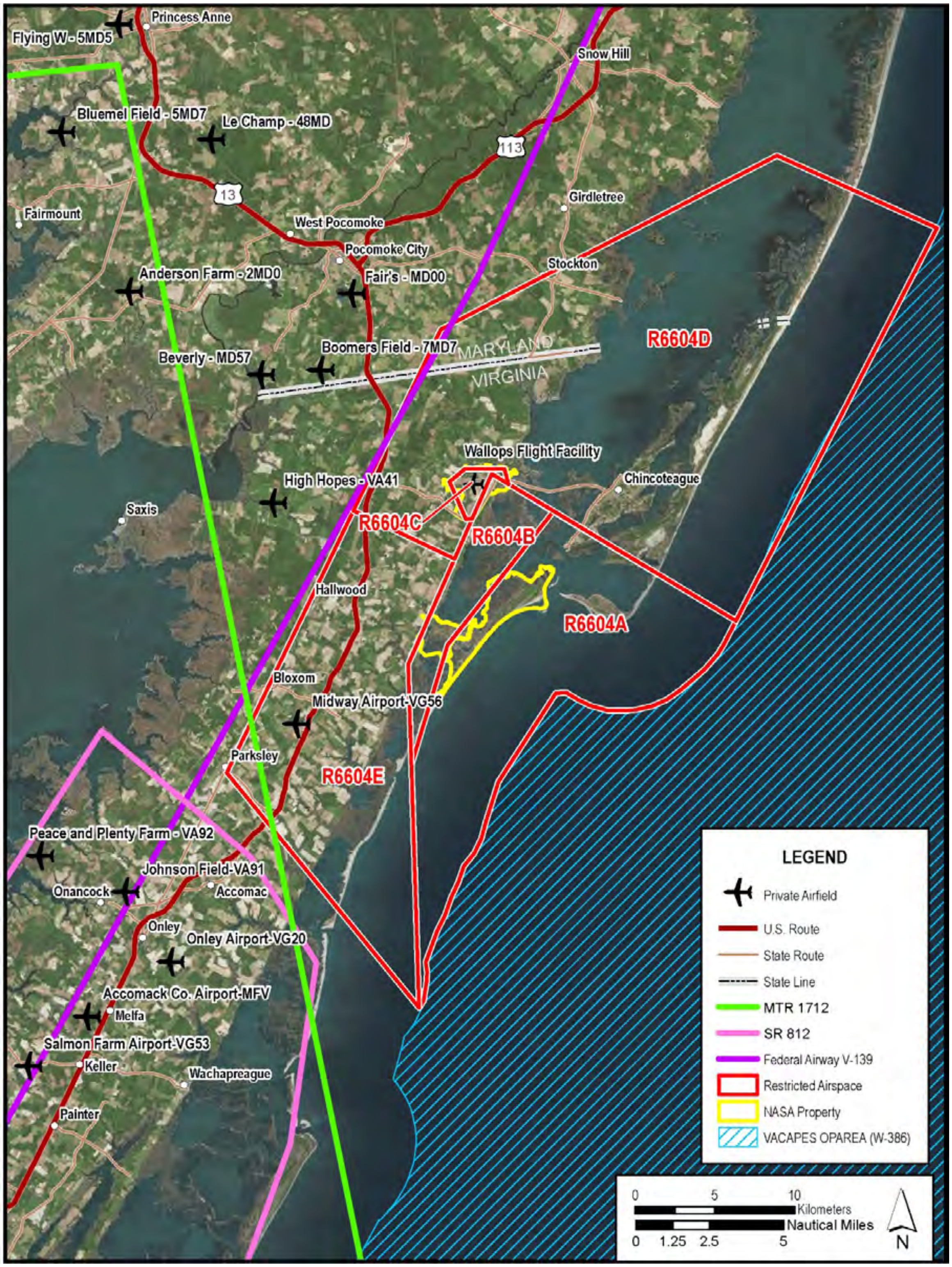
The ROI for airspace includes the airspace over the WFF Main Base airfield and Restricted airspace above the WFF launch facilities, and offshore warning areas. **Figure 3-6** shows a view of the airspace within the WFF ROI.

Controlled and Uncontrolled Airspace

Around the Main Base airfield, WFF operates controlled Class D airspace which extends from the surface vertically to 760 m (2,500 ft) in a 9.25 km (5 nm) radius around the center of the airfield. Prior to entering the airspace, pilots are required to establish and maintain two-way radio communications with the WFF airport tower, which serves as the air traffic control (ATC) facility. Aircraft operations at the airfield include takeoff, landing, or practice approach, each of which counts as one operation. Outside of Class D airspace, and after ATC operating hours, the FAA assigns the responsibility for units of airspace to ARTCCs. The WFF airfield is located within the Washington ARTCC. Airfield operations at WFF average 44 per day for an approximate 61,000 annual airfield operations, the flight operations envelope at WFF.

Special Use Airspace

R-6604 A/B/C/D/E (R-6604 A-E) is NASA controlled/restricted airspace (**Figure 3-6**). This restricted airspace consists of five independent airspace units that may be activated individually or together. R-6604 A-E is available 24 hours a day, 7 days a week from the surface to unlimited altitude. Non-participating aircraft must contact the WFF Range Control Center or the Washington ARTCC to obtain clearance to transit through any portion of an activated restricted area.



Source: NASA 2019b

Figure 3-6. Airspace Use Surrounding WFF

The Navy Fleet and Area Control (FACSFAC) VACAPES controls and schedules the offshore warning areas, including W-386. As a designated ATC facility, FACSFAC is responsible for all aircraft (general, military, and commercial) operating within its area of responsibility, the scheduling of offshore warning areas and military operating areas, and the preparation of NOTAMs and NTMs for broadcast by the FAA and U.S. Coast Guard, respectively. FACSFAC VACAPES also coordinates ATC and flight monitoring. W-386 is available from the surface to unlimited altitude. R-6604 A-E connects to the VACAPES Operations Area offshore warning area W-386. Close coordination between FACSFAC, NASA, and FAA ATC facilities enables effective, real-time, joint use of R-6604 A-E and the VACAPES Range Complex warning areas. When in use by NASA or the Navy, R-6604 A-E and W-386 are "hot" and the scheduled airspace blocks are closed to all nonparticipating users. When not in use, R-6604 A-E and W-386 are "cold" and the airspace blocks are returned to the NAS, allowing civilian aircraft to transit through R-6604 A-E or that portion of W-386. (NASA 2019b)

Military Training Routes

Military Training Route (MTR) visual route (VR) 1712 that crosses the southwestern corner of R-6604E airspace is owned and operated by the 113th Wing at Andrews AFB. Typically, MTRs are aerial corridors across the United States in which military aircraft can operate below 3,050 m (10,000 ft) faster than the maximum FAA safe speed of 250 knots (288 miles per hour) to which all other aircraft at that height are restricted. VR1712 is solely a visual route where visibility must be greater than or equal to 8 km (5 mi) and the cloud ceiling must be greater than or equal to 914 m (3,000 ft) above ground level (AGL). The 113th Wing operates MTR VR1712 daily from 7:30 a.m. to sunset. The operating altitude is 150 to 460 m (500 to 1,500 ft) AGL. (NASA 2019b)

Slow routes (SR) are similar to VRs except SRs are flown at airspeeds of 250 knots (288 miles per hour) or less. Unlike instrument routes and VRs, SRs are not part of the MTR system and therefore have no directive guidance in the Aeronautical Information Manual or FAA Order JO 7610.4x, including weather minima. Weather minima for flight on SR routes are specified in appropriate service directives (although some routes may list weather minimums in the Remarks/Special Operating Procedures). Also, unlike instrument routes or VRs, Flight Service Stations are not notified of a scheduled SR. SR812 lies southwest of R-6604E and is bidirectional. The combat helicopter wing at Naval Station Norfolk schedules SR812 through FACSFAC VACAPES and flies the route at 150 m (500 ft) AGL approximately twice weekly out of Norfolk and Chambers Field. (NASA 2019b)

En Route Airways and Jet Routes

Airway V-1, Airway V-139, and the Atlantic coastline are used by general aviation pilots traveling north and south along the Delmarva Peninsula. The FAA's Performance Data Analysis and Reporting System (PDARS) is a NAS system designed as an integrated performance measurement tool that facilitates operational analysis to improve the NAS. The system consists of a dedicated network of computers located at FAA sites that use specialized software for collecting detailed air traffic management system data. A PDARS analysis was performed for air traffic between March 1, 2015, and March 1, 2016. The survey area included the portion of V-139 that is adjacent to R-6604 A-E, as well as portions of the coastline and V-1. The PDARS concluded that air traffic flying in this area below an altitude of approximately 914 m (3,000 ft) mean sea level, averaged 18 visual flight rule flights and 14 instrument flight rule flights per day for a total of approximately 32 flights per day. According to the FAA, most general aviation traffic on V-139 occurs at altitudes between approximately 3,050 and 4,000 m (10,000 and 13,000 ft) mean sea level (NASA 2019b).

Airports and Airfields

Accomack County airport lies approximately 16.7 km (9 nm) off the southwestern edge of R-6604E and would be outside the FAA required 5.5 km (3 nm) airport exclusion zone. This airport averages approximately 17,155 operations per year. In addition, three private airfields (Taylor, Midway, and Crippen Creek Farm) underlie the R-6604 C/D/E airspaces. Midway and Crippen Creek Farm airfields lie under the MTR corridor for VR1712.

Aircraft transiting through a Restricted Area or Warning Area can transit several airspace units on a single mission, each counting as one airspace operation. Thus, an aircraft passing through both R-6604A and R-6604B would constitute two airspace operations. This is true even if the units can be scheduled and used as a group; each unit is counted as a separate operation. Between October 2014 and September 2015, R-6604A was activated 324 times for a total of 5,457 hours and R-6604B was activated 246 times for a total of 2,182 hours. W-386 currently supports approximately 1,720 manned and 400 unmanned sorties, while the entire VACAPES currently supports approximately 8,200 manned and 630 unmanned flights per year (NASA 2019b).

Air Traffic Control

WFF operates controlled Class D airspace with the WFF airport tower, which serves as the ATC facility. Outside of Class D airspace, and after ATC operating hours, the FAA assigns the responsibility for units of airspace to ARTCCs. The WFF airfield is located within the Washington ARTCC.

Restricted airspace R-6604 A/B/C/D/E (R-6604 A-E) is NASA controlled while the Navy FACSFAC VACAPES controls and schedules the offshore warning areas. Close coordination between FACSFAC, NASA, and FAA ATC facilities enables effective, real-time, joint use of R--6604 A-E and the VACAPES Range Complex warning areas.

All airspace outside the U.S. territorial limit is in international airspace. Because the offshore airspace is in international airspace, the procedures outlined in International Civil Aviation Organization Document 444, Rules of the Air and Air Traffic Services, are followed. The FAA acts as the U.S. agent for aeronautical information to the International Civil Aviation Organization and air traffic in the overwater areas is managed by the Washington ARTCC. (NASA 2019b)

3.4.3 Public Health and Safety (WFF)

The WFF Safety Office plans, develops, and provides functional management of policies and procedures for safety and establishes and approves safety procedures for the protection of property and the public. The health and safety analyses at WFF include consideration of potential hazards associated with operations and maintenance activities such as fueling, handling, assembly, and checkout for all launch activities; occupational hazards; facility fire, crash, and rescue; and risks to the public, NASA personnel, contractors, and civilians from potentially hazardous activities such as flight operations, flight trajectory and dispersion, and launch failures at WFF.

A safe environment is one in which there is no, or optimally reduced, potential for death, serious bodily injury or illness, or property damage. Human health and safety addresses public safety during construction, demolition, and renovation activities; and during subsequent operations of those facilities. Various stressors in the environment can adversely affect human health and safety. Identification and control or elimination of these stressors can reduce risks to health and safety to acceptable levels or eliminate risk entirely. Emergency services are organizations which ensure public safety and health by addressing different emergencies. The three main emergency service functions include police, fire and rescue service, and emergency medical service.

The U.S. Notice to Mariners provides timely marine safety information for the correction of all U.S. Government navigation charts and publications from a wide variety of sources, both foreign and domestic. To ensure the safety of life at sea, the information published in the NTM is designed to provide for the correction of unclassified nautical charts, the unclassified NGA/DLIS Catalog of Hydrographic Products, United States Coast Pilots, NGA List of Lights, USCG Light Lists, and other related nautical publications produced by NGA, NOS, and the USCG.

Environmental health and safety risks to children are defined as those that are attributable to products or substances a child is likely to come into contact with or ingest, such as air, food, water, soil, and products that children use or to which they are exposed. (NASA 2019b)

3.4.3.1 Regulatory Setting

In addition to complying with all applicable FAA aviation safety guidance, WFF has an established Aviation Safety Program that must be followed during all piloted aircraft and Unmanned Aircraft System (UAS) operations. Defined in GPR 8715.2, Aviation Safety Program, the program is overseen by an Aviation Safety Council and coordinated by an on-site Aviation Safety Officer. Key program elements include aircraft safety training, education, and awareness; airfield driver safety training and certification; hazard and mishap reporting and investigation; and airworthiness reviews following changes in aircraft design or configuration.

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks requires federal agencies to "make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children and shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks."

3.4.3.2 Region of Influence

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

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

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

The ROI for potential impacts related to the health and safety of workers includes work areas associated with FE-2 flight test launch operations. The population of concern includes the workers employed at WFF, but also other personnel directly involved with range operation and training activities currently occurring at WFF.

The ROI for potential impact related to public health and safety also includes the areas adjacent to WFF that could be affected by the proposed launch. These areas include the WFF overwater training areas. The population of concern consists of visitors to the area and permanent residents.

WFF Operations

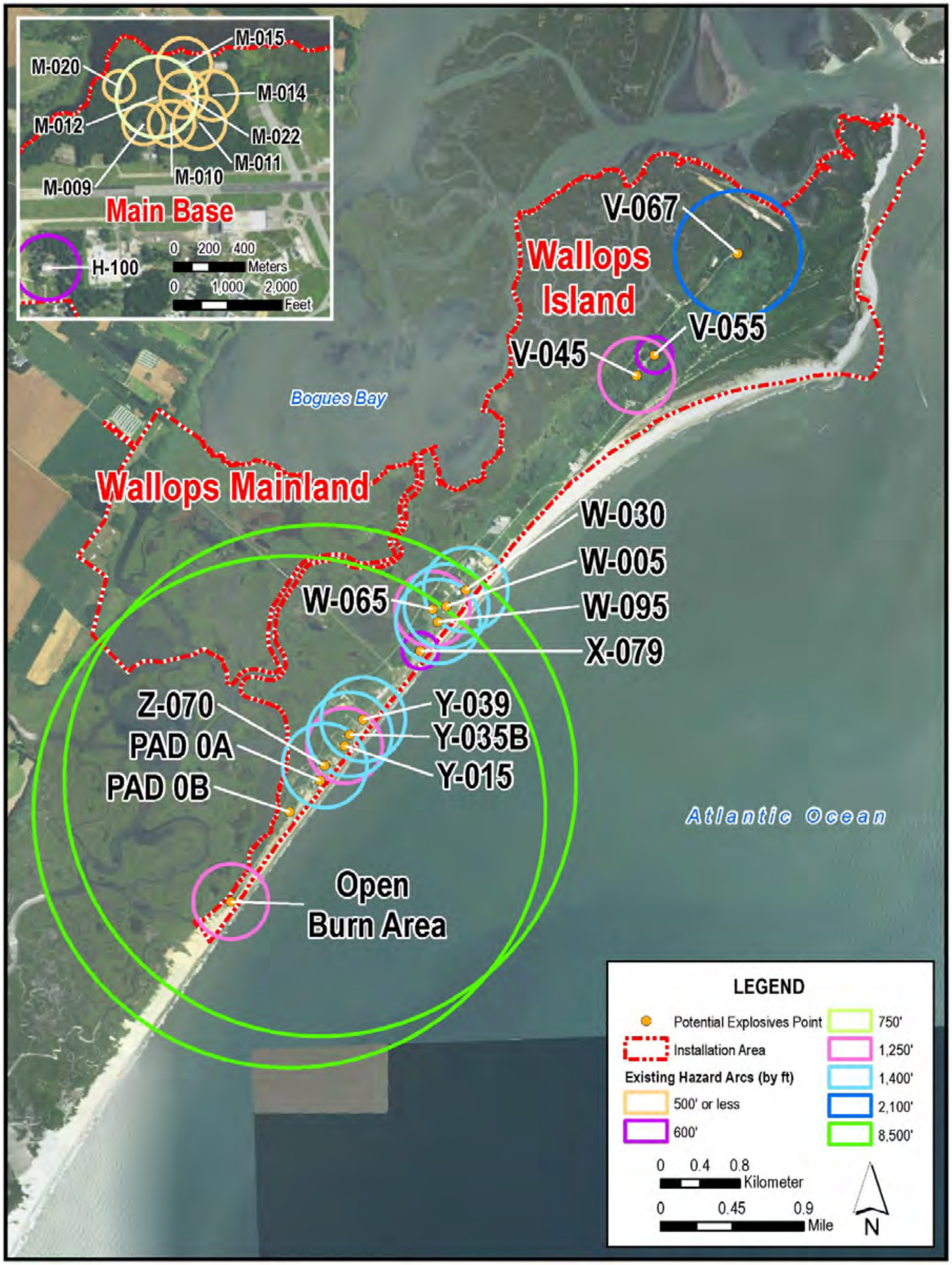
Day-to-day institutional operations and maintenance activities conducted at WFF are performed in accordance with applicable NASA institutional safety and mission programs and controls. The WFF Safety Office plans, develops, and implements facility programs and controls for the safety of personnel, protection of property, and operations of facilities. This organization develops, plans, and promotes occupational health and safety and emergency (i.e., fire, crash, and rescue) planning and operations. It also reviews contractor prepared Safety Plans for construction, modification, or demolition of facilities and infrastructure. Safety controls are established to minimize the potential hazards associated with institutional and workplace activities. (NASA 2019b)

The WFF Safety Office is responsible for the application of safety policies, principles, and techniques to assure the safety and integrity of the public, workforce, and infrastructure. The WFF Safety Office has the responsibility to ensure safe mission activities from preparation through operation and post-operations, both for missions launched from the WFF Range and those supported off range. NASA has established mission specific ground safety guidelines. These guidelines outline ground safety requirements, range user and tenant/partner responsibilities, and safety data requirements to which all range users must comply. In addition, WFF requires all range users to submit formal documentation pertaining to their proposed operations for safety review. Mission specific Safety Plans are prepared by the WFF Safety Office and address all potential ground hazards related to a given mission in accordance with the WFF Range Safety Manual. The Ground Safety Plan outlines controls for minimizing risks to human health and specifically addresses topics such as hazard arcs; hazardous materials handling; explosive safety; personal protective equipment; health and safety monitoring; and training. (NASA 2019b)

Ground and Range Safety. A common safety practice at WFF is to establish restricted-access hazard arcs around the location of these activities to separate the hazardous procedures from other operations and from the general public. For example, once a launch vehicle is erected on a launch pad, a hazard arc whose size is calculated based on the potential hazards of that vehicle (e.g., the types and quantities of propellant onboard, rocket reliability, flight trajectory, and types of debris expected if the flight were terminated) is activated around the launch pad. Operational controls (e.g., evacuation areas, temporary road closures, etc.) are established within and at the perimeter of the hazard arc to minimize the potential hazards associated with the operations of the launch range. Recent launch vehicle launches from WFF (e.g., Antares, Minotaur V) have required hazard arcs ranging from approximately 2,600 m (8,500 ft) to 2,750 m (9,000 ft). **Figure 3-7** depicts common hazard arcs that are activated throughout WFF.

The WFF Safety Office typically reopens a hazard area within 2 to 3 hours following a nominal launch. However, in the case of a launch incident or failure, it may be days before the WFF Safety Office deems the area safe enough for personnel to enter.

Payload operations may involve lasers, radioactive materials, biological specimens, and chemicals, all of which require specialized safety procedures when used at WFF. Laser use must comply with NASA Procedural Requirements (NPR) 1800.1, NASA Occupational Health Program Procedures, Chapter 4; ANSI Z136.1-2007, American National Standards for Safe Use of Lasers; and ANSI Z136.6-2005, Safe Use of Lasers Outdoors, as well as applicable federal and Virginia OSHA regulations regarding laser use. Radioactive materials must be licensed by the Nuclear Regulatory Council and if flown, must be approved by the NASA Nuclear Flight Safety Approval Manager. Biological specimens must be properly categorized and handled in accordance with Centers for Disease Control protocol. Tracking and data systems operations must be within the accepted levels for human exposure to radio frequency electromagnetic fields and comply with all Institute of Electrical and Electronics Engineers (IEEE) standards.



Source: NASA 2019b

Figure 3-7. Existing Wallops Island Hazard Arcs

Safety considerations for launch vehicle launches also include toxic materials dispersion, and distance focusing overpressure considerations. Toxics include a variety of hazardous materials that could be transported through the atmosphere from either a normal or terminated flight and may include rocket exhaust products such as hydrogen chloride and carbon monoxide, or propellants such as hydrazine and oxides of nitrogen. The effects of toxic materials cannot be contained within a certain pre-defined hazard area as they are dictated by atmospheric conditions. Distance focusing overpressure analyses determine the risk to the public given the potential for a shock wave to strengthen in the far field after reflecting off temperature gradients in the atmosphere. As such, the effects of these hazards are analyzed real-time during launch countdown using industry accepted computer models. As the extent of potential hazard could change with the weather, the areas requiring clearance are also subject to change. To ensure maximum operational flexibility while also upholding NASA's rigorous safety standards during variable weather conditions, one concept prevails: the farther the hazardous activity is from the general public, the smaller the risk of harm. It is standing NASA safety policy that hazardous activities must be conducted as far away from the public as possible and only performed within the boundaries established by NASA safety guidelines. (NASA 2019b)

Missile Flight Analysis. A flight trajectory analysis is completed prior to each flight to define the flight safety limits for guided and unguided systems. Launch vehicles with flight termination systems are terminated by destruction of the vehicle if the flight is deemed erratic or crosses the established destruct boundary. All stages are required to be equipped with flight termination systems unless the maximum range of the vehicle is within established launch range boundaries or the vehicle is determined to be inherently safe. Flight termination boundaries are designed to protect the public and personnel by ensuring that vehicle destruction occurs within a predetermined safety zone.

Risk criteria have been established by NASA in order to protect the public, mission essential and critical operations personnel, and property from risks associated with operations. These criteria are consistent with the National Range Commanders Council guidelines (e.g., RCC 321). (NASA 2019b)

Ordnance Management and Safety. All personnel involved with operational programs at WFF follow appropriate safety protocols, including OSHA regulations and training requirements. The handling, processing, storage, and disposal of hazardous materials or hazardous wastes from operations and maintenance activities are accomplished in accordance with all applicable federal and state requirements. A full description of the management of hazardous materials, toxic substances, and hazardous waste is provided in **Section 3.4.4**, Hazardous Materials and Wastes.

Ocean Area Clearance. Flight-related risks for each type of WFF project are distinct; NASA has specialized procedures applicable to launch vehicles, sounding rockets, balloon operations, piloted aircraft and UAS, and rocket-boosted projectiles. WFF coordinates all operations with the FAA, U.S. Navy, Coast Guard, and other organizations as required in order to clear potential hazard areas. If necessary, NTMs and NOTAMs depicting the hazard areas are published at least 24 hours prior to an operation. Additionally, the WFF Office of Communications regularly distributes both electronic and faxed notices of launch-related hazard areas to a group of more than 100 recipients that includes local watermen, marinas, and marine transportation companies. (NASA 2019b)

To further enhance WFF's range safety program, at WFF's request the USACE amended an existing permanent danger zone in the waters of the Atlantic Ocean off Wallops Island and Chincoteague Inlet that protects the public from hazards associated with rocket launching operations (see **Figure 3-8**). The amendment increases the danger zone to a 56 km (30 nm) sector.

Prior to a hazardous operation proceeding, the range is determined to be cleared using inputs from ship sensors, visual surveillance of the range from aircraft and range safety boats, radar data, and acoustic information from a comprehensive system of sensors and surveillance from shore.

Transportation Safety. To facilitate the transportation of rocket motors declared hazardous waste from the Main Base to Wallops Island, NASA has its own hazardous waste transporter license (VA8800010763). However, NASA uses licensed hazardous waste transporters to transport hazardous waste off site to licensed treatment, storage, and disposal facilities (NASA 2019b).

Fire and Crash Safety. The Safety Office also manages the WFF Fire Department, which provides crash, fire, and rescue response to the facility along with emergency services to the neighboring community. The WFF Fire Department also has a Mutual Aid Agreement with the Accomack Northampton Fireman's Association for any outside assistance needed at WFF. The local fire companies closest to WFF are in the towns of Atlantic, Chincoteague, and New Church, Virginia. First responders to a mishap consider such factors as rescue, evacuation, fire suppression, safety and security of the area, and other actions immediately necessary to prevent loss of life or further property damage.

WFF Fire Department personnel are housed in two buildings on the facility, one on Wallops Island and one on the Main Base. There are 24-hour fire and protection services, and personnel are also trained as first responders for hazardous materials, waste, and oil spills. All are Emergency Medical Technicians, and at least two employees per shift are Advanced Life Support certified. Rescue vehicles include structural engines, aircraft firefighting vehicles, ambulances, HAZMAT trucks and trailers, technical rescue trailers, utility pickup trucks, and tracked all-terrain vehicles (NASA 2019b).

3.4.4 Hazardous Materials and Wastes (WFF)

This section discusses hazardous materials, hazardous waste, toxic substances, and contaminated sites.

In general, hazardous materials and wastes are defined as those substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, would present substantial danger to public health and welfare or to the environment when released into the environment. The terms *hazardous materials, toxic substances, and hazardous waste* are often used interchangeably when used informally to refer to contaminants, industrial wastes, dangerous goods, and petroleum products. Each of these terms, however, has a specific technical meaning based on the relevant regulations.

3.4.4.1 Regulatory Setting

Hazardous Materials

A hazardous material is defined as any substance that is:

> Listed in Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Designated as a biological agent or other disease-causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformations in such persons or their offspring; Listed by the U.S. DOT as hazardous materials under 49 CFR 172.101 and appendices; or Defined as a hazardous waste per 40 CFR 261.3 or 49 CFR 171.

Hazardous material handling, storage, and disposal are federally regulated by the USEPA in accordance with the Federal Water Pollution Control Act, CWA, TSCA, RCRA, CERCLA, and CAA.

Toxic Substances

The promulgation of TSCA (40 CFR Parts 700-766) represented an effort by the Federal Government to address those chemical substances and mixtures for which it was recognized that the manufacture, processing, distribution, use, or disposal may present unreasonable risk of personal injury or health of the environment, and to effectively regulate these substances and mixtures in interstate commerce. The TSCA Chemical Substances Inventory lists information on more than 62,000 chemicals and substances.

Asbestos and lead are among the toxic chemical substances regulated by USEPA under TSCA; the most common forms are found in buildings, namely ACM and lead based paint (LBP). ACM includes materials that contain more than one percent asbestos and are categorized as either friable or non-friable. LBP includes paint having lead levels equal to or exceeding 0.5% by weight.

In addition to asbestos and lead, renovation/demolition activities have the potential to disturb mercury and PCBs. Buildings may contain liquid mercury in thermostats and thermometers. Fluorescent lighting fixtures typically contain elemental mercury in the fluorescent light bulb; compact fluorescent lamps also contain mercury. In addition, fluorescent lighting fixture ballasts have the potential to contain PCBs.

Hazardous Waste

RCRA 40 CFR 261.3 and Virginia's 9 VAC 20-60 govern Virginia's hazardous waste management. RCRA defines hazardous waste as wastes or combination of wastes that, because of quantity or concentration; or physical, chemical, or infectious characteristics, may either cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. All hazardous wastes are classified as solid wastes. A solid waste is any material that is disposed, incinerated, treated, or recycled except those exempted under 40 CFR 261.4.

As a special note, military munitions used for their intended purposes on ranges or collected for further evaluation and recycling are not considered hazardous waste per the Military Munitions Rule (40 CFR 266.202). The Military Munitions Rule amended portions of RCRA (40 CFR Parts 260 through 270) and defined when conventional and chemical military munitions become solid waste potentially subject to RCRA.

Storage Tanks

The 1984 Hazardous and Solid Waste Amendments to RCRA regulate underground storage tanks (USTs), including requirements for tank notification, reporting and record-keeping for existing tanks; corrective action; financial responsibility; compliance monitoring and enforcement; and approval of state programs. In addition, bulk storage containers and tanks are regulated under 40 CFR 112, which requires preparation of a Spill Prevention, Control, and Countermeasure Plan.

Virginia's UST Technical Regulation (9 VAC 25-580-10 et seq.) is like the federal regulation, except it requires notifications from owners of all regulated USTs that remain in the ground. The latest UST amendments effective September 15, 2010, incorporate the Federal Energy Policy Act of 2005 requirements of secondary containment, delivery prohibitions, and operator training. Since May 8, 1986, each existing UST, any new USTs, any changes to USTs, and any closure of USTs must be reported to the Virginia Department of Environmental Quality (NASA 2019b).

Virginia's Facility and AST Regulation (9 VAC 25-91) requires registration of aboveground storage tanks (ASTs) having an aggregate AST capacity, or an individual AST, of more than 2,500 liters (660 gallons) of oil. The Virginia AST requirements were updated on November 1, 2015, to incorporate new performance standards and to align Virginia's regulatory requirements with federal requirements and current industry standards (NASA 2019b).

3.4.4.2 Region of Influence

The ROI for hazardous materials and hazardous waste would be limited to areas of the Main Base, Mainland, and Wallops Island to be used for launch preparation, launch, and post-launch activities and in areas where hazardous materials are stored and handled.

The WFF Integrated Contingency Plan (ICP), developed by NASA to meet the requirements of 40 CFR Part 112 (Oil Pollution Prevention and Response), 40 CFR Part 265 Subparts C and D (Hazardous Waste Contingency Plan), and 9 VAC 25-91-10 (Oil Discharge Contingency Plan), serves as the facility's primary guidance document for the prevention and management of oil, hazardous material, and hazardous waste releases (NASA 2017).

Hazardous Materials

Hazardous materials are used at WFF for solid rocket propellants; during payload processing operations and spacecraft integration; and in machine shops, paint booths, and laboratories. Hazardous materials used include ammonium perchlorate/aluminum, nitrocellulose/nitro-glycerine, hydrazine, cutting fluids, solvents, flammables, paint thinners, and laboratory reagents.

The 2018 ICP update includes the following procedures for hazardous materials management at WFF:

- Complete daily, weekly, monthly, and annual site inspections, as outlined in the Facility Inspection, Tests, and Records section of the ICP using facility inspection checklists.
- Perform preventive maintenance of equipment, secondary containment systems, and discharge prevention systems described in the ICP, as needed, to keep them in proper operating conditions.
- Conduct annual employee training, as outlined in the Discharge Response, Equipment and Training section of the ICP.
- If either of the following occurs, submit the SPCC Plan to the USEPA Regional Administrator, along with other information:
    - The facility discharges more than 3,800 liters (1,000 gallons) of oil from aboveground storage containers into or upon the navigable waters of the United States or adjoining shorelines in a single spill event; or
    - The facility discharges oil in a quantity greater than 160 liters (42 gallons) in each of two spill events from aboveground storage containers into or upon the navigable waters of the United States or adjoining shorelines within any 12-month period.
- Review the ICP on an annual basis. Update the Plan to reflect any "administrative changes" that are applicable, such as personnel changes or revisions to contact information, such as phone numbers. Administrative changes must be documented in the Plan Review Log, but do not have to be certified by a Professional Engineer.

- Review the SPCC Plan at least once every 5 years and amend it to include more effective prevention and control technology, if such technology will significantly reduce the likelihood of a spill event and has been proven effective in the field at the time of the review. ICP amendments, other than administrative changes discussed above, must be recertified by a Professional Engineer.
- Amend the SPCC Plan within 6 months whenever there is a change in facility design, construction, operation, or maintenance that materially affects the facility's spill potential. The revised Plan must be recertified by a Professional Engineer (NASA 2018).

Hazardous Wastes

Wallops Main Base is separated from Mainland/Wallops Island by approximately 11.2 km (7 mi) of public roadway. As the Main Base and Mainland/Wallops Island are not contiguous, each has been assigned its own USEPA hazardous waste generator number (VA8800010763 and VA7800020888, respectively). The Main Base and Mainland/Wallops Island areas are both classified as Large Quantity Generators; each area has the potential to generate more than 1,000 kg (2,205 lb) of hazardous waste and/or 1 kg (2.2 lb) of acute hazardous waste per month. To facilitate the transportation of rocket motors declared hazardous waste from the Main Base to Wallops Island, NASA has its own hazardous waste transporter license (VA8800010763). However, NASA uses licensed hazardous waste transporters to transport hazardous waste off site to licensed treatment, storage, and disposal facilities (NASA 2019b).

At WFF, hazardous waste generators are responsible for:

- placing hazardous waste in proper containers,
- labeling containers as to contents, and including the words “hazardous waste”,
- storing hazardous waste in a satellite accumulation area at or near the point of generation under the control of a RCRA and ICP trained operator and ensuring that the waste is transported by the Environmental Office to a less-than-90-day accumulation area within 3 days of accumulating 208 liters (55 gallons) of hazardous waste or 0.95 liters (1 quart) of acutely hazardous waste, and
- properly completing and submitting a disposal inventory sheet to the Environmental Office.

Following transfer from the satellite accumulation area, hazardous wastes generated on the Main Base are stored at accumulation areas located at Building B-029 and Building N-223, although Building N-223 is employed primarily for the storage of used oil. Hazardous wastes generated on the Mainland/Wallops Island are stored at Building U-081 (NASA 2017).

In calendar year 2016, a total of 14,463 kg (31,885 lb) of hazardous waste was generated at WFF. This includes a total of 10,341 kg (22,797 lb) from the Main Base and 4,122 kg (9,088 lb) from Mainland/Wallops Island. Hazardous waste generated included rags containing lead, crushed fluorescent tubes, acetic acid, jet fuel from maintenance activities, chemicals associated with tank cleaning, paint, and paint thinners. When the hazardous materials in rocket motors are declared hazardous waste (i.e., unsafe for transport to a facility specializing in disposal of rocket motors), they are open burned at the RCRA permitted open burn area on the south end of Wallops Island until all the rocket propellant is burned and the hazardous characteristic of reactivity is removed. The rocket motor casings are recycled as scrap metal (NASA 2019b).

Pollution Prevention/Recycling/Waste Minimization

WFF has a single stream recycling program that was launched in 2011. Recycling containers are placed on each floor in every building of the facility, diverting plastic, aluminum, glass, cardboard, and paper from local landfills. Additional resources exist on the facility to recycle used oils and solvents, chemicals, fluorescent lights, batteries, toner cartridges, scrap metal and wood, and packing materials.

Installation Restoration Program

The WFF Environmental Compliance and Restoration (ECR) Program is responsible for the planning, implementation, and oversight of the investigation of past site activities to ensure the protection of human health and the environment. Projects include former NASA sites and Navy sites related to past operations. Projects are prioritized to ensure sites with the highest priority are assessed first.

The ECR Program manages the investigation, response, and remedial activities at the former NASA operational areas at WFF under the Administrative Agreement on Consent (AAOC) executed between NASA and USEPA [EPA Docket Number: RCRA-03-2004-0201TH]. The AAOC applies to past releases of hazardous substances, waste and/or constituents by NASA at WFF and identifies CERCLA response requirements, policies, and guidance as the primary process for planning for and performing the work necessary to complete remedial and corrective actions appropriate to those releases.

As part of the AAOC, NASA, USEPA, and VDEQ have agreed that investigation, response, and remedial activities for sites resulting from former Navy activities at WFF (prior to NASA ownership) will be addressed as Formerly Used Defense Sites (FUDS) managed by the USACE. The FUDS program authorizes the USACE as the lead DOD agency for the environmental restoration of properties that were formerly under DOD control. In February 2015, NASA and the Department of the Army signed a Memorandum of Agreement which divided responsibilities for response actions between NASA and USACE. NASA agreed to assume responsibility of 104 structures (i.e., buildings, tanks, substructures, etc.) and to assume responsibility for further investigations and actions for Areas of Concern (AOCs) related to transformers left in place when the Navy ceased operations on Wallops Island. For Wallops FUDS, NASA agreed to complete the future investigation and response actions using Environmental Restoration, FUDS funds appropriated to the DOD and transferred to NASA. (NASA 2019b)

For sites involving only past petroleum contamination or releases, NASA manages the investigation, response, and remedial activities with oversight from VDEQ, Tidewater Regional

Office, located in Virginia Beach, Virginia. NASA follows guidelines in general accordance with the VDEQ October 4, 2001, *Guidance Document #01-2024 Petroleum Storage Tank Program Technical Manual* and the VDEQ October 12, 2001, *Guidance Document #01-2025 Petroleum Storage Tank Program Compliance Manual.*

Between 1988 and 1996 a series of facility-wide surveys, assessments, and inspections were performed by NASA, under the oversight of USEPA and VDEQ. The purpose of these investigations was to evaluate the WFF facilities and identify AOCs that may pose a risk to human health or the environment. Thirty AOCs were initially identified at WFF as a result of these assessments. Since 1998, USACE has also conducted a series of ongoing assessments and investigations to determine responsibility and eligibility for AOCs under the FUDS program. Each of the 12 FUDS Projects established in this program include multiple sites or AOCs with similar contaminants, sources, and/or locations. Currently there are 7 active CERCLA sites managed under the AAOC, one active petroleum site, and 11 active FUDS Projects. NASA has coordinated activities at these AOCs with USEPA and VDEQ, and has taken actions to address potential risks, on a priority basis, under the appropriate environmental and regulatory programs. Actions conducted at the AOCs include supplemental investigations, sampling programs, removals, product recovery, remedial investigations, feasibility studies, remediation, and closeout. Land use restrictions and institutional controls exist at the active sites to prevent future development and groundwater usage (NASA 2019b).

Underground and Aboveground Storage Tanks

WFF has an active and on-going project to reduce the number of petroleum storage tanks on the facility. WFF (and specified partners/tenants) own and operate 44 ASTs and 7 USTs of various sizes with a maximum AST storage capacity of 796,810 liters (210,495 gallons) and maximum UST storage capacity of 102,000 liters (27,000 gallons). Both ASTs and USTs primarily store heating oil for buildings, with the next most common usage to store fuel oil for emergency generators (NASA 2017). Occasionally, portable ASTs containing diesel fuel and gasoline are brought to WFF by outside construction contractors for the duration of their contract. Prior to commencing work, these contractors are required to submit a Health and Safety Plan for approval by the WFF Safety Office. Contractors are required to notify WFF of containers brought to the facility with a capacity greater than 208 liters (55 gallons), and ASTs of 2,500 liters (660 gallons) or greater must have Facilities Management Branch approval and include a SWPPP or other approved spill response plan. WFF requires that all containers include 110% secondary containment. If the tank will be in use on WFF for more than 120 days, the contractor must provide proof that the tank is registered with the VDEQ. (NASA 2019b)

Asbestos, Lead-Based Paint, and Polychlorinated Biphenyls

The promulgation of TSCA (40 CFR Parts 700-766) represented an effort by the Federal Government to address those chemical substances and mixtures for which it was recognized that the manufacture, processing, distribution, use, or disposal may present unreasonable risk of personal injury or health of the environment, and to effectively regulate these substances and mixtures in interstate commerce. The TSCA Chemical Substances Inventory lists information on more than 62,000 chemicals and substances.

Asbestos and lead are among the toxic chemical substances regulated by USEPA under TSCA; the most common forms are found in buildings, namely ACM and LBP. ACM includes materials that contain more than one percent asbestos and are categorized as either friable or non-friable. LBP includes paint having lead levels equal to or exceeding 0.5% by weight.

In addition to asbestos and lead, renovation/demolition activities have the potential to disturb mercury and PCBs. Buildings may contain liquid mercury in thermostats and thermometers. Fluorescent lighting fixtures typically contain elemental mercury in the fluorescent light bulb; compact fluorescent lamps also contain mercury. In addition, fluorescent lighting fixture ballasts have the potential to contain PCBs. (NASA 2019b)

Liquid Fuels and Other Toxic Fuels

With respect to liquid propellants such as petroleum, cryogenic, and hypergolic propellants, the propellant and oxidizer are stored in separate tanks per WFF's Range Safety Manual (NASA 2019a). Storage and handling of all three types of liquid propellants adhere to WFF procedures. Currently, there is a Liquid Fueling Facility located adjacent to Launch Pad 0-A. Fueling of launch vehicles with petroleum or cryogenic propellants is performed at Launch Pad 0-A, and refilling of these propellant tanks occurs onsite. Up to 2,270 kg (5,000 lb) of hypergolic propellants would be stored in Building Z-025 and 27,200 kg (60,000 lb) of nitrogen tetroxide in Building Z-020 on Wallops Island, or hypergolic propellants would be transported to WFF months prior to fueling and would be stored in DOT-approved shipping containers inside controlled access facilities on Wallops Island. Payloads would be fueled directly from these containers. In the event of a hypergolic propellant release, WFF's Hydrazine Contingency Plan would be followed. (NASA 2019a)

3.5 Atlantic Broad Ocean Area

This section includes air quality and biological resources within the Atlantic BOA along the over-ocean flight corridor for the FE-2 flight test.

The potential impacts to the following resource areas are considered to be negligible or non-existent so they were not analyzed in detail in this EA/OEA:

Water Resources: There are no groundwater or surface water resources along the over-ocean flight corridor that would be affected by the FE-2 flight test. There would be no disturbance to ocean waters beyond the settling of the individual booster stages hundreds of kilometers (miles) apart as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). No impacts would occur to water resources within the over-ocean flight corridor from the FE-2 flight test.

Geological Resources: There would be no drilling, mining, or construction in the open ocean and no sediment disturbance beyond the settling of the individual rocket booster stages hundreds of kilometers (miles) apart as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). There would be no impacts to geological resources in the over-ocean flight corridor from the FE-2 flight test.

Cultural Resources: There are no identified cultural resources along the flight path within the over-ocean flight corridor; therefore, there would be no impacts to cultural resources within that area from the FE-2 flight test.

Land Use: The FE-2 flight path would avoid populated land masses with their associated assigned land uses. There would be no changes, and therefore, no impacts, from the FE-2 flight test to land use along the flight path over the over-ocean flight corridor.

Airspace: The over-ocean flight corridor is located over international airspace and, therefore, has no formal airspace restrictions governing it. Over-ocean flight tests must comply with DOD Instruction 4540.01, *Use of International Airspace by US Military Aircraft and for Missile/Projectile Firings*. Commercial and private aircraft would be notified through NOTAMs issued through the FAA in advance of the FE-2 flight test launch at the request of RTS as part of their routine operations. Test flight operations would be conducted in accordance with WFF procedures and would not expand or alter currently controlled airspace. There would be no impacts to airspace from the FE-2 flight test.

Noise: The FE-2 flight would occur at high altitude where it would be generally undetected by vessels or aircraft at the ocean's surface. Sonic booms are generated following launch and during terminal flight and impact; these areas are not within the over-ocean flight corridor. Therefore, there would be no impacts to noise within the over-ocean flight corridor from the FE-2 flight test.

Infrastructure: No changes would occur to infrastructure in the over-ocean flight corridor from the FE-2 flight test; therefore, there would be no impacts to infrastructure in the over-ocean flight corridor.

Transportation: Transportation services would be unaffected by the FE-2 flight test over the open ocean. The payload flight would occur at high altitude where it would be generally undetected by vessels or aircraft. Public NOTAMs and NTMs would be issued along the flight path to ensure the safety of both aircraft and vessels. Components would drop over predetermined open ocean areas to ensure, along with the public notices, that there would be no vessels or aircraft in the vicinity. There would be no impacts from the FE-2 flight test to transportation along the flight path over the open ocean.

Public Health and Safety: The FE-2 flight would occur at high altitudes where it would be generally undetected by vessels or aircraft. NOTAMs and NTMs would be issued along the flight path to ensure the safety of personnel on aircraft and vessels. Components would drop over predetermined open ocean areas to ensure, along with the public notices, that there would be no vessels or aircraft in the vicinities. Range Safety at WFF would monitor the flight until takeover by remote range safety as the payload comes into the BOA impact area. If the FE-2 flight strays outside its designated corridor, it would be considered to be malfunctioning and to constitute an imminent safety hazard. The destruct package, which is installed in all flight vehicles capable of impacting inhabited areas, would be activated. This effectively halts powered flight, causing the remaining hardware to fall into the ocean along a ballistic trajectory. The low potential for a flight failure, combined with the low density of vessels in the open ocean, makes any potential impact discountable. There would be no impacts from the FE-2 flight test to public health and safety along the flight path over the over-ocean flight corridor.

Hazardous Materials and Wastes: Each of the three rocket motor boosters would exhaust on-board propellant before dropping into the ocean, while fairings would not carry hazardous materials. *De minimus* residual quantities of other materials may remain on the boosters and fairings; these would be carried to the ocean floor by the sinking components. There would be no impacts to hazardous materials and wastes along the over-ocean flight corridor from the FE-2 flight test.

Socioeconomics: There would be no impact to shipping activities in the BOA and no other socioeconomic impacts.

Environmental Justice: There would be no disproportionate impacts within the over-ocean flight corridor to minority populations or low-income populations under EO 12898 from the FE-2 flight test.

Visual Resources: The FE-2 flight would occur at high altitude where it would be generally undetected by vessels or aircraft. There would be no changes from the FE-2 flight test to visual resources along the flight path over the over-ocean flight corridor.

Marine Sediments: There would be no marine sediment disturbance beyond the settling of the rocket components as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). There would be no impacts to marine sediments in the over-ocean flight corridor from the FE-2 flight test.

3.5.1 Air Quality (Atlantic BOA)

The regulatory setting and background information provided in **Section 3.2** for the Pacific Ocean Flight Corridor would apply to the Atlantic Ocean Flight Corridor.

3.5.1.1 Region of Influence – Over-Ocean Flight Corridor

Dominant during much of the year, the prevailing westerlies winds effectively disperse air emissions along the over-ocean flight corridor. Because of the lack of local air pollution sources, the dispersal of emissions by westerlies winds, and the lack of topographic features that inhibit dispersion, air quality along the Atlantic BOA over-ocean flight corridor is considered good. Unlike the Continental United States, tropospheric ozone is not a concern in this general area.

Changes in sea level have occurred throughout history, with the primary influences being global temperatures; Arctic, Antarctic, and glacial ice masses; and changes in the shape of the oceanic basins and land/sea distribution. Generally, with rising global temperatures, less ice is created or maintained throughout the Earth and sea levels rise. Currently, Bermuda and other small islands located within the over-ocean flight corridor may be affected by rising sea levels from global climate change.

3.5.2 Biological Resources (Atlantic BOA)

Biological resources in the Atlantic BOA are defined as in **Section 3.1.3**. The biological resources described in this section are those within the affected environment of the Atlantic Ocean, specifically those BOAs subject to FE-2 overflight, splashdown of FE-2 vehicle components, and areas subject to payload impact (**Figure 3-9**).

3.5.2.1 Regulatory Setting

For the purposes of this EA/OEA, special status species in the Atlantic BOA ROI are those species listed as threatened or endangered under the ESA, species protected under the MMPA, and species protected under the MBTA. The regulatory setting under the ESA, MMPA, and MBTA are described in detail in **Section 3.1.3.1** including relevant definitions under these Acts. The MSA as described in **Section 3.1.3.1** also applies to the Atlantic BOA, and resources regulated by this Act are discussed below.

Spent motor drop zone 1 occurs almost entirely within the area evaluated in the VACAPES EIS/OEIS (U.S. Navy 2009). Data from the VACAPES area represent some of the best available data for the marine affected environment in the Atlantic BOA ROI.

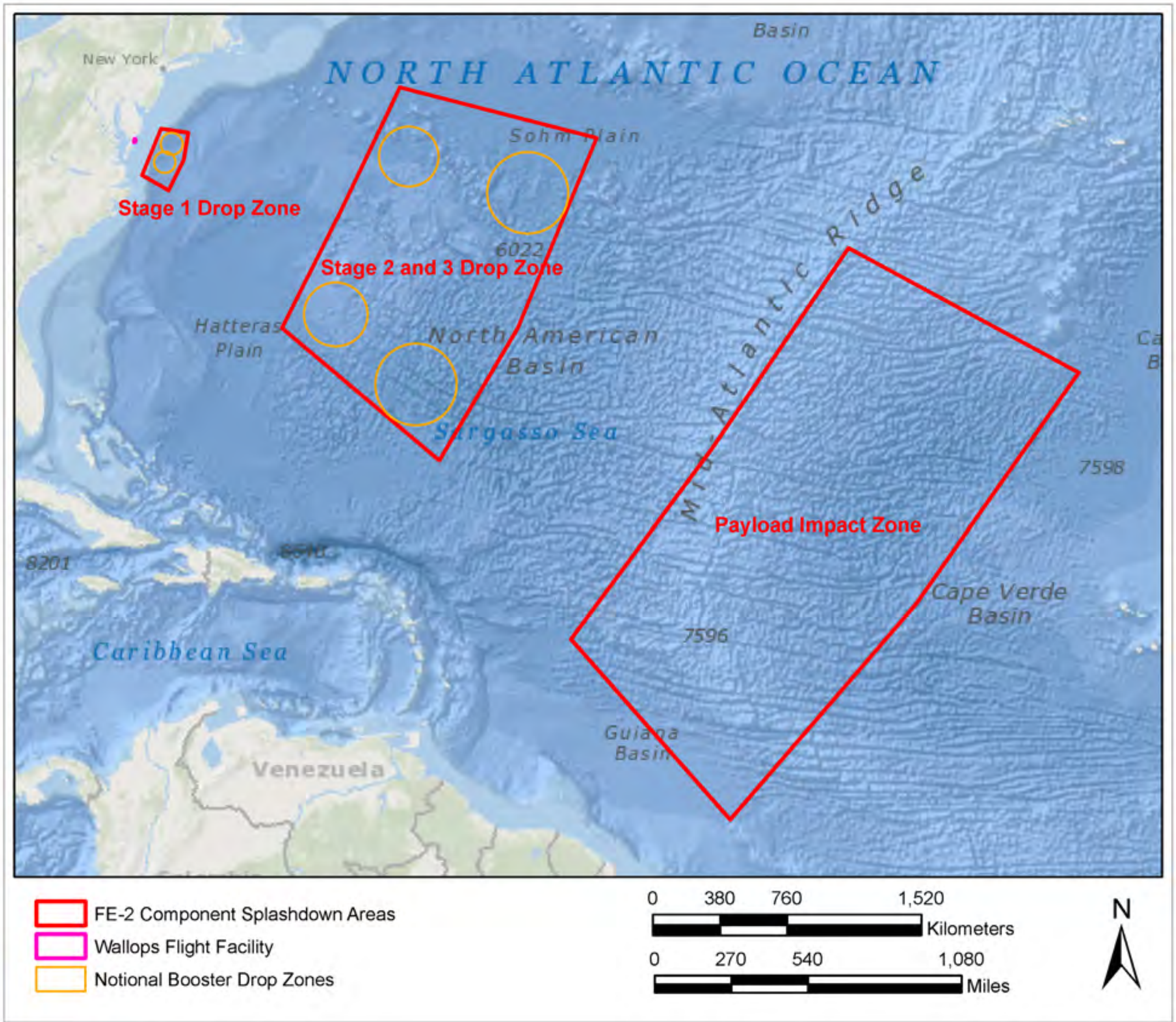


Figure 3-9. Representative FE-2 Booster Drop Zones and Impact Areas for Spent Boosters and Payload Components in the Atlantic Ocean.

3.5.2.2 Biological Resources in the Atlantic BOA Region of Influence

There are no terrestrial habitats in the Atlantic BOA ROI. Some seabirds that breed on land and forage in open ocean area of the Atlantic have the potential to occur in the ROI. The waters of the Atlantic BOA consist of deep ocean waters with both pelagic and benthic habitats. Pelagic areas support communities of planktonic (drifting) and nektonic (swimming) organisms. Benthic communities are made up of marine organisms that live on or near the sea floor such as bottom dwelling fish, mollusks, crustaceans, annelids, anthozoans, and echinoderms.

Marine Vegetation in the Atlantic BOA

Marine vegetation in the Atlantic BOA consists of a diversity of macro-algae and photosynthetic plankton (phytoplankton). While these are not plants, as defined in **Section 3.1.3**, these photosynthetic organisms are included in the marine vegetation section.

Phytoplankton are primary producers which dominate the base of the highly productive and diverse marine food web. Since phytoplankton occur only in areas with adequate light, temperature, and nutrient conditions, the distribution and abundance of phytoplankton in the Atlantic BOA is highly variable. In general, the concentration of phytoplankton is highest in nearshore areas and decreases with distance from shore and with increases in bottom depth (U.S. Navy 2009). Phytoplankton may also be concentrated in areas of seasonal upwelling in the Atlantic.

One of the most significant marine algae groups in the ROI are algae in the brown algae genus *Sargassum*. *Sargassum* float in extensive mats on the ocean surface where they provide food and shelter for a variety of marine organisms including loggerhead turtles (U.S. Navy 2009). The concentration of these pelagic floating mats often depends on the wind and ocean currents. While Sargassum is likely to occur in the ROI, especially in the VACAPES area (U.S. Navy 2009), the density and distribution of Sargassum in the ROI is largely seasonal and variable. Large mats of Sargassum are known to occur on the western boundary of the Gulf Stream where the warm waters of the Gulf Stream meet the cool waters of the Labrador Current and a high diversity and concentration of marine organisms occur (U.S. Navy 2009).

Marine Wildlife in the Atlantic BOA

Marine wildlife in the Atlantic BOA that are considered in this EA/OEA are those that have the potential to be in the area exposed to elevated noise levels from the FE-2 flight, to splashdown of FE-2 vehicle components, to splashdown of the FE-2 payload, to hazardous chemicals, or to vessel traffic.

Marine Mammals. Thirty-seven marine mammal species have the potential to occur in the Atlantic BOA ROI. All marine mammal species in the ROI (**Table 3-17**) are protected under MMPA and six species are listed under the ESA. The U.S. Navy has modeled marine mammal densities within Navy training and operational areas in the Atlantic, including the VACAPES area, in their Navy's Marine Species Density Database (NMSDD) for the Atlantic Fleet Training and Testing Study Area (U.S. Navy 2017b). The NMSDD models contain estimates for marine mammal densities throughout the spent motor drop zones as well as for a portion of the payload impact zone (**Table 3-17**) and provide the best available data for marine mammal densities and distributions in the Atlantic BOA ROI. Species such as the bottlenose dolphin (*Delphinus delphis*), North Atlantic right whale (*Eubalaena glacialis*), white-beaked dolphin (*Lagenorhynchus albirostris*), harbor porpoise (*Phocoena phocoena*), and the seal species are found primarily in coastal waters and are most abundant in the stage 1 drop zone. Other species such as the pygmy killer whale (*Feresa attenuata*), Fraser's dolphin (*Lagenodelphis hosei*), melon-headed whale (*Peponocephala electra*), and spinner dolphin (*Stenella longirostris*) have higher densities in the spent motor drop zone of stages 2 and 3 and in the payload impact zone (**Table 3-17**).

Table 3-17. Maine Mammal and Sea Turtles Known to Occur or with the Potential to Occur in the Atlantic BOA ROI and Estimated Density in the ROI.

Common Name	Scientific Name	Federal Listing Status	Maximum Average Density (per km^2)[1]		
			Stage 1 Drop Zone	Stage 2 and 3 Drop Zone	Payload Impact Zone
Baleen Whales					
Minke whale	*Balaenoptera acutorostrata*	MMPA	0.00206	0.00047	0.00021
Sei whale	*B. borealis*	E, MMPA	0.00121	0.00015	0.00001
Bryde's whale	*B. edeni*	MMPA	0.00005	0.00008	0.00010
Blue whale	*B. musculus*	E, MMPA	0.00001	0.00001	0.00001
Fin whale	*B. physalus*	E, MMPA	0.00137	0.00004	0.00003
North Atlantic right whale	*Eubalaena glacialis*	E, MMPA	0.00007	-	-
Humpback whale	*Megaptera novaeangliae*	E, MMPA	0.00013	0.00037	0.00104
Beaked Whales					
Northern bottlenose whale	*Hyperoodon ampullatus*	MMPA	0.00031	-	-
Beaked Whale Group			0.02276	0.01212	0.00347
Sowerby's beaked whale	*Mesoplodon bidens*	MMPA			
Blainville's beaked whale	*M. densirostris*	MMPA			
Gervais' beaked whale	*M. europaeus*	MMPA			
Ture's beaked whale	*M. mirus*	MMPA			
Cuvier's beaked whale	*Ziphius cavirostris*	MMPA			
Delphinids					
Common dolphin	*Delphinus delphis*	MMPA	0.50043	0.00048	0.00001
Pygmy killer whale	*Feresa attenuata*	MMPA	0.00087	0.00161	0.00228
Pilot Whale Group			0.04051	0.03608	0.06690
Short-finned pilot whale	*Globicephala macrorhynchus*	MMPA			
Long-finned pilot whale	*G. melas*	MMPA			
Risso's dolphin	*Grampus griseus*	MMPA	0.02996	0.00108	0.00120
Fraser's dolphin	*Lagenodelphis hosei*	MMPA	0.00026	0.00299	0.00329
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	MMPA	0.04032	0.01444	0.00021
White-beaked dolphin	*L. albirostris*	MMPA	0.00001	-	-
Killer whale	*Orcinus orca*	MMPA	0.00002	0.00002	0.00002
Melon-headed whale	*Peponocephala electra*	MMPA	0.00452	0.00863	0.01411
False killer whale	*Pseudorca crassidens*	MMPA	0.00092	0.00192	0.00381
Pantropical spotted dolphin	*Stenella attenuata*	MMPA	0.04044	0.04879	0.00933
Clymene dolphin	*S. clymene*	MMPA	0.01556	0.02663	0.02284
Striped dolphin	*S. coeruleoalba*	MMPA	0.15744	0.02752	0.00152
Atlantic spotted dolphin	*S. frontalis*	MMPA	0.17536	0.03380	0.01808
Spinner dolphin	*S. longirostris*	MMPA	0.00842	0.01653	0.02764
Rough-toothed dolphin	*Steno bredanensis*	MMPA	0.00179	0.00400	0.00733
Bottlenose dolphin	*Tursiops truncatus*	MMPA	0.12155	0.01376	0.02954

Common Name	Scientific Name	Federal Listing Status	Maximum Average Density (per km²)[1]		
			Stage 1 Drop Zone	Stage 2 and 3 Drop Zone	Payload Impact Zone
Porpoises					
Harbor porpoise	*Phocoena phocoena*	MMPA	0.03382	0.00034	-
Sperm Whales					
Kogia Group			0.00109	0.00071	0.00146
Pygmy sperm whale	*Kogia breviceps*	MMPA			
Dwarf sperm whale	*K. sima*	MMPA			
Sperm whale	*Physeter macrocephalus*	E, MMPA	0.01853	0.00752	0.00330
Pinnipeds					
Seal Group			0.000002	-	-
Gray seal	*Halichoerus grypus*	MMPA			
Harbor seal	*Phoca vitulina*	MMPA			
Sea Turtles					
Leatherback turtle	*Dermochelys coriacea*	E	0.02087	ND	ND
Hardshell Turtle Group[2]			0.04603	ND	ND
Loggerhead turtle	*Caretta caretta*	T	0.14869	ND	ND
Atlantic green turtle	*Chelonia mydas*	T	ND	ND	ND
Hawksbill turtle	*Enetmochelys imbricata*	E	ND	ND	ND
Kemp's ridley turtle	*Lepidochelys olivacea*	E	0.00828	ND	ND

Sources: U.S. Navy 2009, U.S. Navy 2017b
Abbreviations: MMPA = Marine Mammal Protection Act, E = federal endangered; T = federal threatened; ND = No Data
[1] Density estimates are the highest (across seasons) average density for the drop zones and portion of the payload impact zone with density coverage in the NMSDD (U.S. Navy 2017b).
[2] Hardshell turtles are unidentified turtles which may be loggerhead, green, hawksbill, or Kemp's ridley turtles. In addition to unidentified hardshell turtles, estimates are available for turtles identified as loggerhead or Kemp's ridley.

Major threats to marine mammals in the Atlantic BOA are similar to those discussed for the Pacific Ocean in **Section 3.2.2**. No critical habitat for marine mammals occurs in the Atlantic BOA ROI.

Sea Turtles. Five species of sea turtle have the potential to occur in the Atlantic BOA ROI (**Table 3-17**). All five of these species are listed as threatened or endangered under the EAS. While little information is available concerning sea turtle density and distribution in the open-ocean, the U.S. Navy modeled sea turtle density for continental shelf waters within the U.S. EEZ (U.S. Navy 2017b). Therefore, reliable abundance information is available for sea turtles for the motor drop zone closest to WFF. The U.S. Navy (2017b) had adequate data to generate density estimates for loggerhead turtles, Kemp's ridley turtles, and leatherback turtles. Density estimates for a hardshell turtle group were also derived due to an abundance of records which were unidentified sea turtles or green or hawksbill turtles (**Table 3-17**; U.S. Navy 2017b). The hardshell turtle group includes all sea turtle species except leatherback turtles. Loggerhead turtles are the most abundant sea turtles in this portion of the ROI, with leatherback and Kemp's ridley turtles being regularly observed as well (U.S. Navy 2017b). General sea turtle characteristics and threats are the same as those discussed for the Pacific BOA in **Section 3.2.2**.

The only designated critical habitat for any listed species in the ROI is the pelagic *Sargassum* habitat of the loggerhead turtle (**Figure 3-10**). This area convergence zone at the margin of the Gulf Stream allows *Sargassum* growth in concentrations that support adequate prey abundance and cover for young loggerhead turtles (79 FR 39856 [July 10, 2014]).

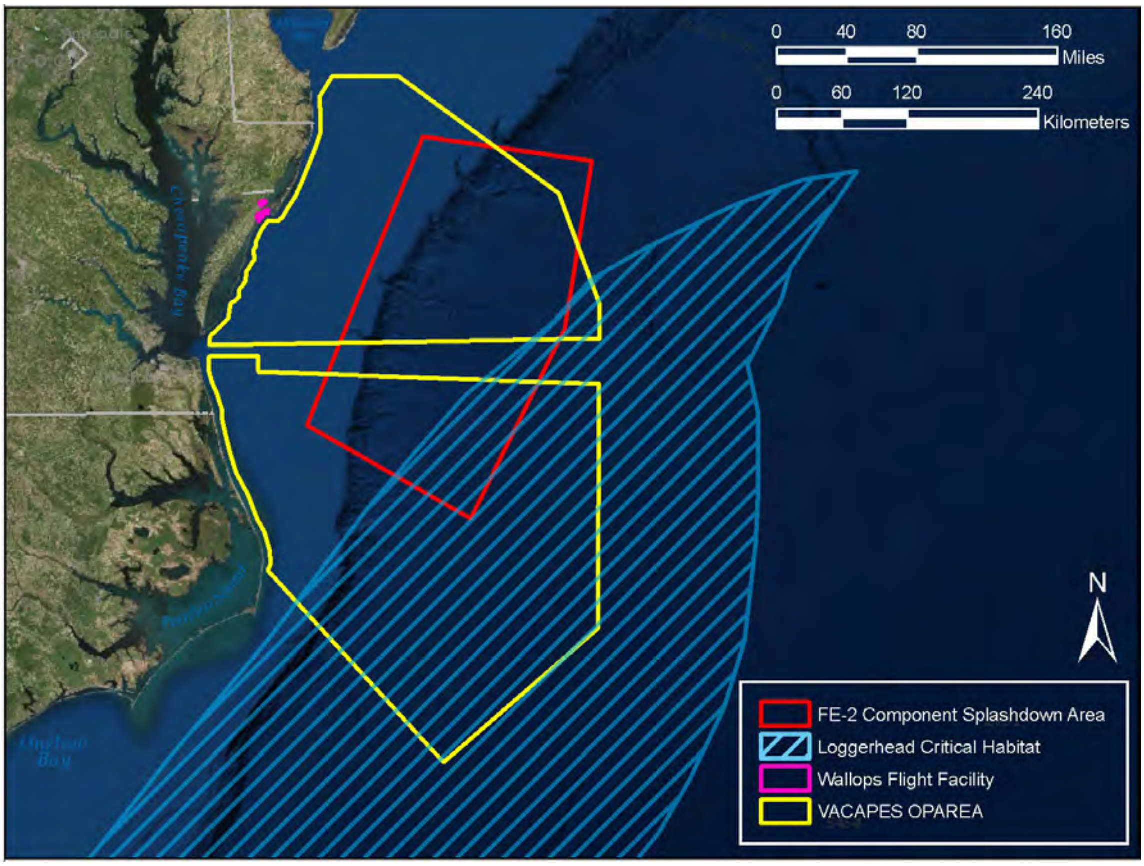


Figure 3-10. Stage 1 Motor Drop Zone in the Atlantic BOA and Loggerhead Turtle Designated Critical Habitat.

Birds. While no terrestrial habitat occurs in the Atlantic BOA ROI, many seabirds have wide-ranging foraging and non-nesting season distributions, and migratory land birds could migrate over the Atlantic BOA. It is possible that some seabird species may forage or rest at sea in the ROI. Two special status species have the potential to occur in the ROI: the Bermuda petrel (*Pterodroma cahow*) and the roseate term (*Sterna dougallii*; U.S. Navy 2009). Both species are protected under the ESA and MBTA. No critical habitat for any bird species occurs in the ROI.

Bermuda petrels are listed as endangered under the ESA. These seabirds feed on squid, shrimp, and small fish at the sea surface in the North Atlantic Ocean (U.S. Navy 2009). The population of this species is very small, estimated at only 250 birds in 2005 (U.S. Navy 2009). These birds breed only in Castle Harbor, Bermuda where they occur in small breeding colonies from October through June (U.S. Navy 2009). During the non-breeding season, birds are found at-sea, primarily in Gulf Stream waters between Bermuda and North Carolina (U.S. Navy 2009). These birds are likely to occur in portions of the ROI at certain times of the year, especially in drop zone for spent boosters 2 and 3 during the breeding season.

Roseate terns are also listed as an endangered species under the ESA. Northern populations of this seabird occur mostly in coastal areas between Massachusetts and New York during the breeding season (U.S. Navy 2009). The Caribbean population is also known to breed in the Bahamas among other locations in the Caribbean (U.S. Navy 2009). During the non-breeding season, roseate terns may be found in waters around the Bahamas, Cuba, and the Lesser Antilles where they feed on schooling fish by diving (U.S. Navy 2009). The density and distribution of these birds in the Atlantic BOA is unknown and is likely to be variable, depending on ocean conditions and prey availability.

Many other seabirds have the potential to occur in the ROI including the VACAPES study area (U.S. Navy 2017b). Seabird distribution and abundance varies greatly with season, prey availability, and by species. Primary foraging areas for many breeding seabirds and migration corridors for birds including terns, gulls, skimmers, pelicans, loons, cormorants, and gannets are found within 19 km (10 nm) of the shoreline near WFF (U.S. Navy 2009). Areas further offshore provide pelagic foraging and habitat for non-breeding and transient seabirds such as loons, gannets, and terns (U.S. Navy 2009). Seabird density and distribution in the pelagic areas that make up the BOA ROI are unknown but are likely variable, and overall densities are likely low in the open ocean.

Fish. Due to the wide spatial footprint of the Atlantic BOA ROI, the area has the potential to provide a wide diversity of habitats for a variety of nearshore, epipelagic, mesopelagic, and benthic marine fish species. These habitats support a very diverse and spatially and temporally dynamic assemblage of fish species including many species that are important in commercial and recreational fisheries (U.S. Navy 2009). In the Navy's VACAPES area, which includes much of the stage 1 motor drop zone, fish assemblages are highly variable due to seasonal and climatic changes, varying life history strategies, fishing pressure, natural abundance cycles, and migration patterns (U.S. Navy 2009). Fish species in the Mid-Atlantic Bight include over 300 temperate, subtropical, and tropical species (U.S. Navy 2009). Some common fish species in the VACAPES area include bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*), Atlantic cod (*Gadus morhua*), Atlantic herring (*Clupea harengus*), American shad (*Alosa sapidissima*), summer flounder (*Paralichthys dentatus*), butterfish (*Peprilus triacanthus*), black sea bass (*Centropristis striata*), and many shark species (U.S. Navy 2009). Important fisheries species include Atlantic yellowfin tuna (*Thunnus albacares*), Atlantic bluefin tuna (*T. thynnus*), Atlantic bigeye tuna (*T. obesus*), white marlin (*Tetrapturus albidus*), blue marlin (*Makaira nigricans*), sailfish (*Istiophorus platypterus*), swordfish (*Xiphias gladius*), dolphinfish (*Coryphaena hippurus*), and wahoo (*Acanthocybium solanderi*; U.S. Navy 2009).

Essential Fish Habitat. As defined in **Section 3.1.3**, EFH consists of the waters and substrate needed by fish to spawn, breed, feed, or grow to maturity and may include waters within the U.S. EEZ (seaward boundary out to a distance of 370 km [200 nm]); 50 CFR §600.805). As such, the only designated EFH occurs within the stage 1 motor drop zone of the Atlantic BOA ROI. The number of fish species and life stages with designated EFH in this area is quite extensive and is detailed in the VACAPES Range Complex Final EIS/OEIS (U.S. Navy 2009). Given the limited scope of the potential effects of the action on EFH, this document includes only a general overview of EFH in the stage 1 spent motor drop zone.

In general, fisheries management councils designate EFH for marine species for separate life stages; eggs, larvae, juveniles, adults, and spawning adults. At least 94 species (not including corals) with designated EFH for at least one life stage may occur in the ROI as detailed in the VACAPES Range Complex Final EIS/OEIS (Table 3.9-2 in U.S. Navy 2009). In addition to fish, macroalgae such as *Sargassum* and invertebrates such as crabs, lobsters, and scallops also have designated EFH. The EFH in this portion of the ROI includes benthic habitats (e.g., rocks, gravel, cobbles, sand, etc.), structure habitat (e.g., artificial reefs, shipwrecks, natural sponge and coral habitats), *Sargassum* habitat (pelagic mats of *Sargassum*), Gulf Stream habitat, and water column habitat (U.S. Navy 2009). Several species with designated EFH also have designated Habitat Areas of Particular Concern (HAPC) which may occur within the ROI (Table 3.9-4 in U.S. Navy 2009). Designated HAPCs include an Existing Coral, Coral Reefs, Life or Hardbottom HAPC (U.S. Navy 2009) in the southwestern portion of the stage 1 motor drop zone.

Invertebrates. Invertebrate communities in the Atlantic BOA ROI consist of both pelagic and benthic assemblages. Pelagic communities are dominated by zooplankton, which include a diversity of organisms from microscopic protists to multicellular animals such as jellyfish (U.S. Navy 2009). These plankton assemblages include the larvae and gametes of invertebrates such as corals and mollusks as well as some vertebrate larvae such as those of some fish. As with phytoplankton, the abundance and distribution of zooplankton is seasonal an depends on temperature, salinity, nutrient availability, oxygen concentration, and food availability (U.S. Navy 2009). As a result, zooplankton is seasonally and spatially variable in the Atlantic BOA with concentrations in areas of high primary productivity, including the Gulf Stream and areas of upwelling (U.S. Navy 2009).

Benthic invertebrate communities include a variety of organisms including cnidarians, annelids, crustaceans, and mollusks. These benthic communities depend primarily on the type of bottom habitat or substrate in an area (U.S. Navy 2009). Both soft bottom and hard bottom habitats occur in the Atlantic ROI. Benthic invertebrates which occur in soft bottom habitats are generally organisms such as polychaete worms, amphipods, annelid worms, bivalves, and sea stars (U.S. Navy 2009). Hard bottom habitats can support a diversity of sessile organisms including bryozoans, hard and soft corals, anemones, hydrozoans, and sponges (U.S. Navy 2009). The continental shelf off the coast of WFF primarily consists of soft bottom habitats, but there are some hard bottom habitats as well as artificial hard bottom habitats such as artificial reefs and shipwrecks (U.S. Navy 2009).

The highest diversity and abundance of corals in the Atlantic ROI is likely in Spent Motor Drop Zone 1 in the VACAPES areas. Temperate corals are found on the continental shelf in the VACAPES area, and deep-sea corals are found on the continental slope between 200 and 1,000 m (650 to 3280 ft) deep (U.S. Navy 2009). Many species of coral are known to occur in the vicinity of spent motor drop zone 1, and most of these are deep water species (U.S. Navy 2009). Deep sea corals in the ROI are found on top of canyons, plateaus, edges of the continental shelf, and bases of slopes where they can occur as solitary colonies or thickets and banks (U.S. Navy 2009, Packer et al 2007). Canyons such as Baltimore Canyon, Washington Canyon, Norfolk Canyon, and Submarine Canyon in the ROI are known to support a diversity of hard and soft deep-sea corals (Packer et al. 2007). These deep-sea coral communities can support a wide diversity of invertebrate species and may act as spawning and feeding areas for fish species (U.S. Navy 2009). As discussed in the "Essential Fish Habitat" section, EFH has been designated for coral, coral reef, live or hard bottom EFH in spent motor drop zone 1.

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4.0 Environmental Consequences

This chapter presents the potential environmental consequences of the Proposed Action and No Action Alternative when compared to the affected environment resource areas described in **Chapter 3.0**. **Sections 4.1** through **4.5** provide a detailed discussion of the potential direct and indirect effects of implementing the Proposed Action and the No Action Alternative at each location under each of the resource topics evaluated. **Section 4.6** provides a summary of impacts and impact avoidance measures. As discussed in **Chapter 3.0**, the information and data presented are commensurate with the importance of the potential impacts. The resources evaluated in this chapter are the same as those evaluated in the FE-1 flight test EA completed in 2017. The actual FE-1 flight test resulted in impacts that were in line with the analysis presented in the FE-1 EA.

Additional analyses to address any concerns from EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* and EO 13045 (as amended by EO 13229 and 13296), *Federal Actions to Address Protection of Children from Environmental Health Risks and Safety Risks* are discussed in **Sections 4.1.6, 4.3.4**, and **4.4.3**.

4.1 Pacific Missile Range Facility/Kauai Test Facility

4.1.1 Air Quality (PMRF/KTF)

Effects on air quality are based on estimated direct and indirect emissions associated with the action alternatives. The ROI for assessing air quality impacts is the air basin surrounding PMRF. Estimated emissions from a proposed federal action are typically compared with the relevant national and state standards to assess the potential for increases in pollutant concentrations.

4.1.1.1 Kauai Test Facility, Pacific Missile Range Facility – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline air quality. Therefore, no impacts to air quality or air resources would occur with implementation of the No Action Alternative.

4.1.1.2 Kauai Test Facility, Pacific Missile Range Facility – Proposed Action

The Proposed Action would launch a developmental payload on a STARS booster missile with impact of the payload on Illeginni Islet at RTS, USAKA. Launches of the STARS have been analyzed in various environmental documents (USASDC 1992, U.S. Navy 2008, U.S. Navy 2017a) and have been determined to not have a significant impact on air quality.

The Proposed Action would include one launch of a STARS booster with the developmental payload from KTF. The STARS booster has been previously launched at SNL/KTF, and it is anticipated that the launch of the FE-2 flight test at the same site would have a similar air quality to that described for previous STARS missile launches.

The first-stage booster releases emissions at a rate of about 217 kilograms per second (kg/sec) (478.4 lb/sec). The emission rates of the major components of the STARS first stage booster and the 8-hour average concentrations of these materials at 3,000 m (9,842 ft) from the launch pad indicate that they are less than the applicable standards (**Table 4-1**).

Table 4-1. STARS Emission Rates and Concentrations

		8-Hour Average Concentration at 3,000 meters | mg/m^3			
	Emission Rate kg/sec (lb/sec)	**Winds at 5.5 km/hr (3.4 mi/hr)**	**Winds at 24 km/hr (15 mi/hr)**	**Winds at 48 km/hr (30 mi/hr)**	**Standard 8-Hour TLV[(a)] mg/m^3**
Hydrogen Chloride	32.2 (70.9)	1.3	0.08	0.03	7.5
Aluminum Oxide	60.3 (132.9)	0.22	0.14	0.08	10
Nitrogen Dioxide	42.5 (93.7)	1.6	0.10	0.05	5.6 [NAAQS annual average – 1001]
Carbon Dioxide	6 (13.2)	N/A	N/A	N/A	9,000
Carbon Monoxide	77 (169.9)	N/A	N/A	N/A	N/A

(a) TLV =threshold limit value published by American Conference of Governmental Industrial Hygienists (ACGIH)
Abbreviations: kg/sec = kilograms per second, lb/sec = pounds per second, mg/m^3 = milligrams per cubic meter, mi/hr = miles per hour, N/A = not applicable, NAAQS = National Ambient Air Quality Standards

Table 4-2 lists major exhaust components from STARS missiles launched from PMRF. In the stratosphere (10 to 50 km [6.2 to 31 mi] above the Earth's surface), missile launch emissions could potentially affect global warming (the greenhouse gas effect) and contribute to depletion of the stratospheric ozone layer. Of the chemical species that form during launches, the most environmentally significant are hydrochloric acid, aluminum oxide, nitrogen, and carbon dioxide.

Table 4-2. Estimated Emissions from a STARS Missile Launch[1] at SNL/KTF

Emission	Aluminum Oxide[2]	Carbon Monoxide	Carbon Dioxide[3]	Hydrogen	Water	Hydrochloric Acid[2]	Nitrogen Oxides[2]	Lead	Others
Tons per launch	5.628	4.185	0.431	0.318	0.959	1.943	1.855	0.000	0.027

[1] Exhaust products are total for all three stages

[2] Ozone-depleting substances

The Navy FE-2 flight test would result in temporary air emissions during the liftoff of the STARS booster. The quantities of combustion products aluminum oxide, carbon monoxide, carbon dioxide, and hydrogen chloride generated by the entire first stage burn of the STARS booster are relatively minor amounts that are dispersed within a short time after liftoff. Thus, the minor amounts of combustion products would result in only very minor short-term impacts to air quality. The FE-2 flight test would incrementally contribute to global emissions of GHGs. However, no significant impacts are anticipated.

4.1.2 Water Resources (PMRF/KTF)

Effects on water quality are based on estimated direct and indirect impacts associated with the action alternatives. The ROI for assessing water resources impacts is the area surrounding PMRF.

4.1.2.1 Water Resources at Kauai Test Facility, Pacific Missile Range Facility – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline water resources. Therefore, no significant impacts to water resources would occur with implementation of the No Action Alternative.

4.1.2.2 Water Resources at Kauai Test Facility, Pacific Missile Range Facility – Proposed Action

Analysis of STARS launch-related impacts is covered in the STARS EIS (USASDC 1992). The EIS evaluated the potential impacts of launch emissions, spills of toxic materials, and early flight termination. The analysis concluded that hydrogen chloride emissions would not significantly affect the chemical composition of surface or groundwater; that there would be no significant increase in aluminum oxide in surface waters due to launches; that sampling of surface waters in the vicinity of the launch site showed that hydrogen chloride, potentially deposited during past launches, has not affected surface water quality on PMRF or adjacent areas; and that contamination from spills of toxic materials would be highly unlikely.

Subsequent sampling and analysis, prior to and following a 26 February 1993 STARS target launch, showed little or no evidence that the launch produced any adverse impact on water, soil, or vegetation (USASSDC 1993a). Based on the Calendar Year 2005 Annual Site Environmental Report for Tonopah Test Range and Kauai Test Facility, there were no reportable releases at the SNL/KTF under EPCRA or CERCLA in 2005. In addition, there were no compliance issues with respect to any state or federal water pollution regulations in 2005. As reported in the Annual Site Environmental Report, a NPDES permit is not required due to the lack of significant storm water runoff discharging into “Waters of the US,” as defined in 40 CFR 122.

The results of soil sampling conducted in 1999, 2002, and 2007 show that most reported values are below the USEPA residential screening levels. Iron and thallium exceed the residential screening level; however, they are below the industrial screening level. Arsenic exceeds the USEPA industrial screening level; however, the State of Hawai`i has identified action levels based on bioavailable arsenic. As presented in the Hawai`i Department of Health Technical Report (Hawai`i Department of Health 2006) background concentrations of arsenic in soil in Hawai`i may range up to 20 milligrams per kilogram (mg/kg) [20 parts per million (ppm)] or higher (up to 50 mg/kg (50 ppm) in some cases). In addition, much of the arsenic in pesticide-contaminated soil appears to be tightly bound to soil particles and not available for uptake in the human body. This portion of the arsenic is essentially nontoxic. These two factors led to a need for further guidance, particularly with respect to the use of bioaccessible arsenic data in human health risk assessments and in the development of risk-based, soil action levels.

The highest level found in the KTF report was 56 mg/kg (56 ppm). This would fall into the Hawai`i Department of Health Category 2 Soils (C-2): Bioaccessible Arsenic >19 mg/kg and <95 mg/kg. Long-term exposure to Category 2 (C-2) soils is not considered to pose a significant risk to workers provided that lawns and landscaping are maintained to minimize exposure and control fugitive dust.

Impacts on water resources have not been identified from these constituents at the levels found on PMRF. Sampling for perchlorate was conducted at PMRF in October and November 2006, and the results indicated perchlorate levels were within guidelines. Based on this previous analysis and sampling, the Proposed Action activities would not adversely affect water resources.

The launches of the STARS booster have been analyzed in various environmental documents (USASDC 1992, U.S. Navy 2008) and have been determined to not have a significant impact on water resources. Therefore, implementation of the Proposed Action would not result in significant impacts to water resources.

4.1.3 Biological Resources (PMRF/KTF)

Potential environmental consequences of the Proposed Action on biological resources are evaluated based on the best available information about species distributions and in the context of the regulatory setting discussed in **Chapter 3.0**. Potential impacts of STARS missile launches on biological resources within the PMRF ROI have been addressed in detail in the Advanced Hypersonic Weapon Program EA (USASMDC/ARSTRAT 2011), the HRC EIS/OEIS (U.S. Navy 2008), and the FE-1 EA/OEA (U.S. Navy 2017a). The U.S. Navy has consulted with USFWS on effects of PMRF base-wide operations on terrestrial ESA-listed species, and USFWS issued a programmatic Biological Opinion for base-wide operations (which would include the FE-2 launch) in 2014. Consultation was reinitiated for Newell's shearwaters in 2015, and a Biological Opinion was issued for effects of base-wide operations on this species in 2018 (USFWS 2018).

4.1.3.1 Biological Resources at PMRF/KTF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.1.3.2 Biological Resources at PMRF/KTF – Proposed Action

The Proposed Action is evaluated for the potential impacts on biological resources at PMRF/KTF ROI. Potential impacts of the Proposed Action in this area could result from exposure to FE-2 stressors including elevated SPLs, direct contact from debris, hazardous chemicals, artificial lighting, and increased human activity and equipment operation.

Launches of the new booster configurations as part of the Proposed Action testing would be similar to launches of the STARS previously analyzed in the Strategic Target System EIS and the PMRF Enhanced Capability EIS (USASDC 1992; U.S. Navy 1998). No new facilities would be required. The launch azimuth and flight termination system would be the same as that of the previously analyzed STARS boosters.

Existing radars and the ground hazard area would also be the same. As a result, impacts on biological resources would be similar to those previously analyzed and are expected to be minimal. Impacts on threatened and endangered species at PMRF are not expected to be different than for any other terrestrial wildlife species. Additionally, installation personnel would continue to manage habitats according to the Installation Natural Resources Management Plan (INRMP), which is designed to protect and benefit threatened and endangered species.

4.1.3.2.1 Consequences for Biological Resources at PMRF/KTA

Terrestrial Vegetation at PMRF/KTF

Overall, terrestrial vegetation is not expected to be significantly impacted by any FE-2 stressors at PMRF/KTF as described below.

No ground clearing or construction is expected for the Proposed Action. The launch would take place at a previously disturbed, previously used, and previously analyzed location. Vegetation near the launch pad could be impacted by the heat generated at launch; however, vegetation is typically cleared from areas adjacent to the launch site and duration of high temperature is extremely short (a few seconds). Plants also have the potential to be impacted by hydrogen chloride or aluminum oxide emissions at launch. However, analyses of the STARS system (USASDC 1992) concluded that there is no evidence of any long-term adverse impact on vegetation from heat or chemical emission in two decades of launches on PMRF. Compliance with relevant Navy policies and procedures during this launch event should continue to minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. Equipment imported to the launch site at PMRF/KTF from the mainland or other islands would be inspected prior to loading and upon arrival to reduce the risk of introduction or spread of invasive species.

No long-term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on PMRF, and critical habitat for the ohai and lau`ehu would not be affected by the action.

Terrestrial Wildlife at PMRF/KTF

Terrestrial wildlife species at PMRF such as birds as well as marine organisms that haulout on land (**Table 3-2**) may be impacted by elevated SPLs from launch as well as hazardous chemicals, artificial lighting, and direct contact from debris. The launch site at KTF is in an area that has routine human activity, equipment operation, and launch activity. Overall, terrestrial wildlife is not expected to be significantly impacted by FE-2 stressors during launch activities at PMRF.

Elevated Sound Pressure Levels. As analyzed for previous STARS launches at PMRF (U.S. Navy 2008), noise from launches and launch related activity may startle nearby wildlife, causing flushing behavior in birds, but this startle reaction would be of short duration. The brief noise peaks produced by missiles are comparable to levels produced by thunder at close range (120 decibels [dB] to 140 dB peak; U.S. Navy 2008). Disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause birds and other mobile wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended.

Monitoring of birds in areas similarly exposed to launch noise during the breeding season indicates that adults respond to launch noise by flying away from nests but returning within 2 to 4 minutes (U.S. Navy 2008). Terrestrial species at PMRF are already habituated to high levels of noise associated with ongoing activities at this facility.

Direct Contact from Debris. No impacts on wildlife due to direct contact from debris are expected during normal flight operations. The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact at PMRF or along the flight corridor. In most cases, an errant missile would be moving at such a high-speed that resulting missile debris would strike the water further downrange (U.S. Navy 2008). If monk seals or sea turtles were observed in the launch safety zone the launch would be delayed until the animals leave.

Exposure to Hazardous Chemicals. Results of monitoring conducted following a STARS launch from SNL/KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions (U.S. Navy 2008). The program included surveys of representative birds and mammals for both prelaunch and post-launch conditions. Birds flying through an exhaust plume may be exposed to concentrations of hydrogen chloride that could irritate eye and respiratory membranes; however, most birds would not come into contact with the exhaust plume, because of their flight away from the initial launch noise (U.S. Navy 2008). Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals would not cause injury because it is inert and not absorbed into the skin (U.S. Navy 2008). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions (U.S. Navy 1998).

In the unlikely event of an on-pad fire or early flight failure over land of this solid propellant missile, most or all of the fuel would likely burn up before being extinguished. Any remaining fuel would be collected and disposed of as hazardous waste. Soil contamination which could result from such an incident is expected to be localized, along with any impacts on vegetation or wildlife.

Artificial Lighting. Pre-launch activities at KTF include final vehicle and experiment assembly, preflight checks, and demonstration of system performance. If program activities are required to occur at night, the U.S. Navy would coordinate these activities through PMRF to comply with the Dark Skies policy and avoid disorienting Newell's shearwaters with artificial lights. The launch vehicle would launch from Pad 42 at KTF. In 2011, USASMDC/ARSTRAT conducted a similar test using the same launch vehicle from Pad 42 during the Newell's shearwater fledging season. USFWS issued a Biological Opinion for that launch. The launch pad was lit using the green lighting system for more than a week prior to the night launch, and there were no Newell's shearwater fall-out events at the launch pad. Newell's shearwaters and other bird species are not likely to be significantly impacted by artificial lighting from FE-2 activities. The effects of PMRF base-wide operations, including FE-2 launches, on Newell's shearwaters have been address through previous U.S. Navy consultations with USFWS, and a final Biological Opinion for base-wide operations was issued in 2018 (USFWS 2018).

Marine Vegetation at PMRF/KTF

Marine vegetation at PMRF is not likely to be impacted by the Proposed Action (i.e., FE-2 stressors). The chances of launch emissions impacting marine vegetation are remote. Launch emissions would be dispersed in the atmosphere, and any chemicals that entered the marine environment would be further diluted by ocean water. As discussed above, no debris that results in direct contact is expected during normal flight operations. The chances of a launch mishap that would result in debris entering the marine system are very low.

Marine Wildlife at PMRF/KTF

Overall, marine wildlife are not expected to be significantly impacted by any FE-2 stressors at PMRF/KTA. Any impacts, if realized, would likely be limited to short-term startle reactions, and marine wildlife would be expected to return to normal behaviors within minutes. No marine wildlife would be exposed to artificial lighting or increased levels of human activity and equipment operation stressors.

Elevated Sound Level Impacts. Impacts of elevated SPLs on marine wildlife species can vary from temporary behavioral effects to physical injury or even death. As analyzed for previous STARS launches at PMRF (U.S. Navy 2008), noise from launches and launch related activity may startle nearby wildlife, but this startle reaction would be of short duration. The brief noise peaks produced by missiles are comparable to levels produced by thunder at close range (120 dB to 140 dB peak; U.S. Navy 2008).

The offshore waters where marine wildlife reside would be subject to much lower SPLs as sound pressures attenuate with distance from the launch site. Disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause mobile marine wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended. Standard operating procedures at PMRF incorporate procedures to avoid wildlife that are foraging or resting such as sea turtles, Hawaiian monk seals, or cetaceans. Marine species at PMRF are likely already habituated to high levels of noise associated with ongoing activities at this facility.

Direct Contact from Debris. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations. According to analysis contained in the PMRF Enhanced Capability EIS (U.S. Navy 1998), debris from shore-based missile launch programs is not expected to produce any measurable impacts on offshore benthic (sea floor) resources (U.S. Navy 2008). The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact along the flight corridor, potentially in offshore waters (U.S. Navy 2008). If humpback whales, monk seals, or sea turtles were observed in the offshore launch safety zone, the launch would be delayed (U.S. Navy 1998). In the event of a launch mishap, some fish near the surface could be injured or killed by larger pieces of debris. It is unlikely that the smaller pieces of sinking debris would have sufficient velocity to harm individual marine mammals or fish.

No impacts to EFH are expected for normal flight operations as debris is not expected to enter the marine environment. The chances of a launch mishap that might introduce debris into EFH are very low, and any debris would likely be small and widely scattered.

Exposure to Hazardous Chemicals. Within offshore waters, the potential ingestion of contaminants by fish and other marine species would be remote because of atmospheric dispersion of the emission cloud, the diluting effects of the ocean water, and the relatively small area of the EFH that would be affected (U.S. Navy 2008). Results of monitoring conducted following a STARS launch from KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions (U.S. Navy 2008). The program included surveys of representative birds and mammals for both prelaunch and post-launch conditions. Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals would not cause injury because it is inert and not absorbed into the skin (U.S. Navy 2008). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions (U.S. Navy 1998).

In the unlikely event of an early flight failure over offshore waters, scattered pieces of burning propellant could enter coastal water and potentially affect wildlife or EFH closer to shore. Concentrations of toxic materials would be highest in the shallow waters near PMRF and have a greater chance of being ingested by feeding animals (U.S. Navy 2008). However, the potential for a launch mishap is very low, and in most cases the errant missile would be moving at a rapid rate such that pieces of propellant and other toxic debris would strike the water further downrange. The debris would also be small and widely scattered, which would reduce the possibility of ingestion.

4.1.4 Airspace (PMRF/KTF)

The analysis of airspace management and use involves consideration of many factors including the types, locations, and frequency of aerial operations, the presence or absence of already designated (controlled) airspace, and the amount of air traffic using or transiting through a given area.

4.1.4.1 Airspace at SNL/KTF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to airspace. Therefore, no significant impacts to airspace would occur with implementation of the No Action Alternative.

4.1.4.2 Airspace at SNL/KTF – Proposed Action

The U.S. Navy SSP FE-2 flight test would be like previous missile tests including FE-1, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described for missile launches in previous environmental documentation (USASDC 1992, U.S. Navy 2008, U.S. Navy 2017a) for PMRF and SNL/KTF.

The advanced planning and coordination with the FAA regarding scheduling of special use airspace, and coordination of the proposed FE-2 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace. Therefore, implementation of the Proposed Action would not result in significant impacts to airspace.

4.1.5 Noise (PMRF/KTF)

Analysis of potential noise impacts includes estimating likely noise levels from the Proposed Action and determining potential effects to sensitive receptor sites.

4.1.5.1 Noise at SNL/KTF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline noise levels. Therefore, no significant impacts due to the noise environment would occur with implementation of the No Action Alternative.

4.1.5.2 Noise at SNL/KTF – Proposed Action

The study area for the analysis of effects to noise resources associated with the Proposed Action includes KTF and PMRF.

The Proposed Action would include the launch of a STARS booster with the developmental payload from SNL/KTF. The STARS booster has been previously launched at SNL/KTF (USASDC 1992, U.S. Navy 2008, 2017b), and noise levels would be the same as previous launches. The nearest on-base housing area is located approximately 5.6 km (3.5 mi) south of the northern KTF and PMRF launch areas. The nearest off-base residential area is Kekaha, which is approximately 12.9 km (8 mi) south of the northern KTF and PMRF launch areas. Based on previous measurements of noise for STARS launches at PMRF/Main Base shown in **Table 3-6,** the noise level at the on-base housing would be less than the 97 dB level measured at 3 km (2 mi).

KTF supports a variety of sounding rocket missions; therefore, occasional rocket, missile, or drone launches produce high-intensity, short-duration sound events. Data collected in the nearest town of Kekaha indicated that levels were no louder than noise generated from passing vehicles on a nearby highway. No noise-sensitive land uses are affected by existing noise levels. For the reasons given in the previous paragraph and the previous NEPA analyses (USASDC 1992, U.S. Navy 2008, 2017a) of past STARS booster launches, implementation of the FE-2 flight test would not result in significant impacts to the noise environment.

4.1.6 Public Health and Safety (PMRF/KTF)

The safety and environmental health analysis contained in the respective sections addresses issues related to the health and well-being of military personnel and civilians living on or in the vicinity of SNL/KTF and PMRF. Additionally, this section addresses the environmental health and safety risks to children.

4.1.6.1 Public Health and Safety at SNL/KTF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to public health and safety. Therefore, no significant impacts would occur with implementation of the No Action Alternative.

4.1.6.2 Public Health and Safety at SNL/KTF – Proposed Action

The study area for the analysis of effects to public health and safety resources associated with the Proposed Action includes SNL/KTF and PMRF.

The FE-2 flight test would include the launch of a STARS booster with the payload from SNL/KTF. The STARS booster has been previously launched at SNL/KTF. The testing of the developmental payload at the same site would have a similar potential health and safety impact as described for past launches of the STARS booster. The proposed solid propellants would be similar to past launches, and the FE-2 team would follow the same health and safety procedures developed under existing plans. PMRF and SNL/KTF SOPs would be followed for launch site preparation, booster handling, and all hazardous operations. PMRF Missile Flight Analysis, Ground Safety, Range Safety, Ocean Clearance, Transportation Safety, and Fire and Crash Safety procedures would be followed to ensure the safety of workers and members of the public.

For the reasons given in the previous paragraph and the previous NEPA analyses (USASDC 1992, U.S. Navy 2008, 2017b) of past STARS booster launches, implementation of the Proposed Action would not result in significant impacts to public health and safety.

In accordance with EO 13045, *Protection of Children from Environmental Health and Safety Risks*, the Navy has determined that, since the majority of the FE-2 flight test would be conducted on DOD property and out in the open ocean, the FE-2 flight test has no environmental health and safety risks that may disproportionately affect children.

4.1.7 Hazardous Materials and Wastes (PMRF/KTF)

The hazardous materials and wastes analysis contained in the respective sections addresses issues related to the use and management of hazardous materials and wastes as well as the presence and management of specific cleanup sites at KTF.

4.1.7.1 Hazardous Materials and Wastes at SNL/KTF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change associated with hazardous materials and wastes. Therefore, no significant impacts would occur with implementation of the No Action Alternative.

4.1.7.2 Hazardous Materials and Wastes at SNL/KTF – Proposed Action (All Alternatives)

The study area for the analysis of effects to hazardous materials and wastes associated with the Proposed Action includes SNL/KTF and PMRF.

The flight test would include the STARS booster with the developmental payload launched from KTF. The STARS booster has been previously launched at SNL/KTF, and hazardous materials and wastes would be the same for those launches. The launch of the Proposed Action would be anticipated to use similar hazardous materials and produce similar hazardous waste. This launch is included in the overall number of missile launches proposed in the HRC EIS/OEIS. Hazardous material usage and waste generation would continue to be managed by PMRF under appropriate state and federal requirements. For the reasons given in the previous paragraph and the previous NEPA analyses (USASDC 1992, U.S. Navy 2008, 2017a) of past STARS booster launches, implementation of the Proposed Action would not result in significant impacts with hazardous materials and wastes.

4.2 Pacific Ocean Flight Corridor

4.2.1 Air Quality (Pacific Ocean Flight Corridor)

Effects on air quality are based on estimated direct and indirect emissions associated with the action alternatives. The ROI for the over-ocean flight corridor is the global upper atmosphere over the Pacific BOA along the flight path from outside the launch area at SNL/KTF to outside the impact area at RTS. During flight, the emissions within the over-ocean flight corridor from the FE-2 flight test have the potential to affect air quality in the global upper atmosphere.

Estimated emissions from a proposed federal action are typically compared with the relevant national and state standards to assess the potential for increases in pollutant concentrations.

4.2.1.1 Air Quality in the Over-Ocean Flight Corridor – No Action Alternative

Under the No Action Alternative, the FE-2 flight test would not occur and there would be no change to baseline air quality. Therefore, no significant impacts to air quality or air resources would occur with implementation of the No Action Alternative.

4.2.1.2 Air Quality in the Over-Ocean Flight Corridor – Proposed Action (All Alternatives)

Air Quality

For all alternatives, the FE-2 vehicle would launch from SNL/KTF and travel along a predetermined flight corridor over the Pacific BOA before payload descent for impact at RTS.

The FE-2 vehicle would launch from SNL/KTF to RTS with rocket emissions occurring in the over-ocean flight corridor as propellant is burned until exhausted from the rocket motor boosters. The active flight time over the ROI would be measured in minutes. Exhaust emissions would contain both chlorine compounds and free chlorine, produced primarily as hydrogen chloride at the nozzle.

Approximately 5.6 tons of aluminum oxide and 1.9 tons of nitrogen (**Table 3-7**) are released over a period of minutes. The aluminum oxide is emitted as solid particles and can activate chlorine in the atmosphere. Chlorine and hydrogen chloride would have a tropospheric lifetime long enough to eventually mix with the stratosphere. Both aluminum oxide and nitrogen oxides are of concern with respect to stratospheric ozone depletion. Nitrogen oxides contribute to catalytic gas phase ozone depletion, and the exact magnitude of ozone depletion that can result from a buildup of aluminum oxide over time has not yet been determined quantitatively. However, following the FE-2 flight test, the majority of aluminum oxide would be removed from the stratosphere through dry deposition and precipitation.

The production of nitrogen oxide species from solid rocket motors is dominated by high-temperature "afterburning" reactions in the exhaust plume. As the temperature of the exhaust decreases with increasing altitude, less nitrogen oxide is formed. On a global scale, the quantity of NO_x emissions from a single STARS vehicle would represent a very small fraction of nitrogen species generated. Additionally, diffusion and winds would disperse the nitrogen oxide species. No significant effect on ozone levels from NO_x is expected.

Emissions of hydrogen chloride and aluminum oxide from a single launch of a STARS booster (**Table 3-7**) would be substantially less than those that were released by a single Space Shuttle launch, and on a global scale the level of emissions would not be statistically significant. Because the emissions of hydrogen chloride, aluminum oxide, and nitrogen oxides from a launch of a STARS booster would be relatively small compared to emissions released on a global scale, the large air volume over which these emissions are spread, and the dispersion of the emissions by stratospheric winds, a single launch of a STARS booster should not have a significant impact on stratospheric ozone. Therefore, impacts from a single launch of a STARS vehicle for the FE-2 flight test would not be expected to have a significant impact on the upper atmosphere.

STARS rocket motor emissions from the FE-2 flight test would not have a significant impact on stratospheric ozone depletion. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that any incremental effects on the global atmosphere would be discountable and insignificant.

Impacts of the FE-2 flight test launch on global warming, climate change, and ozone depletion in the atmosphere have also been considered as part of cumulative impacts in **Chapter 5.0**.

Greenhouse Gases and Climate Change within Over-Ocean Flight Corridor

Carbon dioxide is the only GHG identified in the Kyoto Protocol or the Hawai`i rule that would be emitted during the FE-2 flight test. Because of the solid propellant used, the launch would release only 0.4 ton of carbon dioxide. This does not include a small number of support ocean vessels, aircraft, and other equipment that would be used along the flight path, at RTS, and around USAKA to support the terminal phase preparations and operations, which would be limited and temporary. The availability of GHG emission factors for vessels and some aircraft is limited. Therefore, GHG emissions from those sources were not quantified in this analysis. The amount of emissions that would be released, however, is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time associated with conducting the FE-2 flight test activities. This limited amount of emissions would not likely contribute to global warming or climate change to any discernible extent.

Therefore, implementation of the FE-2 flight test would not result in significant impacts to GHGs and climate change in the over-ocean flight corridor.

4.2.2 Biological Resources (Pacific Ocean Flight Corridor)

Potential environmental consequences of the Proposed Action on biological resources are evaluated based on the best available information about species distributions and in the context of the regulatory setting discussed in **Chapter 3.0**.

4.2.2.1 Biological Resources in the Pacific Ocean Flight Corridor – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.2.2.2 Biological Resources in the Pacific Ocean Flight Corridor – Proposed Action

The Proposed Action is evaluated for the potential impacts on marine biological resources in the Pacific Ocean Flight Corridor of the ROI. Potential impacts of the Action in this area include exposure to FE-2 stressors including elevated SPLs, direct contact from launch vehicle components, exposure to hazardous chemicals, and increased human and vessel activity. The potential for the Proposed Action to adversely impact biological resources including those special-status species described in **Section 3.2.2** is evaluated in this section. In-depth analyses of the effects of the FE-2 Action on ESA and MMPA protected species have been completed in the FE-2 Biological Assessment (U.S. Navy 2019) and have been reviewed by NMFS in a Biological Opinion (NMFS 2019a, **Appendix C**) and by USFWS in a Letter of Concurrence (**Appendix A**).

4.2.2.2.1 Potential Stressors in the Pacific Ocean Flight Corridor

The following stressors have the potential to impact biological resources in the Pacific Ocean Flight Corridor.

Exposure to Elevated Sound Pressure Levels

The Proposed Action has the potential to result in elevated SPLs both in-air and underwater in the BOA. The primary elements of the Proposed Action that would result in elevated SPLs in the BOA are: (1) sonic booms and (2) splashdown of vehicle components.

Sound creates vibrations that travel through air or water. Sound vibrations are characterized by their frequency (generally expressed in Hz) and amplitude or loudness, which is quantified here using the logarithmic dB. In water, SPLs are typically referenced to a baseline of 1 micropascal (µPa), whereas in-air pressures are typically referenced to 20 µPa. Unless noted, all SPLs in this EA/OEA are presented as in-water sounds with all dB levels referenced to (re) 1 µPa. For many organisms it can be useful to distinguish between peak exposure levels (dB_{peak}) and total exposure over time (sound exposure level [SEL]). For some organisms, effects are compared to thresholds based on the root mean square (RMS) sound pressure level, which is the quadratic mean sound pressure over the duration of the sound.

Sonic Booms. The launch vehicle and the developmental payload would fly at velocities sufficient to generate sonic booms from close to launch at PMRF and extending to impact at or near Kwajalein Atoll. Sonic booms create elevated pressure levels both in-air and underwater. The sonic boom generated by the FE-2 test flight has been estimated and is detailed in the FE-2 Biological Assessment (U.S. Navy 2019). The FE-2 sonic boom overpressures in the water at the ocean surface were estimated to be near their maximum level (145 dB) near the launch site and would only be at this level for a short downrange distance and extending out from the flightpath less than 28 km (15 nm).

In-air at the ocean surface, sonic boom SPLs would not exceed 119 dB re 20 µPa in the BOA.

Splashdown of Spent Rocket Motors and Other Vehicle Components. Elevated SPLs would occur in the ocean as spent rocket motors and payload components impact the ocean's surface. Estimates of splashdown forces and associated SPLs for FE-2 spent motors and the nose fairing have been estimated based on the size, shape, weight, trajectory, and impact velocity of the components (**Table 4-3**).

Table 4-3. Estimated Stage Impact Contact Areas and Peak Sound Pressure Levels for FE-2 Vehicle Components.

Stage	Contact Area m^2 (ft^2)	Peak Sound Pressure Level **(dB re 1 µPa)**
Stage 1 Spent Motor	27.73 (81.12)	218
Stage 2 Spent Motor	10.17 (33.38)	205
Nose Fairing	16.81 (55.14)	196
Stage 3 Spent Motor	5.94 (19.5)	201

Source: U.S. Navy 2019

Effect Thresholds for Marine Species. Noise from sonic booms or splashdown of vehicle components could affect the behavior and hearing sensitivity in marine mammals, birds, sea turtles, and fish in the Action Area. Loud sounds might cause these organisms to quickly react, altering their normal behavior either briefly or more long term or may even cause physical injury. The extent of the effect depends on the frequency and intensity of the sound as well as on the hearing ability of the organism. Consultation species have different hearing abilities and thresholds for effects, which have been detailed in the FE-2 Biological Assessment (U.S. Navy 2019) and are summarized in **Table 4-4**. In general, an SPL that is sufficient to cause physical injury to auditory receptors is a sound that exceeds an organism's permanent threshold shift (PTS) level. Depending on the species, higher SPLs may induce other physical injury or, in extreme cases, even death. The extent of physical injury depends on the SPL as well as the anatomy of each species.

A temporary threshold shift (TTS) is when an organism is exposed to sound pressures below the threshold of physical injury but may result in temporary hearing alteration. These sound levels may impede a marine mammal's, bird's, sea turtle's, or fish's ability to hear, even after the exposure has ended, temporarily raising the threshold at which the animal can hear. TTS can temporarily impair an animal's ability to communicate, navigate, forage, and detect predators. The onset of threshold shift in hearing in cetaceans depends on the total exposure to sound energy, a function of SPL and duration of exposure. As a sound gets louder, the duration required to induce threshold shifts gets shorter (National Research Council 2005).

Table 4-4. Acoustic Thresholds for PTS, TTS, and Behavioral Disruption from Single Exposure to Impulsive In-Water Sounds in Marine Wildlife. Peak SPL Thresholds **in dB re 1 μPa.**

Group	PTS threshold (dB SPL_{peak})	TTS Threshold (dB SPL_{peak})	Behavioral Disruption[1]
Low-frequency hearing cetaceans	219	213	NA
Mid-frequency hearing cetaceans	230	224	NA
High-frequency hearing cetaceans	202	196	NA
Phocids	218	212	NA
Birds (in-water)	212 dB SEL (non-lethal injury)	UNK	UNK
Sea turtles	230 (non-lethal injury)	224	160
Fish	229 (lethal injury)	186 dB SEL_{cum}	150 dB_{RMS}

Source: NOAA 2018

[1] For single explosive events, behavioral disturbance is likely to be limited to a short-lived startle reaction; therefore, the U.S. Navy does not use any unique behavioral disturbance thresholds for marine mammals exposed to single explosive-like events.

Another common effect of elevated SPL is behavioral modification. Most observations of behavioral responses to anthropogenic sounds have been limited to short-term behavioral responses, which include disturbance to feeding, resting, or social interactions. Responses such as sudden diving, change in swim speed, and change in respiration rate can have an effect on foraging and can decrease the foraging efficiency of various species. A disruption in foraging, or a reaction that forces an animal to expend energy diving or fleeing, may also affect the animal's energy budget (energy income against expenditure), with the outcome of less energy available for important biological functions. Responses can also include changes in the type or timing of an animal's vocalizations and masking of sounds produced from the impacted individual or from other individuals of the same species in the area such that those near the sound source will not hear those calls. Marine mammals have been observed to decrease their vocalizations in response to noise (Aguilar de Soto 2006, IWC 2007), which can have further implications on breeding, feeding, and social interacting.

__Methods for Estimating Elevated Sound Level Effects__. For each species group and each vehicle component, the range to threshold was calculated using a spherical spreading model:

$$Range\ to\ Threshold\ (m) = 10^\wedge\left(\frac{dB_{source} - dB_{threshold}}{x}\right)$$

where x is the spreading coefficient (x=20 for deep ocean waters and x=15 for shallow waters), and SPLs are in dB_{peak} re 1 μPa. Then an affect area was calculated for each relevant threshold using:

$$Affect\ Area\ (m^2) = \pi(Range\ to\ Threshold)^2.$$

The number of marine mammal and sea turtle exposures to elevated SPL effects from splashdown of components was calculated based on the best-known density information for each species and the affect area. Species densities in the Action Area were estimated based on the best available scientific data incorporated in models of the Navy's Marine Species Density

Database for the Hawai`i-Southern California Training and Testing Study Area (Hanser et al. 2017) as described in the FE-2 Biological Assessment (U.S. Navy 2019). The number of exposures was calculated as species density times affect area. Results are presented as both estimated number of exposures and the chances of an individual animal exposure. Density data for most fish and seabird species are not available for the Pacific Ocean Flight Corridor ROI; therefore, estimates of the number of exposures were not possible for these species.

Direct Contact

The Proposed Action would result in spent rocket motors splashing down into the BOA. These falling components would directly impact aquatic habitats and have the potential to directly contact marine organisms. Spent rocket motors from the three stages of the FE-2 launch vehicle would splash down into the BOA (**Figure 3-2**). The nose fairing connecting the payload to the third stage motor is expected to fall into the second spent motor drop zone. The first stage motor is 4.62 m (182 in) long with a diameter of 1.37 m (54 in) with an additional interstage section that is 87.12 cm (34.3 in) long with a diameter of 1.37 m (54 in). The second stage motor is 2.26 m (89 in) long with a diameter of 1.37 m (54 in), and the third stage motor is 1.32 m (52 in) long with a diameter of 1.37 m (54 in). Direct contact areas for these individual components are listed in **Table 4-3** and total approximately 61 m^2 (189 ft^2).

<u>Methods for Estimating Direct Contact Effects</u>. Based on the above discussed direct contact affect areas, and the best available species density information, chances of direct contact to cetaceans and sea turtles in the BOA were calculated in the FE-2 Biological Assessment (U.S. Navy 2019). Calculations were based on methodology in the FE-1 EA (U.S. Navy 2017a), Mariana Islands Training and Testing Activities Final EIS (Appendix G in U.S. Navy 2015), and the Hawai`i-Southern California Training and Testing EIS (Appendix F in U.S. Navy 2018b). Species densities in the spent motor drop zones were estimated based on the best available scientific data incorporated in models of the NMSDD for the Hawai`i-Southern California Training and Testing Study Area (Hanser et al. 2017). Sea turtles were combined into a “sea turtle guild” for analyses due to the lack of species-specific occurrence data (Hanser et al. 2017).

The probability or impact and total number of exposures were calculated for each of four splashdown scenarios, for each marine mammal or sea turtle species, and for each FE-2 component. The scenario-specific probability and exposure were averaged over the four scenarios (using equal weighting) to obtain single scenario-averaged estimates of probability and number of exposures. Results are presented as both estimated number of exposures and the chances of an individual animal exposure.

Vessel Strike and Increased Human Activity

The Proposed Action has the potential to increase ocean-going vessel traffic in the Action Area. The Action would result in vessel traffic in the BOA for on-board sensor placement along the flight path (**Figure 3-1**). A series of sensors would be onboard three vessels: the MATSS, the Range Safety System onboard the U.S. Motor Vessel *Pacific Collector*, and the Pacific Tracker. All of these sensors are existing programs and would be scheduled for use based on availability.

Marine organisms have the potential to be affected by vessel strike primarily by being at the surface when a vessel travels through an area. Organisms at the surface are at risk of being struck by the vessel or its propellers. Organisms that are not found at the sea surface have the potential of being struck when a vessel drops anchor or if a vessel runs aground.

Exposure to Hazardous Chemicals

The Proposed Action has the potential to introduce hazardous chemicals into the Action Area. Any substances of which the launch vehicle is constructed or that are contained on the launch vehicle and are not consumed during FE-2 flight or spent motor jettison (**Table 2-1**) would fall into the BOA when first-, second-, and third-stage launch vehicle motors and nose fairing are released. The launch vehicle includes rocket motors, rocket propellant, magnesium thorium in the booster interstage, asbestos in the second stage, battery electrolytes (lithium-ion and silver-zinc), radio frequency transmitters, and small electro-explosive devices (**Table 2-1**). Though the batteries carried onboard the rocket motors would be discharged by the time they splash down in the ocean, they would still contain small quantities of electrolyte material. These materials, along with residual amounts of propellant, asbestos, and heavy metals contained in the first- and third-stage motors or nose fairing, may contaminate seawater. The release of such contaminants could harm marine organisms that come in contact with or ingest these hazardous chemicals.

In an evaluation of the effects of rocket systems that are deposited in seawater, NASA concluded that the release of hazardous materials carried onboard launch vehicles would not significantly impact marine life. Materials would be rapidly diluted in the seawater and, except for the immediate vicinity of the debris, would not be found at concentrations that produce adverse effects (U.S. Navy 2008). Overall, larger and heavier vehicle components would sink fairly quickly to the ocean floor. Ocean floor depths in the BOA are so deep that consultation organisms would likely not be in contact with these materials. Any chemicals that do leak into the water column would be quickly diluted by ocean currents and the very large volume of ocean water.

4.2.2.2.2 Consequences for Biological Resources in the Pacific Ocean Flight Corridor

Marine Wildlife in the Pacific Ocean Flight Corridor

Within the Pacific Ocean Flight Corridor, the FE-2 flight test flight is not expected to have a discernible or measurable impact on benthic or planktonic invertebrates because of their abundance, their wide distribution, and the protective influence of the mass of the ocean around them. The potential exists, however, for impacts to larger vertebrates in the open ocean area, particularly those that must come to the surface to breathe (e.g., marine mammals and sea turtles) or that feed at the surface (e.g., seabirds). Potential stressors to such species could occur from exposure to elevated noise (sonic booms and splashdown pressures), direct contact from falling booster stages and other vehicle components, and exposure to hazardous chemicals released into the water.

Marine Mammals. Overall, marine mammals are not expected to be significantly impacted by any FE-2 stressors in the Pacific Ocean Flight Corridor. Any effects, if realized, would likely be limited to short-term startle reactions, and marine mammals would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: Elevated SPLs from sonic booms are not expected to impact marine mammals in the BOA as maximum SPLs for sonic booms in the BOA (145 dB re 1 μPa) do not exceed the PTS, TTS, or behavioral thresholds for cetaceans or pinnipeds.

Elevated SPLs from vehicle component splashdown are not expected to impact marine mammals in the BOA as the calculated chances of a marine mammal being exposed to sounds loud enough to cause temporary or permanent injury are extremely low (**Table 4-5**). Splashdown SPLs in the BOA do not exceed the PTS or TTS thresholds for cetaceans with mid-frequency hearing (16 species). For cetaceans with low-frequency hearing, elevated sound levels only exceed the TTS threshold for splashdown of the spent stage 1 motor. There is a 1 in 9.8×10^6 to 1 in 2.0×10^9 chance (depending on the species) of a cetacean with low-frequency hearing (6 species) being exposed to SPLs great enough to cause TTS (**Table 4-5**). Cetaceans with high-frequency hearing have a slight risk of being affected by elevated SPLs from splashdown of FE-2 launch vehicle components in the BOA. Splashdown of both the stage 1 and 2 motors may generate SPLs loud enough to exceed the PTS and TTS thresholds in these animals, and the stage 3 motor and nose fairings may generate SPLs that exceed the TTS for cetaceans with high-frequency hearing. Overall, there is a 1 in 7.58×10^5 chance that a cetacean with high-frequency hearing would be exposed to SPLs high enough to elicit PTS and a 1 in 1.86×10^5 chance of TTS exposure for cetaceans with high-frequency hearing (**Table 4-5**). Cetaceans with high-frequency hearing include only pygmy and dwarf sperm whales.

Hawaiian monk seals have a similarly low chance of being affected physically by the elevated SPLs generated by falling FE-2 components in the BOA (**Table 4-5**). Hawaiian monk seals only have the potential to occur in motor drop zone 1. In this area, splashdown of the spent stage 1 motor would have the potential to exceed the PTS threshold for monk seals out to 1 m (3 ft) and would have the potential to exceed the TTS threshold out to 2 m (6 ft). Resulting chances of effect are 1 in 1.06×10^{10} of being exposed to SPLs above the PTS threshold and 1 in 2.67×10^9 for TTS for Hawaiian monk seals (**Table 4-5**).

Table 4-5. Estimated Number of Marine Mammal and Sea Turtle Exposures to Acoustic Impacts and Direct Contact from FE-2 Launch Vehicle Component Splashdown in the BOA.

Species	Maximum Average Density (/km²)[1]	Number of Exposures to Elevated SPLs			Estimated Total Number of Exposures to Direct Contact
		PTS	TTS	Behavioral Disturbance	
Marine Mammals					
Balaenoptera acutorostrata	0.00423	-	4.20E-08	-	3.62E-06
B. borealis	0.00016	-	1.59E-09	-	2.26E-07
B. edeni	0.00015	-	1.23E-09	-	1.74E-07
B. musculus	0.00005	-	4.97E-10	-	1.36E-07
B. physalus	0.00006	-	5.96E-10	-	1.24E-07
Feresa attenuata	0.00440	-	-	-	1.91E-06
Globicephala macrorhynchus	0.00991	-	-	-	3.59E-06
Grampus griseus	0.00470	-	-	-	4.94E-06
Indopacetus pacificus	0.00310	-	-	-	2.46E-06
Kogia breviceps	0.00291	3.82E-07	1.56E-06	-	1.40E-06
K. sima	0.00714	9.38E-07	3.83E-06	-	3.13E-06
Lagenodelphis hosei	0.02100	-	-	-	9.20E-06
Megaptera novaeangliae	0.00968	-	1.02E-07	-	7.97E-06
Mesoplodon densirostris	0.00086	-	-	-	5.30E-07
Orcinus orca	0.00006	-	-	-	5.13E-08
Peponocephala electra	0.00200	-	-	-	8.76E-07
Physeter macrocephalus	0.00155	-	-	-	1.75E-06
Pseudorca crassidens	0.00125	-	-	-	1.71E-06
Stenella attenuata	0.00658	-	-	-	2.25E-06
S. coeruleoalba	0.00743	-	-	-	2.12E-06
S. longirostris	0.01024	-	-	-	2.97E-06
Steno bredanensis	0.00488	-	-	-	1.28E-06
Tursiops truncatus	0.00339	-	-	-	1.90E-06
Ziphius cavirostris	0.00030	-	-	-	2.02E-07
Neomonachus schauinslandi	0.00003	9.42E-11	3.75E-10	-	6.02E-09
Marine Mammal Total		1.32E-06	5.53E-06		5.17E-05
Sea Turtles					
Sea Turtle Guild [2]	0.00430	-	-	0.00918	1.41E-06

Abbreviations: PTS = Permanent Threshold Shift; TTS = Temporary Threshold Shift.
[1] Density Data Source: Navy's Marine Species Density Database (Hanser et al. 2017). Average densities were calculated for each motor drop zone. The maximum average density among the three drop zones is presented.
[2] Sea turtles were combined into a "sea turtle guild" in the Hawai`i-Southern California Training and Testing Study Area Marine Species Density Database due to the lack of species- specific occurrence data (Hanser et al. 2017). This sea turtle guild is composed of primarily green and hawksbill turtles as they account for nearly all sightings in the study area; however, in theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles (Hanser et al. 2017).

Direct contact: Direct contact from splashdown of vehicle components is not expected to impact marine mammals in the BOA as the calculated chances of a marine mammal being injured are so low as to be discountable. The estimated chance of a marine mammal being exposed to direct contact from falling FE-2 components in the BOA is between 1 in 109,000 and 1 in 19,500,000 depending on individual species (**Table 4-5**). While we have included all possible species in these analyses with density estimates from other areas of the Pacific Ocean, it is important to note that many of these species are extremely unlikely to occur in the BOA of the Action Area during certain times of the year. The estimated chance of a Hawaiian monk seal exposure to direct contact from falling FE-2 components is 1 in 166,000,000 (**Table 4-5**). Even when totaled across species, the estimated chance of any marine mammal exposure is only 1 in 19,500 (**Table 4-5**). The model does not account for animal movement or avoidance behaviors. The exposure estimates were modeled based on conservative assumptions including the assumption that animals are at the surface 100 percent of the time and are likely an overestimation of probability of effect.

Vessel strike and increased human activity: Marine mammals in the Pacific Ocean Flight Corridor are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors. While cetaceans and monk seals breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in the Action Area. Given that marine mammal density in this area is low and seasonal, the chances of a marine mammal being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Exposure to hazardous chemicals: Hazardous material release in the Pacific Ocean Flight Corridor is not likely to adversely impact marine mammals. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed, and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and marine mammals are not likely to occur. Due to the low density and patchy distribution of marine mammals in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Sea Turtles. Overall, sea turtles are not expected to be significantly impacted by any FE-2 stressors in the Pacific Ocean Flight Corridor. Any impacts, if realized, would likely be limited to short-term startle reactions, and sea turtles would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: Elevated SPLs from sonic booms are not expected to impact sea turtles in the BOA as maximum SPLs for sonic booms in the BOA (145 dB re 1 μPa) do not exceed the PTS, TTS, or behavioral thresholds for sea turtles.

Elevated SPLs from vehicle component splashdown are not expected to impact sea turtles in the BOA as the calculated chances of a sea turtle being exposed to sounds loud enough to cause temporary or permanent injury are extremely low (**Table 4-5**). Splashdown of FE-2 components would not exceed the acoustic thresholds for mortal injury, PTS, or TTS for sea turtles in the ROI. Based on the best available density data for sea turtles, there is a slight chance that a sea turtles' behavior may be affected by elevated sound pressures in the BOA (**Table 4-5**). The chance of an individual sea turtle being in the area affected by sound pressures high enough to induce behavioral disturbance in the BOA is 1 in 109 for the five turtle species combined (**Table 4-5**).

Direct contact: Direct contact from splashdown of vehicle components is not expected to impact sea turtles in the BOA as the calculated chances of a sea turtle being injured are low as to be discountable. The estimated chance of a sea turtle exposure to direct contact from falling FE-2 vehicle components in the BOA is 1 in 710,000 (**Table 4-5**). As with cetaceans, it is important to note some of the drawbacks of this model that may lead to overestimation of effect. The model is based on the best available density data. Since many density studies of turtles are conducted in nearshore areas, density estimates in deep ocean areas are largely unknown. The model also assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components.

Vessel strike and increased human activity: Sea turtles in the Pacific Ocean Flight Corridor are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors. While sea turtles breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in the Action Area. Given that sea turtle density in this area is low and seasonal, the chances of a sea turtle being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Exposure to hazardous chemicals: Hazardous material release in the Pacific Ocean Flight Corridor is not likely to adversely impact sea turtles. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and turtles are not likely to occur. Due to the low density and patchy distribution of sea turtles in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Birds. Overall, seabirds are not expected to be significantly impacted by any FE-2 stressors in the Pacific Ocean Flight Corridor. Any impacts, if realized, would likely be limited to short-term startle reactions, and seabirds would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: Elevated SPLs from FE-2 activities in the BOA are not expected to impact seabirds in the BOA. Maximum SPLs for sonic booms in the BOA (145 dB re 1 μPa) do not exceed the PTS thresholds for seabirds underwater. Only splashdown of the stage 1 motor creates SPL above the injury threshold for birds and this only over an area of 12 m^2 (14 yd^2). Given the low density and patchy distribution of seabirds in the ROI, it is very unlikely that a seabird would be in the area with SPLs above the underwater injury threshold.

Seabirds such as Newell's shearwater have the potential to be exposed to elevated in-air SPLs also. Estimates of in-air SPLs for vehicle splashdown indicate that splashdown SPLs might exceed the injury threshold for shearwaters in-air over a total area of approximately 0.54 km^2 (0.21 mi^2; for all components) in the BOA and may exceed the behavioral disturbance threshold for these birds over 26,861 km^2 (U.S. Navy 2019). It is not expected that shearwaters would be in the area of physical injury; however, some birds might be subject to behavioral disruption. Due to the short-duration of elevated SPLs for this single-event, any behavioral disturbance is expected to be limited to short-term startle responses.

<u>Direct contact</u>: Direct contact from splashdown of vehicle components is not expected to impact seabirds in the BOA. Given the small direct contact affect area and the low and patchy distribution of seabirds in the Pacific Ocean Flight Corridor, it is very unlikely that a seabird would be subject to direct contact from FE-2 vehicle components.

<u>Vessel strike and increased human activity</u>: Seabirds in the Pacific Ocean Flight Corridor are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors. While seabirds may rest on the ocean surface, they are very mobile animals which can fly away from approaching vessels and have even been known to follow vessels to feed on prey in the wake of vessels. Given that seabird density in this area is low and seasonal, the chances of a seabird being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

<u>Exposure to hazardous chemicals</u>: Hazardous material release in the Pacific Ocean Flight Corridor is not likely to adversely impact seabirds. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and seabirds and their prey are not likely to occur. Due to the low density and patchy distribution of seabirds in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

<u>*Fish*</u>*.* Overall, fish are not expected to be significantly impacted by any FE-2 stressors in the Pacific Ocean Flight Corridor. Any impacts, if realized, would likely be limited to short-term startle reactions, and fish would be expected to return to normal behaviors within minutes.

<u>Elevated sound level Impacts</u>: Elevated SPLs from sonic booms are not expected to impact fish in the BOA as maximum SPLs for sonic booms in the BOA (145 dB re 1 μPa) do not exceed the PTS, TTS, or behavioral thresholds for fish.

Elevated SPLs from vehicle component splashdown are not expected to adversely impact fish in the BOA. Fish in the BOA have the potential to be exposed to SPLs high enough to exceed the injury threshold (TTS threshold) up to 40 m (131 ft) from splashdown and to levels above the behavioral disruption threshold out to 2.5 km (1.4 nm). Due to the low densities and patchy distribution of many fish species along the projected flight path and the fact that fish occur at some depth below the water surface, it is very unlikely that individuals would be affected. The affect areas above assume that organisms are at the surface of the water. Just as SPL dissipates with distance from a sound source, sound levels also decrease with water depth. If a fish were to be exposed to elevated SPLs, it is likely that the effects would be limited to temporary behavioral effects due to the short duration (less than 1 second) of potential exposure to elevated noise from a splashdown, and there is no reason to expect that there would be significant or lasting effects or that animal behaviors would not return to normal within minutes of the disruption.

Direct contact: Direct contact from splashdown of vehicle components is not expected to impact fish in the BOA. Given the small direct contact affect area and the low density and patchy distribution of fish in the Pacific Ocean Flight Corridor, it is very unlikely that special status fish would be subject to direct contact from FE-2 vehicle components.

Vessel strike and increased human activity: Fish in the Pacific Ocean Flight Corridor are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors. Given that seabird density in this area is low and seasonal, and that fish occur at some depth below the surface, the chances of fish being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Exposure to hazardous chemicals: Hazardous material release in the Pacific Ocean Flight Corridor is not likely to adversely impact fish. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and most fish species are not likely to occur. Due to the low density and patchy distribution of special status fish in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Essential Fish Habitat. Only spent motor drop zone 1 occurs in the Hawaiian Islands EEZ, the only portion of the ROI where EFH is designated. The deep waters of spent motor drop zone 1 are from 500 to 4,500 m (1,640 to 14,800 ft) deep. EFH for bottomfish and crustaceans occurs within spent motor drop zone 1 as detailed in **Table 3-3**. The Proposed Action involves a single test; therefore, a single stage 1 motor would drop into this area. Given the limited size and characteristics of this component, direct contact and hazardous chemicals from the stage 1 motor would not significantly reduce the quality and/or quantity of EFH. No impacts to EFH are expected as a result of the FE-2 Action.

4.3 U.S. Army Kwajalein Atoll

4.3.1 Biological Resources (USAKA)

Potential environmental consequences of the Proposed Action on biological resources are evaluated based on the best available information about species distributions and in the context of the regulatory setting discussed in **Chapter 3.0**.

4.3.1.1 Biological Resources at Kwajalein Atoll – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.3.1.2 Biological Resources at Illeginni Islet – Preferred Action

The Proposed Action is evaluated for the potential impacts on biological resources at Illeginni Islet. Potential impacts of the Action in this area include exposure to FE-2 stressors including elevated SPLs, direct contact from payload components or impact debris, disturbance from human activity and equipment operation, and exposure to hazardous chemicals.

4.3.1.2.1 Potential Stressors at Illeginni Islet

The following stressors have the potential to impact biological resources at Illeginni Islet:

Exposure to Elevated Sound Pressure Levels

The Proposed Action has the potential to result in elevated SPLs both in-air and underwater near Illeginni Islet. The primary elements of the Proposed Action that would result in elevated SPLs near Illeginni Islet are: (1) sonic booms and (2) impact of the FE-2 payload. General characteristics of sound and SPL units are discussed in **Section 4.2.2.2.1**.

Sonic Booms. At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 175 dB near the impact. At the point of impact, the sonic boom footprint would narrow to about 46 km (25 nm) at this peak pressure. For the entire FE-2 flight path, affect areas for sonic booms were calculated at various acoustic intensities (U.S. Navy 2019). Approximately 2.4 km^2 (0.9 mi^2) of ocean surface would be exposed to SPLs up to 170 dB, 45 km^2 (17 mi^2) to SPLs up to 160 dB, and 474 km^2 (183 mi^2) to SPLs up to 150 dB.

In-air at the ocean surface, sonic boom SPLs would not exceed 149 dB re 20 µPa near payload impact at Illeginni Islet.

Payload Impact. Impact of the developmental payload at the terminal end of the flight would also result in elevated in-air and/or underwater sound levels. Estimates for pressure from impact of vehicles using a similar amount of high explosive as those in the payload resulted in SPLs in-air of 140 dB re 20 µPa at 18 m (59 ft; U.S. Navy 2017a). These levels will be used as a bounding case for the current Proposed Action. Using the spherical spreading model above, the dB source level is estimated to be 165 dB in-air and an estimated 191 dB in-water.

For payload impact at Illeginni Islet, in-air pressure levels may remain above 140 dB up to 18 m (58 ft) from the impact site. The impact may result in some in-water elevated SPLs in the shallow waters surrounding Illeginni Islet. Using the cylindrical spreading model for shallower waters and an in-water source level of 191 dB, SPLs may be above 160 dB out to 117 m (383 ft) and above 150 dB out to 541 m (1,775 ft).

Effect Thresholds for Consultation Species. The general consequences of elevated sound pressure on terrestrial and marine wildlife species as well as acoustic effect thresholds are discussed in **Section 4.2.2.2.1** and in the FE-2 Biological Assessment (U.S. Navy 2019).

Methods for Estimating Elevated Sound Level Effects. Methods for estimating the effects of elevated SPLs on terrestrial and marine wildlife are discussed in **Section 4.2.2.2.1**. The only difference in calculations is that a conical (spreading coefficient = 15) rather than spherical spreading model was used to determine the range to threshold. Marine mammals are not expected to be in the shallow waters near Illeginni Islet that may be exposed to elevated SPLs. Density data for sea turtles, fish, and birds near Illeginni Islet are largely lacking. Density data for some species were extrapolated from studies of other Central Pacific Islands such as Guam and Hawai`i as discussed in the corresponding consequences sections below.

Direct Contact

The payload impact on Illeginni Islet is the preferred alternative for the FE-2 test flight. For this terrestrial impact on Illeginni Islet, the payload would likely form a crater including ejecta spreading out from the crater. The designated impact zone is an area approximately 290 m (950 ft) by 137 m (450 ft) on the northwest end of Illeginni Islet (**Figure 4-1**), as limited by available land mass. The footprint of a payload impact on land would be roughly elliptical, but its size would depend on the precise speed of the payload and its altitude. Since speed, altitude, and size information are not available for an FE-2 payload impact, estimates of reentry vehicle cratering from MMIII test flights (USAFGSC and USASMDC/ARSTRAT 2015) were used as a bounding case for potential impacts. For MMIII RVs, the ejecta field from crater formation at impact was expected to cover a semicircular area (approximately 120º) extending 60 to 91 m (200 to 300 ft) from the impact, and the density of ejecta was expected to decrease with distance from the point of impact (USAFGSC and USASMDC/ARSTRAT 2015). Craters from MMIII RVs have been documented to be 6 to 9 m (20 to 30 ft) in diameter and 2 to 3 m (7 to 10 ft) deep.

The payload is planned to impact on Illeginni Islet within the designated impact zone (**Figure 4-1**). While not planned, a shoreline impact has the potential to affect sea turtle nesting habitat. It is possible that a payload impact on the shoreline at Illeginni Islet would affect the nearshore marine environment through ejecta from a crater and/or falling fragments. Direct contact affects in the nearshore marine environment are expected to be within a semicircular area no more than 91 m (300 ft) from the shoreline (**Figure 4-1**). Empirical evidence from MMIII tests corroborates predictions of the propagation of shock waves approximately 37.5 m (123 ft) through the adjacent reef from the point of impact on the shoreline (USAFGSC and USASMDC/ARSTRAT 2015).

Figure 4-1. Representative Maximum Direct Contact Affect Areas for a Shoreline Payload Impact at Illeginni Islet, Kwajalein Atoll.

Methods for Estimating Direct Contact Effects. Although coral reefs are not planned or expected to be targeted, a land payload impact on the shoreline of Illeginni Islet could result in ejecta/debris fall, shock waves, and post-test cleanup operations, which may impact at least some of the fish, coral and mollusk species on the adjacent reef. Attempts would be made to avoid payload impact near these sensitive shoreline areas; however, for the FE-2 EA/OEA and in the FE-2 Biological Assessment (U.S. Navy 2019) the worst-case scenario was analyzed to elucidate the maximum effects of the Proposed Action.

On both sides of Illeginni Islet, the area potentially affected by shock waves is encompassed within the area potentially affected by debris fall (**Figure 4-1**). Since these areas overlap and since harmed individuals should be counted only once in the effects of the Action, the affected habitat area with the largest estimated take, the debris fall/ejecta area, was selected as the worst-case scenario. Although the exact shape of the affect area is impossible to predetermine, the seaward portion of such an area is conceptually illustrated as a rough semi-circle on the lagoon and ocean sides of Illeginni Islet with a radius of 91 m (300 ft; **Figure 4-1**). The aerial extent of potential debris fall effects on the lagoon and ocean sides of Illeginni Islet were calculated to be ½ (πr^2) or 13,008 m^2 (15,557 yd^2). Based on the best professional judgment of NMFS survey divers, approximately 80% or 10,406 m^2 (12,445 yd^2) of the lagoon-side affect area (**Figure 4-1**) is considered potentially viable habitat for consultation fish, coral, and mollusks (NMFS-PIRO 2017c). Similarly, approximately 75% or 9,756 m^2 (11,668 yd^2) of the ocean-side affect area (**Figure 4-1**) is considered potentially viable habitat for consultation fish, coral, and mollusk species (NMFS-PIRO 2017c).

Non-larval forms of 43 coral species, 6 mollusk species, and at least 45 fish species are known to occur in the area that has the potential to be subject to direct contact from FE-2 payload impact at Illeginni Islet (**Section 3.3.1.2**, NMFS-PIRO 2017a). In 2017, NMFS-PIRO completed reports with density estimates for consultation species based on 2014 assessments of the reefs adjacent to the impact area at Illeginni Islet (NMFS-PIRO 2017a and 2017b). The areas surveyed for this assessment encompassed all of the affect area reef habitat on the lagoon side and 99% of the reef area on the ocean side (NMFS-PIRO 2017a and 2017b). Based on coverage area of this assessment, these data are considered the best available information for coral and mollusk species presence and density in the affect area (see **Table 4-6**). The number of adult coral and mollusks potentially affected by the action was calculated as the estimated area of suitable habitat in the affect area times the 99% upper confidence limits (UCL) of the bootstrap mean density values (see **Table 4-6**).

The humphead wrasse (*Cheilinus undulatus*) was not observed during the 2014 surveys for the most recent assessment of consultation organisms at Illeginni Islet (NMFS-PIRO 2017a); however, this species has been recorded in both ocean-side and lagoon-side habitats adjacent to the impact area in other surveys. Based on methods which were previously used for impact analyses at Illeginni Islet, an estimated 8 adults may occur within the entire potential ocean-side affect area, and 0 to 100 juveniles may occur within the entire potential lagoon-side affect area (NMFS-PIRO 2014).

Vessel Strike

Pre-test activities would include vessel traffic to and from Illeginni Islet. Prior to the test flight, radars would be placed on Illeginni Islet and would be transported aboard ocean-going vessels. Sensor rafts would also be deployed near the impact site from an LCU vessel including 12 self-stationing LIDSS rafts, some with hydrophones. Post-test recovery efforts would also result in increased vessel traffic to the payload impact site. There would be several pre-test vessel round-trips to and from Illeginni Islet as well as raft-borne sensor deployment using an LCU. Vessels would be used to transport heavy equipment (such as backhoe or grader) and personnel for manual cleanup of debris, backfilling of any craters, and instrument recovery. Deployed sensor rafts would also be recovered by an LCU vessel. Debris would only be recovered in waters up to approximately 55 m (180 ft) deep. Post-test vessel traffic would likely include several vessel round-trips to and from Illeginni Islet and LCU retrieving raft-borne sensors. Vessel traffic to and from Illeginni Islet would be increased for a period of 10 weeks.

Consultation organisms have the potential to be affected by vessel strike primarily by being at the surface when a vessel travels through an area. Organisms at the surface are at risk of being struck by the vessel or their propellers. Organisms that are not found at the sea surface have the potential of being struck when a vessel drops anchor or if a vessel runs aground.

Disturbance from Human Activity and Equipment Operation

Elevated levels of human activity are expected for approximately 10 weeks at Illeginni Islet. During this period, several vessel round-trips are likely. Helicopters and vessels would be used to transport equipment and personnel to Illeginni Islet. The Action is expected to involve as many as two dozen personnel on Illeginni Islet during the 10-week period. Activities associated with pre- and post-flight operations near the Illeginni shoreline, which could impact sea turtles, fish, corals, or mollusks, include noise, physical contact, turbidity changes, or habitat disturbance. In the event of an impact on the Illeginni shoreline, post-flight operations would be conducted similarly to terrestrial operations, when tide conditions and water depth on the adjacent nearshore reef permit. A backhoe would be used to excavate the crater, excavated material would be screened for debris, and the crater would usually be backfilled with substrate that had been ejected around the wall of the crater. Should any components or debris impact areas of sensitive biological resources such as the coral reef, USFWS or NMFS would be contacted to provide guidance and/or assistance in recovery operations to minimize impacts to resources.

Acoustic effects associated with post-test operations would be consistent with any other land or sea activity that uses mechanized equipment, and the greatest intensity would be centered on the payload impact location. Potential consequences of these acoustic effects include noise avoidance and temporary disruption of feeding or predator avoidance behaviors in sea turtles, some motile invertebrates, and small fish (Mooney et al. 2010). Because these acoustic effects are substantially less intense than sonic boom overpressures, the area of potential effect would be substantially smaller and restricted to habitats near the shoreline.

In the event that recovery operations must take place in the shallow water marine environments at Illeginni Islet, physical contact by humans (e.g., handling, walking on, and kicking with fins) may injure corals and is likely to disturb reef-associated fish and mollusks. Contact by equipment may also injure or kill corals and mollusks and may injure or kill reef-associated fish. The extent of this potential impact would be restricted to the vicinity of the payload land impact site and the access corridor between this site and the adjacent reef.

Exposure to Hazardous Chemicals

The payload would impact over Illeginni Islet. Following the impact of the payload, fragmentation of the payload would disperse any of the residual onboard hazardous materials (**Table 2-2**) such as battery acids, residual explosives, and heavy metals, around the impact point. Onboard the payload there will be up to three lithium ion batteries each weighing between 1 to 23 kg (3 and 50 lb) and two radio frequency transmitters. The batteries carried onboard the payload would be discharged by the time the vehicle impacts on land at Illeginni Islet; however, a small quantity of electrolyte material (on the order of a couple ounces) may still enter the terrestrial environment.

The payload also carries up to 454 kg (1,000 lb) of tungsten alloy which would enter the terrestrial and possible marine environments upon payload impact. The payload structure itself contains heavy metals including aluminum, titanium, steel, magnesium, tungsten, and metal alloys.

Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish, or sea turtles in the area. Any visible battery fragments in the lagoon, in other shallow waters, or on Illeginni Islet would be removed during recovery and cleanup. While every attempt would be made to clean up all visible metal and other fragments, it is possible and likely that some fragments would be too small to be recovered or may be buried by the force of impact. Therefore, it should be considered that a small but unknowable amount of these heavy metals or other substances may remain in the terrestrial or marine environments at Illeginni Islet.

It is also possible that a small but unknowable amount of tungsten alloy would remain at Illeginni Islet. While the effects of tungsten alloys in ecosystems are largely unknown, recent studies have concluded that under certain environmental conditions tungsten may dissolve and some forms of tungsten (depending on soil conditions) can move through soil (Dermatas et al. 2004). In the presence of alloying elements such as iron, nickel, and cobalt, tungsten was sorbed to clay soils and mobility was decreased; however, this sorption also depends on soil conditions such as pH and mineral and organic composition (Dermatas et al. 2004). Soils on Illeginni Islet are primarily well-drained and composed of calcareous sand poor in organic materials with a few carbonate fragments. Some studies suggest that introduction of tungsten into soil increases soil pH and may impact soil microbial communities (Dermatas et al. 2004, Strigul et al 2005). There is also some evidence that soluble tungsten may decrease biomass production, and that plants and worms may take up tungsten ions from the soil (Strigul et al. 2005). While the effects of tungsten remaining in the soil at Illeginni Islet are largely unknown, the impact area is a disturbed area which is primarily paved, mostly lacking vegetation, and is not suitable habitat for most wildlife species. It is unlikely that sensitive terrestrial wildlife would come in contact with remnant tungsten in the soil, and remnant tungsten is not expected to impact vegetation or wildlife abundance or distribution on Illeginni Islet.

Up to four small radars powered by car batteries are considered expendable and would be destroyed by the impact. While the debris from these radars is expected to be recovered, acids and heavy metals may be introduced into the terrestrial environment. Only trace amounts of hazardous chemicals are expected to remain in terrestrial areas. If any hazardous chemicals enter the marine environment, they are expected to dilute and be dispersed quickly by currents and wave action.

Post-flight cleanup activities may include the use of heavy equipment such as a backhoe or grader on Illeginni Islet. This equipment has the potential to introduce fuels, hydraulic fluids, and battery acids into terrestrial habitats. Equipment operation would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be transported to Kwajalein Islet for proper disposal. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous waste incidents would comply with the emergency procedures set out in the KEEP and the UES. Following cleanup and repair operations at Illeginni Islet, soil samples would be collected at various locations around the impact area and tested for pertinent contaminants.

Several mitigation measures will be employed to reduce the potential effects of hazardous chemicals including:

- Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life.
- Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous waste incidents would comply with the emergency procedures set out in the KEEP and the UES.
- Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport and would not intentionally discharge fuels or waste materials into terrestrial or marine environments.
- Debris recovery and site cleanup would be performed for land or shallow water impacts. To minimize long-term risks to marine life, all visible project-related debris would be recovered during post-flight operations, including debris in shallow lagoon or ocean waters by range divers. In all cases, recovery and cleanup would be conducted in a manner to minimize further impacts on biological resources.

4.3.1.2.2 Consequences for Biological Resources at Illeginni Islet

Terrestrial Vegetation at Illeginni Islet

Terrestrial vegetation in the payload impact zone at Illeginni Islet is vegetation of previously disturbed habitat and is predominantly managed vegetation. Therefore, no adverse impacts to terrestrial vegetation are expected.

Terrestrial Wildlife at Illeginni Islet

Sea Turtles and Sea Turtle Nests. Overall, sea turtles on land and sea turtle nests are not expected to be impacted by FE-2 activities on Illeginni Islet.

Only green sea turtles and hawksbill turtles have been observed near Kwajalein Atoll islets. These two species are known to nest or haul out on some Kwajalein Atoll Islets. If a sea turtle or sea turtle nest were struck by debris or ejecta from payload impact, a sea turtle could be killed or injured, or sea turtle eggs could be damaged or destroyed. Turtles also have the potential to be subject to behavioral disruption from elevated sound levels, human disturbance, or equipment operation, significant enough to preclude females from haul-out and nesting. Any debris and ejecta has the potential to include hazardous chemicals including heavy metals. If these chemicals were introduced into sea turtle nesting habitat, they have the potential to dissuade females from nesting, harm sea turtle eggs, or affect the health of sea turtle hatchlings.

Suitable sea turtle haulout and nesting habitat exists on the northwestern and eastern beaches of Illeginni Islet (**Figure 4-1**). In a 2008 survey of Illeginni Islet, suitable nesting habitat for sea turtles was identified, consisting of relatively open sandy beaches and seaward margins of herbaceous strand above tidal influence (**Figure 4-1**; USFWS 2011). These areas were thoroughly surveyed on foot for nesting pits and tracks, but none were found. These nesting and haulout habitats were reevaluated during the 2010 inventory (USFWS and NMFS 2012) and were determined to still be suitable habitat. However, the last known sea turtle nest pits on Illeginni Islet were recorded in 1996 on the northern tip of the islet. No sea turtle nests or nesting activity have been observed on Illeginni Islet in over 20 years. While green and hawksbill turtles are known to use the nearshore waters of Illeginni Islet it is unlikely that sea turtles will haul out or nest on Illeginni Islet.

Mitigation measures will be employed to further decrease the chances of there being effects on sea turtles or sea turtle nests. For at least 8 weeks preceding the FE-2 launch, Illeginni Islet would be surveyed by pre-test personnel for sea turtles, sea turtle nesting activity, and sea turtle nests. If possible, personnel would inspect the area within 2 days of the launch. Pre-test personnel at Illeginni Islet and in vessels traveling to and from Illeginni Islet would look for and report any observations of sea turtles, evidence of sea turtle haul out or nesting, or of sea turtle nests at or near Illeginni Islet.

Birds. Overall, birds on Illeginni Islet are not expected to be significantly impacted by FE-2 activities at Illeginni Islet. Any impacts are likely to be limited to short-term startle reactions, and birds would be expected to return to normal behaviors after the disturbance has ended.

Elevated sound level impacts: A payload impact on Illeginni Islet has the potential to impact nesting, roosting, and foraging bird species. If birds were exposed to elevated sound pressures above PTS threshold levels, physical injury or even death could result. Birds are able to recover from hearing damage better than many other species, and most physical injury would likely be temporary; however, very loud sounds may cause permanent damage.

Sonic boom overpressures generated by the approaching payload (maximum 149 dB re 20 µPa) would exceed the in-air PTS threshold for birds (140 dB re 20 µPa for blast noise), but only over an area of approximately 0.2 km^2 (0.08 mi^2). This PTS affect area is smaller than the potential impact area on Illeginni Islet, and birds are unlikely to occur there. It is likely that birds would be exposed to SPLs lower than the PTS threshold but high enough to cause behavioral disturbance. While birds might be temporarily startled by these sounds, any behavioral or physiological response is likely to be very brief as the duration of the elevated SPLs from sonic booms are on the order of 270 ms. No adverse impacts to birds on or near Illeginni Islet are expected due to elevated SPLs from sonic booms.

Elevated SPLs from payload impact would only exceed the PTS threshold for birds out to 18 m (59 ft) from the point of impact. The impact area is composed primarily of previously disturbed habitat, and mitigation measures to deter birds from nesting and roosting in the impact area would be employed such as visual deterrents (e.g., scarecrows, mylar flags, helium-filled balloons, or strobe lights). Therefore, birds are not expected to be in this disturbed portion of the islet that is the impact zone. Birds are expected to be roosting, foraging, or nesting (depending on the season) in the area surrounding the impact zone that may be subject to SPLs exceeding bird's behavioral disturbance threshold. While birds are likely to be exposed to SPLs high enough to elicit behavioral response, any response to this short duration sound is likely to be limited to temporary startle responses. Bird behavior is expected to return to normal within minutes of impact, and no lasting behavioral or physiological responses are expected. Birds may be more sensitive to elevated sound pressure level disturbance at certain nesting cycle stages (U.S. Navy 2015). There is evidence that elevated noise levels may be more likely to cause nest abandonment during the incubation stage than during brooding of chicks (U.S. Navy 2015). In general, the nesting season for seabirds and shorebirds at Illeginni Islet and other USAKA islets begins in October and continues through April. In 2011, a USFWS and U.S. Geological Survey team (Foster and Work 2011) evaluated the Advanced Hypersonic Weapon impact at the helipad on Illeginni Islet with pre- and post-test site visits. Post-test visits revealed that black-naped terns were actively feeding chicks at nests approximately 65 and 100 m (213 and 328 ft) from the impact site (Foster and Work 2011). White terns were also observed roosting about 140 m (459 ft) from the impact site (Foster and Work 2011). Even during nesting season, short-duration elevated SPLs from FE-2 activities are not expected to cause birds to abandon nests. Elevated SPLs from payload impact are not expected to adversely impact seabirds at and near Illeginni Islet.

<u>Direct Contact and Human Disturbance:</u> Due to the potential for impacts to black-naped terns nesting in the payload impact area on Illeginni Islet, the U.S. Navy had developed several avoidance and minimization measures based on recommendations from USFWS (see **Table 4-12**). The impact area is composed primarily of previously disturbed habitat, and no more than 12 black-naped terns (4 adults and 8 eggs or chicks) would be expected to be in the impact area during daylight hours (**Appendix A**: USFWS Correspondence, Dated 17 April 2019). A maximum of 16 black-naped terns could be in the area when both adults are roosting at or near the nests. Mitigation measures to deter bird from nesting and roosting in the impact area would be employed such as visual deterrents (e.g., scarecrows, Mylar flags, helium-filled balloons, or strobe lights). The impact area would be searched for nests, including eggs and chicks, prior to pre-flight activities and prior to test fights. If black-naped tern nests are found in the payload impact area, nests would be covered with an A-frame structure to protect eggs, chicks, and adults from debris and to serve as a warning to project personnel to avoid the nest area. With these mitigation measures in place, no adverse effects to black-naped terns are expected.

Marine Vegetation at Illeginni Islet

Overall, marine vegetation, including seagrass, is not expected to be impacted by any FE-2 stressors at Illeginni Islet. Most macroalgae species found at Illeginni Islet are common and likely to be found throughout Kwajalein Atoll. Seagrass beds are important habitats for green sea turtles and are relatively limited in distribution. At Illeginni Islet, seagrass beds are known to occur in the harbor as well as down the slopes in and near the harbor entrance. Vessel traffic would occur in the harbor; however, no activities are expected which would physically alter benthic habitats or impact seagrass in Illeginni Harbor.

Marine Wildlife at Illeginni Islet

Marine Mammals. Overall, marine mammals are not expected to be significantly impacted by any FE-2 stressors at Illeginni Islet. Any impacts, if realized, would likely be limited to short-term startle reactions, and marine mammals would be expected to return to normal behaviors within minutes. Marine mammals do not occur in the shallow water habitats near Illeginni Islet that have the potential to be subject to direct contact or hazardous chemical effects.

Elevated sound level impacts: Maximum sonic boom SPLs and SPLs generated by payload impact do not exceed the PTS or TTS thresholds for any marine mammals. Any behavioral disturbance would likely be limited to startle responses, and marine mammals would be expected to return to normal behaviors within minutes.

Vessel strike and disturbance from human activity: A small number of vessel trips would be required to support pre-flight activities and equipment placement and post-flight cleanup activities on and near Illeginni Islet. Cetaceans present in the vicinity of Illeginni Islet are not likely to be impacted by vessel strike or human activity. While cetaceans breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in Kwajalein Atoll. To help avoid any possible impacts, vessel operators would also watch for and avoid cetaceans by adjusting their speed.

Sea Turtles. Overall, sea turtles are not expected to be significantly impacted by any FE-2 stressors in the water near Illeginni Islet. Any impacts, if realized, would likely be limited to short-term startle reactions, and sea turtles would be expected to return to normal behaviors within minutes. Sea turtles are not expected to be in the very shallow water habitats near Illeginni Islet that have the potential to be subject to direct contact or hazardous chemical effects from payload impact.

Elevated sound level impacts: Elevated SPLs from sonic booms and payload impact do not exceed the physical injury thresholds (PTS or TTS) for sea turtles near Illeginni Islet. Sea turtles might be exposed to sonic boom SPLs above the behavioral disturbance threshold over an area of 45 km^2 (17 mi^2). No reliable density data are available for sea turtles near Illeginni Islet or in Kwajalein Atoll. The U.S. Navy has reported the density of green sea turtles at Guam to be 1 per 3.4 km^2 (1 per 1.3 mi^2) in offshore waters and 1 per 2.6 km^2 (1 per 0.988 mi^2) in nearshore waters; and the density of hawksbill sea turtles at Tinian to be 1 per 7.5 km^2 (1 per 2.88 mi^2; U.S. Navy 2015). Turtle densities are likely to vary greatly; however, to estimate the number of sea turtles that might be exposed to elevated SPLs near Illeginni Islet, the best available data were used. It is important to note that although the best available nearshore density data are used, the density and distribution of sea turtles near Illeginni Islet remain unknown. Using these densities, an estimated maximum of 17 green turtles and 6 hawksbill turtles may be exposed to sonic boom SPLs high enough to elicit behavioral response. It is important to note some of the drawbacks of these analyses that may lead to overestimation of effect. The model is based on the best available density data. The model assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components. The estimates for the chances of elevated sound levels affecting individual sea turtles are likely overestimated in these analyses; however, these estimates do provide a conservative estimate of effects. While there is a small chance a sea turtle would be exposed, this is a single event with elevated SPLs lasting less than a second. Any impacts would likely be limited to short-term startle reactions, and sea turtles would be expected to return to normal behaviors within minutes. Sea turtles are not likely to be within 117 m (383 ft) of payload impact (the area in which SPLs would be above the behavioral disturbance threshold), and therefore are not likely to be impacted by elevated SPLs from payload impact.

Vessel strike and disturbance from human activity: A small number of vessel trips would be required to support pre-flight activities and equipment placement and post-flight cleanup activities on and near Illeginni Islet. Sea turtles present in the vicinity of Illeginni Islet are not likely to be impacted by vessel strike or human activity. While sea turtles breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in Kwajalein Atoll. To help avoid any possible impacts, vessel operators would also watch for and avoid sea turtles by adjusting their speed. Disturbance from human activity is not expected to significantly alter the natural behavioral patterns of sea turtles near Illeginni Islet.

Fish. Overall, scalloped hammerhead sharks, reef manta rays, and most other fish species are not expected to be significantly impacted by any FE-2 stressors at Illeginni Islet. Considering the worst-case scenario of a shoreline payload impact, the humphead wrasse may be impacted by direct contact from debris or ejecta and/or disturbance from human activity.

Elevated sound level impacts: Elevated SPLs from sonic booms near Illeginni Islet do not exceed the physical injury thresholds (PTS or TTS) for fish. Sonic boom overpressures would exceed the behavioral disturbance threshold for fish over an area up to 474 km^2 (183 mi^2). The maximum radial distance at which fish might be subject to injury from elevated SPLs generated by payload impact is only 2.2 m (7.2 ft) from payload impact and 541 m (1,775 ft) for behavioral disturbance. Adult fish are not expected to be within 2.2 m (7.2 ft) of payload impact on Illeginni Islet. There are no known reliable density estimates for consultation fish species in the shallow waters near Kwajalein Atoll. Even fish species known to occur near Illeginni Islet likely have very low densities in these areas with patchy distributions. Reef manta ray density estimates are available for nearshore waters in Guam and range from 0.01 to 0.03 fish per km^2 (Martin et al. 2016). Even if an estimate of reef manta ray density on the high end of estimated density (0.03 per km^2) is used, only 14 reef manta rays have the potential to be exposed to SPLs above the behavioral disturbance threshold. Some adult or juvenile humphead wrasse or other reef-associated fish species may be exposed to behavioral disturbance from elevated SPLs as well. If fish are exposed to SPLs above the behavioral disturbance threshold, any behavioral disturbance is expected to be limited to short-term startle response. Elevated SPLs from payload impact are not expected to adversely impact fish near Illeginni Islet.

Direct contact: The impact zone for the FE-2 is a terrestrial area on Illeginni Islet. While marine habitats are not targeted for the FE-2 test, a payload land strike on or near the shoreline could result in ejecta/debris fall and shock wave effects, which have the potential to impact at least some fish species on the adjacent reef. The anticipated worst-case scenario of a payload land impact at Illeginni Islet is considered to be a shoreline strike, which would result in debris fall and shock wave effects within an affected area that would extend outward from the point of strike up to 91 m (300 ft) as described in methods above (**Figure 4-1**). Fish mortality or injury could occur from impact by ejecta/debris fall within this area. Several fish species are known to occur in this affect area and may be impacted by direct contact from debris or ejecta. These fish species occur on reefs throughout Kwajalein Atoll. Given that a shoreline strike is unlikely and that the numbers of fish species near Illeginni Islet is likely a small fraction of the populations of these fish in Kwajalein Atoll, most fish species are not likely to be significantly impacted by direct contact.

One consultation fish species, the humphead wrasse, is likely to be impacted by direct contact in the event of a shoreline payload impact. Based on the methods described above and analyses in the FE-2 Biological Assessment (U.S. Navy 2019), an estimated maximum of 100 juvenile humphead wrasses may be found in lagoon-side and 8 adults in the ocean-side direct contact affect area. The U.S. Navy has concluded that these activities may adversely affect the humphead wrasse (U.S. Navy 2019) and initiated consultation with NMFS. In their Final Biological Opinion (NMFS 2019a; **Appendix C**), NMFS concluded that a total of up to 108 individuals could be affected by direct contact, ejecta, and/or shock waves from an FE-2 payload impact near the Illeginni shoreline. NMFS also concluded that the potential loss of these fish would likely represent a tiny fraction of their species found at Illeginni Islet and across USAKA, and would not eliminate this species at Illeginni Islet or appreciably reduce the likelihood of their survival and recovery across USAKA. (NMFS 2019a; **Appendix C**). Furthermore, NMFS determined that the level of potential take for this species as a result of the Proposed Action is not likely to result in the jeopardy for the species (NMFS 2019a; **Appendix C**).

Disturbance from human activity and equipment operation: Pre-flight human activity and equipment operation is not likely to adversely impact fish species near Illeginni Islet. Species such as sharks and manta rays are highly mobile animals which may exhibit avoidance behavior by leaving areas with increased vessel traffic or other human activity. However, animals are expected to return to normal distributions and behaviors soon after the disturbance has ceased; therefore, impacts are expected to be insignificant.

In the reef areas adjacent to the impact area at Illeginni Islet, reef-associated fish, including the humphead wrasse, may be disturbed by human activity in the event of a shoreline strike. If debris were to enter the marine environment, post-test operations would include debris recovery in these nearshore areas. Fish might be disturbed by humans conducting cleanup operations and have the potential to be disturbed or injured by equipment operation in the debris affect area. Other potential stressors include noise from equipment operation and temporary increases in turbidity.

The extent of the potential impact would be limited to the direct contact affect area adjacent to the terrestrial impact area (**Figure 4-1**). Fish such as the humphead wrasse, which are normally patchy in distribution and usually present as solitary individuals or in very low numbers, might be present. However, due to their natural wariness, they are expected to shy well away from the divers or equipment and not be killed or injured. Any increases in turbidity associated with the operations would be temporary, and turbidity would likely return to background levels within a few hours of the activity's conclusion. Reef-associated fish may exhibit avoidance behavior, temporarily leaving the site of increased human activity, but there is no reason to expect that these fish would not return to these areas once the disturbance has ended.

The U.S. Navy concluded that human disturbance and/or equipment operation may adversely affect the humphead wrasse in the FE-2 Biological Assessment (U.S. Navy 2019) and initiated consultation with NMFS. In their Final Biological Opinion (NMFS 2019a; **Appendix C**), NMFS concluded that a total of up to 108 individuals could be affected by the Proposed Action but that the potential loss of these fish is not expected to eliminate them from Illeginni Islet or to appreciably reduce the likelihood of their survival and recovery at USAKA (NMFS 2019a; **Appendix C**).

<u>Exposure to hazardous chemicals</u>: Chemicals dispersed at Illeginni Islet are not expected to impact fish because most payload fragments and chemicals should be contained within terrestrial environments, all visible debris in terrestrial and shallow water (up to water depths of 15 to 30.5 m [50 to 100 ft]) would be recovered, and any soluble chemicals introduced into the marine environment are expected to be quickly dispersed and diluted by ocean currents and wave action.

<u>Corals and Mollusks</u>. Larval corals and mollusks of many species may be present in the waters near Illeginni Islet as drifting plankton during certain times of the year. Larval coral and mollusks have the potential to be impacted by direct contact from payload debris or ejecta, human disturbance or equipment operation, vessel strike, and/or exposure to hazardous chemicals. However, larval densities in this area are highly variable in space and time, and no reliable density data is available to allow calculation of the number of larvae which might be affected. Even though some individual larvae are likely to affected by FE-2 activities, the total number affected would be a very small (but undeterminable) number of the total larvae for coral and mollusk populations at Illeginni Islet or within Kwajalein Atoll. Therefore, FE-2 activities are not likely to have an adverse impact on larval coral or mollusks.

Non-larval corals and mollusks have the potential to be affected by direct contact from payload debris or ejecta, disturbance from human activity and equipment operation, and exposure to hazardous chemicals. Since at least some adult consultation corals, mollusks, and fish may be affected by direct contact, the U.S. Navy and USASMDC concluded that these activities may adversely affect these species (U.S. Navy 2019) and initiated consultation with NMFS. In their Final Biological Opinion (NMFS 2019a; **Appendix C**), NMFS concluded that up to 10,404 coral colonies, 4 top shell snails, and 63 clams could experience mortality from the payload strike on Illeginni Islet (NMFS 2019a; **Appendix C**). NMFS concluded that the potential loss of these adult coral and mollusk individuals would likely represent a tiny fraction of their species found at Illeginni

Islet and across USAKA, and would not eliminate these species at Illeginni Islet or appreciably reduce the likelihood of their survival and recovery across USAKA (NMFS 2019a; **Appendix C**). Furthermore, NMFS determined that the level of potential take for these species as a result of the Proposed Action is not likely to result in the jeopardy for these species (NMFS 2019a; **Appendix C**).

Direct contact: The extent of the area that may be subject to direct contact from payload debris or ejecta from impact is limited to the area within 91 m (300 ft) of the shoreline and only in the unlikely event of a shoreline impact (**Figure 4-1**). Several coral and mollusk species occur in reefs adjacent to the payload impact area at Illeginni Islet (**Table 3-12** and **Table 3-13**). In 2014 NMFS surveyed both the lagoon-side and ocean-side areas with the potential to be subject to direct contact effects (described in **Section 3.3.2.1**). NMFS also estimated the density of consultation corals and mollusks in the direct contact affect areas (**Table 4-6**). Based on species density and the estimated maximum area that would be affected by direct contact, the numbers of consultation coral colonies and individual mollusks that may be present were estimated for each species on the lagoon side and ocean side of Illeginni Islet (**Table 4-6**). On the lagoon side, estimates of the maximum numbers of consultation coral colonies and individual mollusks are 4,725 and 79, respectively, in habitat affected by debris fall. On the ocean side, a maximum of 5,692 consultation coral colonies and 15 individual mollusks are expected to be in the area with the potential to be affected by direct contact from payload impact.

Table 4-6. Estimated Numbers of Consultation Coral Colonies and Individual Mollusks in Affected Habitats.[1]

	Ocean Side Debris Fall Area				Lagoon Side Debris Fall Area			
Species	Mean Colonies or Individuals (per m^2)	99% UCL (per m^2)	Affected Habitat (m^2)	# of Colonies or Individuals	Mean Colonies or Individuals (per m^2)	99% UCL (per m^2)	Affected Habitat (m^2)	# of Colonies or Individuals
Corals								
Acropora microclados	0.0004	0.0017	9,756	17				
Acropora polystoma	≤0.0004	0.0017	9,756	17				
Cyphastrea agassizi					0.0003	0.0013	10,406	14
Heliopora coerulea					0.16	0.45	10,406	4,683
Pavona venosa					0.0003	0.0013	10,406	14
Pocillopora meandrina	0.3	0.58	9,756	5,658				
Turbinaria reniformis					≤0.0003	0.0013	10,406	14
Coral Subtotal				5,692				4,725
Mollusks								
Hippopus hippopus	0.0003	0.0015	9,756	15	0.002	0.006	10,406	63
Tectus niloticus					0.00006	0.0003	10,406	4
Tridacna squamosa					0.0002	0.0011	10,406	12
Mollusk Subtotal				15				79

[1] The species in this table include those found during a 2004 assessment of the affect areas (NMFS-PIRO 2017a and 2017b). Coral colony and individual mollusk mean densities and 99% UCL provided by NMFS-PIRO (2017a and 2017b).

Not every consultation species individual or colony within an affected area of habitat would be equally vulnerable to the effects of debris fall and shock wave impacts (U.S. Navy 2017a, NMFS-PIRO 2017c). It is important to recall that the estimated numbers of colonies or individuals potentially affected are based on a worst-case scenario of a payload land impact. In the event of a shoreline impact it is likely that only a portion of the corals and mollusks present in the direct contact area would be affected. Payload impact would not be targeted close to the shoreline, and impacts to nearshore consultation species would be avoided. The entire potential affected reef area is very small in comparison to the total comparable reef area surrounding and connected to Illeginni Islet. Moreover, this area is considered extremely small compared to sum of comparable reef areas in the USAG-KA area per the current military use agreement with the RMI, and very small in comparison with comparable reef areas within the entire atoll.

A summary of recorded distributions of these consultation species, based on observations made during USAG-KA inventories between 2010 and 2016, is shown in **Table 3-12**. A total of 125 sites were surveyed for protected corals since 2010 including Illeginni Harbor. These seven species of coral appear to be geographically widespread. Of the 7 coral species that have the potential to be affected by direct contact as adults, all were observed at multiple islets (at least 6 islets) and 5 of these species were observed at all 11 surveyed islets (**Table 3-12**). With the exception of *Acropora polystoma* (found at only 8% of sites) these species appear to be common throughout Kwajalein Atoll as well. Three species were found at approximately 30% of surveyed sites across the atoll (*Pavona venosa* at 32%, *Turbinaria reniformis* at 30%, and *Cyphastrea agassizi* at 28%) while *Acropora microclados* (82% of sites), *Heliopora coerulea* (61% of sites), and *Pocillopora meandrina* (96% of sites) were very common at Kwajalein Atoll (U.S. Navy 2019).

The three consultation mollusk species that are known to occur in the area subject to potential direct contact effects are found throughout Kwajalein Atoll (**Table 3-13**). *Hippopus hippopus* and *Tectus niloticus* have been observed at all 11 of the surveyed USAG-KA islets and *Tridacna squamosa* has been observed at 9 of the 11 (**Table 3-13**). These species are also relatively common, being found at 38% (*Hippopus hippopus*) to 63% (*Tectus niloticus*) of surveyed sites across the atoll since 2010 (U.S. Navy 2019).

While density estimates are not available for non-consultation coral and mollusk species in the direct contact area (**Table 3-12** and **Table 3-13**), some individuals of these species would likely be affected in the event of a shoreline impact. All of these species are present on islets throughout Kwajalein Atoll (**Table 3-12** and **Table 3-13**). All non-consultation coral species recorded in the direct contact area have been recorded during surveys of at least 9 of the 11 surveyed USAKA islets since 2010 (**Table 3-12**). Even in the event of a worst-case scenario shoreline impact, FE-2 activities are not likely to significantly impact the population of these species at Illeginni Islet or throughout Kwajalein Atoll.

<u>Disturbance from human activity and equipment operation</u>: Pre-flight human disturbance and equipment operation are not likely to impact corals and mollusks near Illeginni Islet as these activities are not expected to enter the nearshore marine environment. In the unlikely event of a shoreline impact, human activity and equipment operation including debris recovery would likely

affect some adult mollusks and coral colonies. These affects would be within the direct contact affect area and the impacts on coral and mollusk species would be no greater than (and not in addition to) those described for direct contact above.

Exposure to hazardous chemicals: Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any corals, mollusks, or other invertebrates in the area.

4.3.1.3 Biological Resources in the Offshore Waters of Kwajalein Atoll – Alternative Impact Locations

The Proposed Action is evaluated for the potential impacts on biological resources in the Offshore Water Alternative Impact Locations. Potential impacts of the Action in this area include exposure to elevated SPLs, direct contact from payload components or impact debris, vessel strike, disturbance from human activity and equipment operation, and exposure to hazardous chemicals.

4.3.1.3.1 Potential Stressors in the Offshore Impact Locations

The following stressors have the potential to impact biological resources in the Offshore Alternative Impact Locations:

Exposure to Elevated Sound Pressure Levels

The Proposed Action has the potential to result in elevated SPLs both in-air and underwater near Illeginni Islet. The primary elements of the Proposed Action that would result in elevated SPLs in and near the Offshore Impact Locations are: (1) sonic booms and (2) impact of the FE-2 payload. General characteristics of sound and SPL units are discussed in **Section 4.2.2.2.1**. All SPLs generated by payload flight and impact in the offshore impact locations are the same as those described for Illeginni Islet (**Section 4.3.1.2.1**).

Effect Thresholds for Consultation Species. The general consequences of elevated sound pressure on terrestrial and marine wildlife species as well as acoustic effect thresholds are discussed in **Section 4.2.2.2.1** and in the FE-2 Biological Assessment (U.S. Navy 2019).

Methods for Estimating Elevated Sound Level Effects. Methods for estimating the effects of elevated SPLs on marine wildlife are discussed in **Section 4.2.2.2.1**. Adult corals, mollusks, and reef-associated fish species are not expected to be in the deep ocean waters that may be exposed to elevated SPLs. Density data for marine mammals, sea turtles, and fish in the offshore waters of Kwajalein Atoll are largely lacking. Density data for some species were extrapolated from studies of other deep-water regions of the Central Pacific as discussed in the corresponding consequences sections below and in "Methods for Estimating Direct Contact Effects".

Direct Contact

Utilization of the Offshore Alternative Impact Locations would result in impact of the payload in one of two deep water locations near Kwajalein Atoll. The payload debris could directly impact aquatic habitats and have the potential to directly contact marine organisms. The location southwest of Kwajalein Atoll would be approximately 244 m (800 ft) by 488 m (1,600 ft) with a surface area of 0.1191 km^2 (0.0459 mi^2). The location northeast of Kwajalein Atoll would be approximately 366 m (1,200 ft) by 732 m (2,400 ft) with a surface area of 0.2679 km^2 (0.1033 mi^2). While the footprint of a payload impact within these areas would likely be roughly elliptical, its size would depend on the precise speed of the payload and its altitude. Since speed, altitude, and size information are not available for a payload impact, it is difficult to get an estimate of the area which has the potential for falling debris. For these analyses we use a maximum distance estimated for debris/ejecta for an on-land impact (91 m [300 ft] from impact) for the area exposed to debris in impact zones in deep offshore waters.

Methods for Estimating Direct Contact Effects. Because the size of payload debris entering the marine environment is unknown, the maximum estimated distance for debris spread (91 m or 300 ft) was used as a direct contact area. The estimated number of exposures was calculated as the direct contact area times estimated species density. Species density data for the deep offshore waters of Kwajalein Atoll are lacking; therefore, density estimates for this area were extrapolated from areas in the Central Pacific with reliable density information. For marine mammals and sea turtles, density data from an area around Wake Atoll (700 to 1,500 km [430 to 930 mi] from Kwajalein Atoll) in the Navy's Marine Species Density Database were used along with data from the Hawai`i-Southern California Training and Testing Study Area (Hanser et al. 2017) within 1,500 km (930 mi) of Kwajalein Atoll when available.

Vessel Strike

Pre-test preparation and post-test cleanup and recovery operations would result in increased vessel traffic to and from the offshore alternative impact locations. A station-keeping barge would be used at the offshore impact zones to provide primary scoring and sensor coverage for payload impact. The main instrumentation raft includes considerations for maritime safety (e.g., running lights and station-keeping), international policy (e.g., no intentional ocean dumping should the instrumentation raft be inadvertently struck during the conduct of the mission), and visual deterrents to birds loafing or resting on the raft (e.g., scarecrows, Mylar flags, helium-filled balloons, and strobe lights). Prior to the test flight, sensor rafts would also be deployed near the impact site from an LCU vessel including 12 self-stationing LIDSS rafts, some with hydrophones. Post-test recovery efforts would also result in increased vessel traffic to the payload impact site. Vessels would be used to transport personnel for manual cleanup of visible debris and instrument recovery. Only floating, visible debris would be recovered in the deep-water impact sites. Vessel traffic would likely include several vessel round-trips to and from the offshore impact location. Vessel traffic to and from the offshore impact locations would be increased for no more than 4 weeks.

Consultation organisms have the potential to be affected by vessel strike primarily by being at the surface when a vessel travels through an area. Organisms at the surface are at risk of being struck by the vessel or their propellers. Organisms that are not found at the sea surface have the potential of being struck when a vessel drops anchor.

Disturbance from Human Activity and Equipment Operation

Both pre-flight preparations and post-flight cleanup activities would result in elevated levels of human activity in marine environments. Elevated levels of human activity are expected for a period of up to 4 weeks. Personnel and equipment would be used for preparation of the impact site including placement of radars in ocean areas. Post-flight cleanup would involve recovery of all debris possible, recovery of sensors, and would include personnel and vessels in ocean areas.

Acoustic effects associated with post-test operations would be consistent with any other sea activity that uses mechanized equipment, and the greatest intensity would be centered on the payload impact location. Potential consequences of these acoustic effects include noise avoidance and temporary disruption of feeding or predator avoidance behaviors in sea turtles, some motile invertebrates, and small fish (Mooney et al. 2010). Because these acoustic effects are substantially less intense than sonic boom overpressures, the area of potential effect would be substantially smaller (**Section 4.3.1.2.1**).

Exposure to Hazardous Chemicals

Following the impact of the payload, fragmentation of the payload would disperse any of the residual onboard hazardous materials (**Table 2-2**), such as battery acids, residual explosives, and heavy metals, around the impact point. Onboard the payload there would be up to four lithium ion batteries each weighing between 1 and 23 kg (3 and 50 lb) and two radio frequency transmitters. The batteries carried onboard the payload would be discharged by the time the vehicle impacts; however, a small quantity of electrolyte material (on the order of a couple ounces) may still enter the marine environment. The payload also carries up to 454 kg (1,000 lb) of tungsten alloy which would enter the marine environments upon payload impact. The payload structure itself contains heavy metals including aluminum, titanium, steel, magnesium, tungsten, and other alloys.

Debris would be expected to fall within 91 m (300 ft) of the impact point. Post-flight cleanup of the impact area would include recovery/cleanup off all visible floating debris. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish, or sea turtles in the area.

Since up to 454 kg (1,000 lb) of tungsten alloy would be contained on the payload, that amount of tungsten alloy would be introduced into the marine environments upon payload impact. The effects of tungsten alloys in ecosystems are largely unknown. Generally, dispersion of the tungsten alloy is not expected due to its relatively insoluble nature, the depth at which it would come to rest, which would result in low temperatures, low oxygen content, and no sunlight to facilitate chemical interaction. There also is lack of mixing in the deep-sea water column; the deep Pacific experiences no deep convection of cooled salty surface water because the surface layer is too fresh and buoyant to sink. The bench study and model results (LLNL 2017) indicate very slow dissolution and passivation (i.e., natural chemical encapsulation) of tungsten from FE-2 may occur in sea water such that tungsten concentrations would have little or no impact on marine organisms.

Post-flight cleanup activities may include the use of vessels for radar placement and retrieval and have the potential to introduce fuels and oils into the marine habitats. Equipment operation would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be transported to Kwajalein Islet for proper disposal. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous material releases would comply with the emergency procedures set out in the KEEP and the UES.

4.3.1.3.2 Consequences for Biological Resources in the Offshore Impact Locations

Marine Wildlife in Offshore Waters of Kwajalein Atoll

Terrestrial Wildlife. While terrestrial habitat does not occur in the offshore payload impact zones, foraging seabirds may occur in these areas. Overall, foraging seabirds are not expected to be significantly impacted by FE-2 activities at Illeginni Islet. Any impacts are likely to be limited to short-term startle reactions, and birds would be expected to return to normal behaviors after the disturbance has ended.

Seabirds might be exposed to elevated sound levels from sonic boom and/or payload impact in the offshore impact locations. Elevated SPLs from sonic booms would exceed PTS threshold for birds near payload impact where SPLs would be above 140 dB re 20 µPA over an area less than 2.4 km^2 (0.9 mi^2). While density of foraging seabirds in these areas is unknown, it is likely densities would be very low, and it is unlikely that seabirds would be in the area with SPLs above the PTS threshold. It is possible that birds would be exposed to SPLs lower than the PTS threshold but high enough to cause behavioral disturbance. While birds might be temporarily startled by these sounds, any behavioral or physiological response is likely to be very brief as the duration of the elevated SPLs from sonic booms are on the order of 270 ms. If any behavioral disturbance was realized it would likely be in the form of alert behaviors, minor behavioral changes, or flight response (U.S. Navy 2015). No adverse impacts to birds in or near the offshore impact locations are expected due to elevated SPLs due to sonic booms.

Elevated SPLs from payload impact would only exceed the PTS threshold for birds out to 18 m (59 ft) from the point of impact. Due to the likely low density and patchy distribution of seabirds foraging in these areas, birds are not expected to be in this area or be exposed to SPLs loud enough to cause physical damage. While birds may be exposed to SPLs high enough to elicit behavioral response, any response to this short duration sound is likely to limited to temporary startle responses as described above. Bird behavior is expected to return to normal within minutes of impact, and no lasting behavioral or physiological responses are expected. Elevated SPLs from payload impact are not expected to adversely impact seabirds in the deep offshore impact zones.

Seabirds foraging and resting at-sea are very unlikely to be subject to direct contact effects or exposure to hazardous chemicals. Birds may be disturbed by human activity and vessel operation in the vicinity of the offshore impact locations; however, the disturbance is likely to be limited to short-term startle reactions, and birds would be expected to return to normal behaviors after human activity or equipment operation ceases.

Marine Mammals. Overall, marine mammals are not expected to be significantly impacted by any FE-2 stressors in the Offshore Waters of Kwajalein Atoll. Any impacts, if realized, would likely be limited to short-term startle reactions, and marine mammals would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: The maximum SPLs for sonic booms at the terminal end of payload flight and for payload impact do not exceed the PTS or TTS thresholds for any cetacean species. Animals may have a startle response from these short duration sounds, but animals are expected to return to their normal behavior within minutes of exposure.

Direct contact: Direct contact from payload debris is not expected to impact marine mammals in the deepwater impact zones. For marine mammals with the potential to occur in the deep ocean waters near Kwajalein Atoll the chance of any marine mammal being struck by payload debris is 1 in 684 (**Table 4-7**). The chances for individual species range from 1 in 1,913 for spinner dolphins to 1 in 768,787 for blue whales (**Table 4-7**). While we have included all possible species in these analyses with maximum density estimates from other areas of the Pacific Ocean, it is important to note that many of these species are extremely unlikely to occur near Kwajalein Atoll during certain times of the year. The model does not account for animal movement or avoidance behaviors and assumes animals are at the surface 100% of the time. The exposure estimates were modeled based on conservative assumptions including the assumption that animals are at the surface 100% of the time and likely result in an overestimation of the chances of exposure.

Vessel strike and disturbance from human activity: Marine mammals in the offshore payload impact locations are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position the self-stationing barge and sensor rafts. Post-flight operations would only include a small number of vessel trips to retrieve sensors and any visible, floating debris. While cetaceans and monk seals breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in the Action Area. Given that marine mammal density in this area is low and seasonal, the chances of a marine mammal being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Table 4-7. Estimated Number of Marine Mammal and Sea Turtle Exposures to Direct Contact from FE-2 Payload Impact in Offshore Impact Locations.

Common Name	Scientific Name	Estimated Density in Offshore Waters (per km^2)	Estimated Number of Exposures
Marine Mammals			
Minke whale	*Balaenoptera acutorostrata*	0.00015	3.9023E-06
Sei whale	*B. borealis*	0.00013	3.3820E-06
Bryde's whale	*B. edeni*	0.00412	1.0718E-04
Blue whale	*B. musculus*	0.00005	1.3008E-06
Fin whale	*B. physalus*	0.00006	1.5609E-06
Short-beaked common dolphin[1]	*Delphinus delphis*	-	-
Short-finned pilot whale	*Globicephala macrorhynchus*	0.00339	8.8113E-05
Humpback whale	*Megaptera novaeangliae*	0.00089	2.3153E-05
Killer whale	*Orcinus orca*	0.00009	2.3414E-06
Melon-headed whale	*Peponocephala electra*	0.00267	6.9460E-05
Sperm whale	*Physeter macrocephalus*	0.00222	5.7753E-05
Pantropical spotted dolphin	*Stenella attenuata*	0.01132	2.9449E-04
Striped dolphin	*S. coeruleoalba*	0.00941	2.4480E-04
Spinner dolphin	*S. longirostris*	0.02009	5.2272E-04
Bottlenose dolphin	*Tursiops truncatus*	0.00164	4.2613E-05
Sea Turtles			
Green turtle	*Chelonia mydas*	0.00039	1.0172E-05
Hawksbill turtle	*Enetmochelys imbricata*	0.00039	1.0172E-05

[1] This species did not have density coverage in the Navy's Marine Species Density Database.

Exposure to hazardous chemicals: Hazardous material release in the offshore impact locations is not likely to adversely impact marine mammals. The area affected by the dissolution of chemicals would be relatively small because of the size of the payload and the minimal amount of residual materials it contains. Any chemicals introduced to the water column would be quickly diluted and dispersed and most payload debris would sink to the ocean bottom, where water depths are between 1,500 and 4,800 m (5,000 and 15,700 ft) in the offshore impact locations. Due to the low density and patchy distribution of marine mammals in the deep waters of Kwajalein Atoll, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Sea Turtles. Overall, sea turtles are not expected to be significantly impacted by any FE-2 stressors in the deep Offshore Waters of Kwajalein Atoll. Any impacts, if realized, would likely be limited to short-term startle reactions, and sea turtles would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: The maximum SPLs for sonic booms and payload impact in the offshore impact locations do not exceed the PTS or TTS thresholds for sea turtles. There is a potential for behavioral disruption in sea turtles near the payload impact point. An estimated maximum of 45 km^2 (17 mi^2) would be subject to sonic boom SPLs of 160 dB. Using sea turtle density estimates from the NMSDD (0.000391 per km^2) and the methodologies in **Section 4.2.2.2.1**, the number of sea turtle exposures to SPLs above the behavioral disturbance threshold was calculated. The estimated chance of a sea turtle being exposed to sonic boom SPLs high enough to exceed the behavioral response threshold is 1 in 57 for both green and hawksbill turtles (**Table 4-7**).

The SPLs from payload impact may expose green and hawksbill turtles to SPLs above the behavioral disruption threshold up to 35 m (116 ft) from payload impact. Based on density estimates from the NMSDD (0.000391 per km^2) and the methodologies in **Section 4.2.2.2.1**, the chance of an individual sea turtle being in the area with payload impact SPLs high enough to induce behavioral disturbance is 1 in 645,161 for both green and hawksbill turtles (**Table 4-7**). Though turtle density data in these deep ocean areas near Kwajalein Atoll are unavailable, the model is based on the best available density data for turtles in other deep-water areas of the Pacific. The model assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components. The estimates for the chances of elevated sound levels affecting individual sea turtles are likely overestimated in these analyses; however, these estimates do provide a conservative estimate of effects.

If a sea turtle were exposed to SPLs high enough to exceed the behavioral disturbance threshold, no lasting effects from any realized behavioral disruption are expected for any of the consultation organisms. Animals may have a startle response from this short duration sound, but animals are expected to return to their normal behavior within minutes of exposure. For these reasons, elevated sonic boom and payload impact SPLs are not expected to adversely impact wildlife in the deep ocean waters near Kwajalein Atoll.

Direct contact: Direct contact from payload debris is not expected to impact sea turtles in the deepwater impact zones. Based on density data from the NMSDD for other islands in the Central Pacific, the chance of a sea turtle being struck by payload debris is 1 in 98,310 for both green and hawksbill turtles (**Table 4-7**). As with marine mammals, the model does not account for animal movement or avoidance behaviors and assumes animals are at the surface 100% of the time. The exposure estimates were modeled based on conservative assumptions and likely result in an overestimation of the chances of exposure. Therefore, it is unlikely that sea turtles would be impacted by direct contact from payload impact.

Vessel strike and disturbance from human activity: A small number of vessel trips would be required to support pre-flight activities and equipment placement and post-flight cleanup activities in and near the offshore impact locations. Sea turtles present in the vicinity of the deep-water locations are not likely to be impacted by vessel strike or human activity. While sea turtles breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in Kwajalein Atoll. To help avoid any possible impacts, vessel operators would also watch for and avoid sea turtles by adjusting their speed. Disturbance from human activity is not expected to significantly alter the natural behavioral patterns of sea turtles in or near the offshore impact locations.

Exposure to hazardous chemicals: Hazardous material release in the offshore impact locations is not likely to adversely impact sea turtles. The area affected by the dissolution of chemicals would be relatively small because of the size of the payload and the minimal amount of residual materials it contains. Any chemicals introduced to the water column would be quickly diluted and dispersed and payload debris would sink to the ocean bottom, where water depths are between 1,500 and 4,800 m (5,000 and 15,700 ft) in the offshore impact locations. Post-flight operations would include cleanup of any visible, floating debris. Due to the low density and patchy distribution of sea turtles in the deep waters of Kwajalein Atoll, the likelihood of an animal coming into contact with or ingesting hazardous materials from FE-2 is extremely low.

Fish. Overall, fish are not expected to be significantly impacted by any FE-2 stressors in the deep Offshore Waters of Kwajalein Atoll. Any impacts, if realized, would likely be limited to short-term startle reactions, and fish would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: The maximum SPLs for sonic booms in the offshore impact locations do not exceed the PTS or TTS thresholds for fish. There is a potential for behavioral disruption in fish, over an area of 474 km^2 (183 mi^2) near the payload impact point. The SPLs from payload impact do not exceed the PTS for fish but may expose fish to SPLs above the TTS threshold out 1.8 m (5.9 ft) from payload impact. Adult fish are very unlikely to be within 1.8 m (5.9 ft) of payload impact in the deepwater impact locations. Fish may also be exposed to payload impact SPLs above the behavioral disturbance threshold up to 112 m (368 ft) from impact. There are no known reliable density estimates for fish species in the deep ocean waters near Kwajalein Atoll. Most fish species likely have very low densities in these deep-water areas with patchy distributions. In the event that fish were exposed to elevated SPLs, any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would likely quickly return to normal. Elevated SPLs from payload impact are not expected to adversely impact fish in deep ocean waters near Kwajalein Atoll.

Direct contact: Direct contact from payload debris is not expected to impact fish in the offshore impact zones. While density information for fish species in the deep waters of Kwajalein Atoll are not available, most adult fish are expected to have overall low densities and patchy distributions in these deep waters. Consultation species such as the oceanic manta ray, oceanic whitetip shark, bigeye thresher shark, and Pacific bluefin tuna, which are known to occur in deeper waters, are likely to have very low densities in these areas. Therefore, it is unlikely that fish would be impacted by direct contact from payload impact.

Vessel strike and disturbance from human activity: A small number of vessel trips would be required to support pre-flight activities and equipment placement and post-flight cleanup activities in and near the offshore impact locations. Fish present in the vicinity of the deep-water locations are not likely to be impacted by vessel strike or human activity. Fish species do not need to surface to breathe, are not known to frequent the ocean surface, and are highly mobile animals capable of avoiding vessels. Human activity and vessel operation are not expected to injure or significantly alter the natural behavioral patterns of fish in or near the offshore impact locations.

Exposure to hazardous chemicals: Hazardous material release in the offshore impact locations is not likely to adversely impact fish. The area affected by the dissolution of chemicals would be relatively small because of the size of the payload and the minimal amount of residual materials it contains. Any chemicals introduced to the water column would be quickly diluted and dispersed and payload debris would sink to the ocean bottom, where water depths are between 1,500 and 4,800 m (5,000 and 15,700 ft) in the offshore impact locations. Due to the low density and patchy distribution of fish in the deep waters of Kwajalein Atoll, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Larval Fish, Coral, and Mollusks. Overall, larval fish, coral, and mollusks are not expected to be significantly impacted by any FE-2 stressors in the deep Offshore Waters of Kwajalein Atoll. Larval fish, coral, and mollusks of many species may be present in the waters near Kwajalein Atoll as drifting plankton during certain times of the year. While larval densities are generally highest over reef-habitats, some larvae and gametes may be found in deep waters some distance from reefs. Larval fish, coral, and mollusks have the potential to be impacted by direct contact from payload debris or ejecta, vessel strike (including cavitation), and/or exposure to hazardous chemicals. However, larval densities in this area are highly variable in space and time and no reliable density data is available to allow calculation of the number of larvae that might be affected. Even though some individual larvae are likely to be affected by FE-2 activities, the total number affected would be a very small (but undeterminable) number of the total larvae for fish, coral, and mollusk populations within Kwajalein Atoll. Therefore, FE-2 activities are not likely to have an adverse impact on larval fish, coral or mollusks.

4.3.2 Cultural Resources (USAKA)

Analysis of potential impacts to cultural resources considers both direct and indirect impacts. Direct impacts may be the result of physically altering, damaging, or destroying all or part of a resource, altering characteristics of the surrounding environment that contribute to the importance of the resource, introducing visual, atmospheric, or audible elements that are out of character for the period the resource represents (thereby altering the setting), or neglecting the resource to the extent that it deteriorates or is destroyed.

4.3.2.1 Cultural Resources – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to cultural resources. There would be no site preparation or placement of radars or data collection equipment at Illeginni Islet or Gagan Islet. Therefore, no impacts to cultural resources would occur with implementation of the No Action Alternative.

4.3.2.2 Cultural Resources – Proposed Action (All Impact Location Alternatives)

The ROI is the area where FE-2 flight test activities would occur; there are no identified cultural resources within the deep ocean locations. The preferred site for the developmental payload impact is on the west side of Illeginni Islet. Existing surface cover and site disturbance from construction of a helipad, roads, and facilities, and operations including previous missile flight tests with land impacts encompass almost the entirety of Illeginni Islet. Buildings and other facilities on Illeginni Islet are primarily in the central and eastern portions of the islet.

Illeginni Islet (Preferred Impact Location)

For a land impact, the FE-2 flight test is proposed to occur on the west end of Illeginni Islet. Archaeological surveys have not found indigenous cultural materials or evidence of subsurface deposits on the Islet. The Cold War-era properties potentially eligible for listing on the RMI NRHP are located in the central and eastern portions of the Islet. Because a land impact would not occur in proximity to known or potential cultural resources on Illeginni Islet, implementation of the Proposed Action would not result in significant impacts to cultural resources. Personnel involved in the FE-2 flight test operational activities would be briefed on and would follow UES requirements in handling or avoiding any cultural resources uncovered during operational or monitoring activities.

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

There are no cultural resources associated with either the southwest or northeast BOA location, and, therefore, no impacts to cultural resources.

There would be no significant impact to cultural resources from the FE-2 flight test at any of the three proposed impact zones.

4.3.3 Noise (USAKA)

Analysis of potential noise impacts includes estimating likely noise levels from the Proposed Action and determining potential effects to sensitive receptor sites.

4.3.3.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to noise levels in the ROIs. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.

4.3.3.2 Proposed Action

The ROIs for noise from the FE-2 flight test are Illeginni Islet for a land impact or one of the BOA locations southwest of Illeginni Islet or east of Gagan for a water impact.

Illeginni Islet (Preferred Impact Location)

Terminal flight of the payload over the RMI would create a sonic boom carpet along its flight path. Because of the vehicle’s high altitude during flight, maximum elevated SPLs from sonic booms beneath the flight corridor would be 145 dB re 1 μPa (in air) until descent. As the payload nears RTS, the vehicle would fly towards the pre-designated impact site at Illeginni Islet. During vehicle descent, a focused boom would occur over the intended site and the nearby areas of the Atoll.

At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB. At the point of impact, the sonic boom footprint would narrow. For payload impact at Illeginni Islet, elevated SPLs due to the sonic boom would be present in the air over land and would also be present in the surrounding waters. The duration for sonic boom overpressures produced by the payload are expected to average 75 ms where SPLs are greater than 140 dB and 270 ms where SPLs are less than 140 dB.

Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area.

Within Kwajalein Atoll, Kwajalein and Roi-Namur islets are the only populated islets under USAG-KA management. There are also Marshallese residents located on Ennubirr Islet (southeast of Roi-Namur Islet), Ebeye Islet, Carlos Islet (located a few kilometers [miles] northwest of Kwajalein Islet), and on a few other islets.

While meteorological conditions can influence peak SPLs, noise for these areas is estimated to peak at less than 180 dB near the impact. Because the sonic boom footprints at impact normally do not overlap any RMI communities, there are no residents within 29 km (18 mi) of Illeginni Islet, the sonic boom would be audible only once at any nearby location and last no more than a fraction of a second, and because range evacuation procedures are implemented during such flight tests, no residents or personnel are expected to be subjected to significant noise-related impacts.

The populated islets are located outside the sonic boom footprint and residents at these locations may not hear the noise at all. During the flight test, RTS would verify that no non-mission vessels would be in the area. Depending on a mission vessel's location, on-board personnel may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

Noise levels during pre-test and post-flight activities at the predetermined target site would occur in an unpopulated area without resident receptors. FE-2 flight test personnel and RTS and USAG-KA personnel also may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

As with an Illeginni Islet impact, for an Offshore Waters impact, because of the vehicle's high altitude during flight, maximum elevated SPLs from sonic booms beneath the flight corridor would be 145 dB re 1 μPa in air until descent. As the payload nears RTS, the vehicle would fly towards the pre- designated impact site. During vehicle descent, a focused boom would occur over the intended site and the nearby areas of the Atoll.

At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB (**Table 4-3**). At the point of impact, the sonic boom footprint would narrow. For payload impact at Illeginni Islet, elevated SPLs due to the sonic boom would be present in the air over the ocean. The duration for sonic boom overpressures produced by the payload are expected to average 75 ms where SPLs are greater than 140 dB and 270 ms where SPLs are less than 140 dB.

Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area.

The populated islets are located outside the sonic boom footprint for an Offshore Waters impact and residents at these locations may not hear the noise at all. Noise from the sonic boom would be audible only once, would last no more than a fraction of a second, and would be well within the Army standard of 140 dB (peak sound pressure level) for impulse noise at the closest populated islets. During the flight test, RTS would verify that no non-mission vessels would be in the area. Depending on a mission vessel's location, on-board personnel may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

Noise levels during pre-test and post-flight activities at the predetermined impact site would occur in mostly in unpopulated areas without resident receptors. FE-2 flight test personnel and RTS and USAG-KA personnel may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

As a result of the mitigation measures described above, noise levels for an Offshore Waters impact are not expected to have a significant impact on the human environment and implementation of the FE-2 flight test would not result in significant impacts from noise.

4.3.4 Public Health and Safety (USAKA)

The public health and safety analysis section address issues related to the health and well-being of military personnel and civilians living on or near USAKA. Specifically, this section provides information on hazards associated with a single FE-2 flight test.

Additionally, this section addresses the environmental health and safety risks to children.

4.3.4.1 No Action Alternative

Under the No Action Alternative, the FE-2 flight test would not occur and there would be no change to public health and safety. Therefore, no significant impacts to public health and safety would occur with implementation of the No Action Alternative.

4.3.4.2 Proposed Action

The developmental payload would descend into one of the two Offshore Waters locations or Illeginni Islet. Nominally, the payload would break up on or just before impact. The payload would not have a thrust mechanism and data would be transmitted to range safety personnel to allow a continuing evaluation of the "health" of the FTS and the performance of the payload against the safety criteria. The payload FTS would be designed to cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. This failsafe requires positive action to be taken by range safety personnel to allow the payload to continue flight to the pre-designated impact site. In this manner, the resulting debris would fall short of any protected or inhabited area.

Therefore, the presence of non-mission vessels and aircraft in proximity to the impact zone represents the greatest risk to public health and safety for all the FE-2 flight test alternatives.

Illeginni Islet (Preferred Impact Location)

There are no resident populations in proximity to Illeginni Islet where the payload would impact. A NOTAM and an NTM are transmitted to appropriate authorities to clear commercial, private, and non-mission military vessel and aircraft traffic from caution areas and to inform the public of impending missions. The warning messages describe the time, the area affected, and safe alternate routes. The GRMI also is informed in advance of rocket launches and reentry payload missions. A fact sheet describing the project and the environmental controls would be prepared and would be provided at locations on Ebeye and Kwajalein Islets. Radar and visual sweeps of hazard areas would be regularly scheduled and conducted prior to launch to clear any non-mission ships and aircraft.

Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

As with the land impact site, there are no resident populations in proximity to either of the Offshore Waters locations where the developmental payload would impact. The same precautions to notify the public and ensure there are no vessels or aircraft in the Illeginni Islet area would be undertaken for either deep offshore water impact zone.

In accordance with EO 13045, Protection of Children from Environmental Health and Safety Risks, since the majority of the FE-2 flight test would be conducted on DOD property and out in the open ocean, this EA/OEA has not identified any environmental health and safety risks that may disproportionately affect children.

Based on the above, implementation of the FE-2 flight test would not result in significant impacts to Public Health and Safety at USAKA.

4.3.5 Hazardous Materials and Wastes (USAKA)

The hazardous materials and wastes analysis addresses issues related to the use and management of hazardous materials and wastes as well as the management of specific cleanup within the ROIs at USAKA.

4.3.5.1 Hazardous Materials and Wastes within Kwajalein Atoll – No Action Alternative

Under the No Action Alternative, the FE-2 flight test would not occur and there would be no change associated with hazardous materials and wastes at Kwajalein Atoll. Therefore, no significant impacts would occur to hazardous materials and waste with implementation of the No Action Alternative.

4.3.5.2 Hazardous Materials and Wastes within Kwajalein Atoll – Proposed Action

The payload would descend into Illeginni Islet or one of the two offshore waters locations. The payload would break up on or just before impact.

Illeginni Islet (Preferred Impact Location)

As shown in **Table 2-2**, hazardous materials used in the developmental payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, depleted uranium, beryllium, or radioactive materials would be carried on the developmental payload. Each battery would be environmentally qualified, including safeguards for containing accidental hazardous battery casing leak or electrical anode or cathode shorting during shipping and handling. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence. All explosive devices would be handled in accordance with DOD 6055.09-STD.

Test activities could produce tungsten and metals in soils from impact of the FE-2. Debris from the payload impact would be recovered. USAG-KA and RTS personnel are usually involved in these operations. Post-test recovery operations at Illeginni Island require the manual cleanup and removal of any debris, including hazardous materials, followed by filling in larger craters using a backhoe or grader. Excavated material would be screened for debris and the crater would be back-filled with material ejected around the rim of the crater. Following removal of all experiment items and any remaining debris from the target site, all waste materials would be returned to Kwajalein Islet for proper disposal in the United States. Although unlikely, removal of surface floating debris in the lagoon and ocean reef flats, within 150 to 300 m (500 to 1,000 ft) of the shoreline, would be conducted similarly to land operations when tide conditions and water depth permit.

A 2008 study of geochemical parameters influencing tungsten mobility in soils (Bednar et al. 2008) found that dissolved tungsten reached equilibrium in soil after approximately 48 hours and mobility decreased by approximately one-half within a 4-month period. The long term known impact or potential risk is not conclusively identified in peer reviewed literature. For the FE-2 flight test impacts, a bench study and model results indicated levels of tungsten in Illeginni Islet soil would be below the USEPA Residential RSLs (LLNL 2017) for soil (63 mg/kg) and drinking water (0.016 mg/L) from the end of the flight test to 25 years out, the period for which the model was run.

Samples taken in July 2017, before the FE-1 test, show tungsten levels in soils at the FE-1 site averaged 1.3 mg/kg (range of 0.2 to 8.5 mg/kg), all well below the Residential RSL of 63 mg/kg and well below the RSL for commercial soil (930 mg/kg tungsten).

Sampling of tungsten and other alloy metals in soil at Illeginni Islet was conducted in November 2017 at the FE-1 site after the FE-1 test. The results showed an average tungsten level of 3.0 mg/kg (range of 0.7 to 9.0 mg/kg). Additional soil sampling conducted at the site in February 2018 showed an average tungsten level of 2.3 mg/kg (range of 0.2 to 10.4 mg/kg). The measured post-event tungsten concentrations were all below the Residential RSL of 63 mg/kg and well below the Commercial RSL of 930 mg/kg. The measured post-event tungsten concentrations were also in reasonable agreement with LLNL's 2017 estimates of post-event sediment tungsten concentration of 6.5 mg/kg.

Control soil samples were also collected on the far end of Illeginni Islet in February 2018. The average tungsten concentration in the samples analyzed at the control locations is 0.05 mg/kg (range of 0.03 to 0.07 mg/kg). The values are significantly lower than pre-event tungsten concentrations in the FE-1 impact area and may be an indication of prior activities on Illeginni Islet near the FE-1 impact site.

Sampling of tungsten and other alloy metals was also conducted in September of 2018 as part of the installation of groundwater monitoring wells on Illeginni Islet. Soil boring samples showed an average tungsten concentration of 6.5 mg/kg (range of 1.2 to 21 mg/kg). These tungsten concentrations were all below the Residential RSL of 63 mg/kg and well below the Commercial RSL of 930 mg/kg. (LLNL 2018).

The UES has restoration criteria that trigger when remediation is required. Because the reasonably foreseeable land use at Illeginni Islet is as a test range, the commercial screening criteria is used as the trigger for a risk assessment. If the land use would change, the site would be evaluated under the UES Restoration requirements to determine if the new land use required institutional controls or remediation.

Sampling and analyses of soils are planned after the FE-2 flight test to monitor the tungsten levels in the soils. Based on the results identified to date, FE-2 is not expected to result in an increased tungsten level above the RSLs and an impact to soils is not anticipated.

Water samples collected in the FE-1 site shortly after the event had tungsten concentrations of 0.65 mg/L (range 0.64 to 0.67 mg/L). These values are above the USEPA RSL for tap water of 0.016 mg/L.

In September 2018 seven groundwater monitoring wells were installed on Illeginni Islet, five of them at the FE-1 site. Tungsten was detected in seven of the nine groundwater samples collected from the Illeginni wells. Detected concentrations ranged from 0.055 mg/L to 1.2 mg/L. All detected concentrations exceed the USEPA residential tap water screening level of 0.016 ug/L, including the sample from the background well (0.23 mg/L). Tungsten at the background well may be either naturally elevated or present due to past actions on Illeginni Islet.

The main reason for installing the groundwater monitoring wells was to determine if the groundwater at Illeginni Islet was a viable source of potable water. Section 3-2.4.2 of the UES

(USASMDC/ARSTRAT 2018) defines groundwater quality classes based on total dissolved solids (TDS) content in mg/L, which is equivalent to parts per million (ppm) by mass. The UES-defined classes are as follows:

- Class I: desired source of potable water; TDS not exceeding 500 mg/L (0.5 ppt);
- Class II: potential source of potable water; TDS 500 mg/L to 1,000 mg/L (0.5 to 1.0 ppt);
- Class II: other uses; TDS 1,000 mg/L to 10,000 mg/L (1.0 to 10 ppt);
- Class III: limited use, non-potable; TDS exceeding 10,000 mg/L (10 ppt).

Sampling results from September 2018 through July 2019 are shown in **Table 4-8**.

Table 4-8. Salinity Values for Samples from Monitoring Wells on Illeginni Islet

Wells	Sept 18	Dec 18	Jan 19	Feb 19	Apr 19	May 19	June 19	July 19
MW-01	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MW-02	10.7	2.2	Dry	Dry	13.1	5.2	8.1	1.6
MW-03	3.6	8.3	9.9	5.0	15.1	14.6	14.8	12.2
MW-04	5.0	8.3	10.0	5.1	14.7	14.6	14.4	11.8
MW-05	3.4	7.4	9.0	5.2	14.2	15.0	13.2	11.5
MW-06	1.2	7.2	8.5	4.8	13.3	13.3	11.3	9.9
MW-07	10.2	5.0	6.5	4.3	11.7	12.2	9.9	7.9

None of the samples meet the criteria for Class I desired source of potable water or Class II potential source of potable water, and therefore the groundwater at Illeginni Islet is not considered a viable source of potable water. Additional groundwater sampling is being conducted during 2019 to verify the lack of potable groundwater.

Although the groundwater at Illeginni Islet shows tungsten levels above the RSL, the groundwater is not potable under the UES standards. With the reasonably foreseeable land use at Illeginni Islet as a test range and with the groundwater not being potable, further risk-based analysis is not planned at this time. If the land use would change, the site would be evaluated under the UES Restoration requirements to determine if the new land use required institutional controls or remediation. Additional sampling of the groundwater for tungsten would be conducted following the FE-2 flight test.

In the event of an accidental discharge (fuels, oils, etc.) during test flight operations or post-test cleanup activities, ground personnel would comply with the UES KEEP controlling the spill site and cleanup. No short or long-term impacts from materials associated with either the FE-2 or accidental spills are anticipated.

Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

The payload would breakup prior to or upon impact with the water and recovery would not be attempted. All parts would be expected to sink to the sea floor. Considering the small quantities of hazardous materials contained in the batteries and the dilution and mixing capabilities of the ocean waters, the battery materials released during payload impact should be of little consequence. If there were any floating debris, it would be recovered and brought onboard a vessel for appropriate handling and disposal in accordance with the UES.

The UES, KEEP, and Hazardous Materials Management Plan specified procedures for hazardous materials and waste would be followed. Activity-specific Hazardous Materials Procedures would be submitted by the project or mission proponents to the Commander, USAG-KA for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials would be under the direct control of the user organization to ensure these materials are stored and used in accordance with UES requirements. Identified hazardous materials would be expected to be consumed in operational processes associated with the FE-2 flight test. Disposal of wastes resulting from the FE-2 flight test also would be in accordance with the UES.

Therefore, implementation of the Proposed Action would not result in significant impacts to hazardous materials and wastes.

4.4 NASA Wallops Flight Facility, Virginia

4.4.1 Biological Resources (WFF)

Potential environmental consequences of the Proposed Action on biological resources are evaluated based on the best available information about species distributions and in the context of the regulatory setting discussed in **Chapter 3.0**. Potential impacts of launches from WFF on biological resources have been addressed in detail for a variety of launch vehicles and fuel types.

4.4.1.1 Biological Resources (WFF) – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources from those analyzed in the Final WFF Site-wide Programmatic EIS (NASA 2019b). Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.4.1.2 Biological Resources (WFF) – Alternative Action

The Proposed Action is evaluated for the potential impacts on biological resources in the WFF ROI. Potential impacts of the Action in this area include exposure to elevated SPLs, hazardous chemicals, artificial lighting, and increased human activity and equipment operation. The potential stressors of FE-2 launch activities at WWF would be the same as those for launches at PMRF/KTF described in **Section 4.1.3.2**.

Launches of the booster configurations as part of the Proposed Action testing would be similar to launches of the STARS previously analyzed in the Strategic Target System EIS and the PMRF Enhanced Capability EIS (USASDC 1992; U.S. Navy 1998). The Final WFF Site-wide Programmatic EIS (NASA 2019b) analyzed the impact of a variety of orbital and sub-orbital rocket launches from WFF. All vehicle and launch parameters, including noise and emissions, are well within the extent of launch operations previously analyzed in the WFF Site-wide Programmatic EIS (NASA 2019b). No new facilities or structures would be required at WFF. As a result, impacts on biological resources would be similar to those previously analyzed and are expected to be minimal. NASA consulted with USFWS on the potential effects of WFF Site-wide Programmatic activities, including launches and launch related activities, on ESA-listed threatened and endangered terrestrial species at WFF and USFWS issued a consolidated Biological Opinion on the activities in June 2019 (USFWS 2019). Additionally, installation personnel would continue to monitor protected species in accordance with the WFF Protected Species Monitoring Plan.

Overall, the effects of the Action are consistent with launch activities analyzed in the Final WFF Site-wide Programmatic EIS (NASA 2019b). Therefore, implementation of the Alternative Action would result in no significant change in biological resources from those analyzed in the Final WFF Site-wide Programmatic EIS (NASA 2019b).

4.4.1.2.1 Consequences for Biological Resources (WFF)

Terrestrial Vegetation at Wallops Flight Facility

Overall, terrestrial vegetation is not expected to be significantly impacted by any FE-2 stressors at WFF.

No ground clearing or construction is expected for the Proposed Action. The launch would take place at a previously disturbed, previously used, and previously analyzed location. Vegetation near the launch pad could be impacted by the heat generated at launch; however, vegetation is typically cleared from areas adjacent to the launch site and duration of high temperature is extremely short (a few seconds). Plants also have the potential to be impacted by hydrogen chloride or aluminum oxide emissions at launch. However, analyses of the STARS system (USASDC 1992) concluded that there is no evidence of any long-term adverse impact on vegetation from heat or chemical emission in two decades of launches on PMRF. Compliance with relevant Navy policies and procedures during this launch event should continue to minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. Equipment brought to the launch site at WFF would be inspected prior to loading and upon arrival to reduce the risk of introduction or spread of invasive species.

No long-term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on Wallops Island.

Terrestrial Wildlife at Wallops Flight Facility

Terrestrial wildlife species at WFF such as mammals, birds, reptiles, amphibians, and invertebrates as well as marine organisms that haulout on land (**Table 3-14**) may be impacted by elevated SPLs from launch as well as hazardous chemicals, artificial lighting, and direct contact from debris. The launch site at WFF is in an area that has routine human activity, equipment operation, and launch activity. Overall, terrestrial wildlife are not expected to be significantly impacted by FE-2 launch activities at WFF.

Due to the potential for WFF site-wide activities to affect terrestrial ESA-listed species, NASA has consulted with USFWS, and USFWS issued a consolidated Biological Opinion for activities at WFF, including launches, in June 2019 (USFWS 2019). This Biological Opinion included an incidental take statement for yearly launch activities at WFF and determined that site-wide activities are not likely to jeopardize the continued existence of terrestrial ESA-listed species (USFWS 2019).

Elevated Sound Pressure Levels. As analyzed for previous STARS launches at PMRF (U.S. Navy 2008), noise from launches and launch related activity may startle nearby wildlife, causing flushing behavior in birds, but this startle reaction would be of short duration. The brief noise peaks produced by launch vehicles are comparable to levels produced by thunder at close range (120 dB to 140 dB peak; U.S. Navy 2008). Based on the injury and disturbance thresholds for noise discussed in **Section 4.2.2.2.1**, terrestrial wildlife are not likely to be physically injured by launch noise. Disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause birds and other mobile wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended.

Monitoring of birds in areas similarly exposed to launch noise during the breeding season indicates that adults respond to launch noise by flying away from nests but returning within 2 to 4 minutes (U.S. Navy 2008). Terrestrial species at Wallops Island are already habituated to high levels of noise associated with ongoing activities at this facility.

Direct Contact from Debris. No impacts on wildlife due to direct contact from debris are expected during normal flight operations. The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact at WFF or along the flight corridor. In most cases, an errant missile would be moving at such a high-speed that resulting missile debris would strike the water further downrange (U.S. Navy 2008).

Exposure to Hazardous Chemicals. Results of monitoring conducted following a STARS launch from SNL/KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions (U.S. Navy 2008). The program included surveys of representative birds and mammals for both prelaunch and post-launch conditions. Birds flying through an exhaust plume may be exposed to concentrations of hydrogen chloride that could irritate eye and respiratory membranes; however, most birds would not come into contact with the exhaust plume, because of their flight away from the initial launch noise (U.S. Navy 2008). Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals would not cause injury because it is inert and not absorbed into the skin (U.S. Navy 2008). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions (U.S. Navy 1998).

In the unlikely event of an on-pad fire or early flight failure over land of this solid propellant missile, most or all of the fuel would likely burn up before being extinguished. Any remaining fuel would be collected and disposed of as hazardous waste. Soil contamination which could result from such an incident is expected to be localized, along with any impacts on vegetation or wildlife.

Artificial Lighting. Pre-launch activities at WFF would include final vehicle and experiment assembly, preflight checks, and demonstration of system performance. None of these activities would take place at night and lights are not expected to be turned on at night for any FE-2 activities. If program activities are required to occur at night during the sea turtle nesting season, the U.S. Navy would minimize lighting and coordinate these activities through WFF to avoid disorienting hatchling sea turtles with artificial lights. Given the limited time frame of launch activities, sea turtles hatchlings and other terrestrial wildlife species are not likely to be significantly impacted by artificial lighting from FE-2 activities.

Marine Wildlife at Wallops Flight Facility

Overall, marine wildlife are not expected to be significantly impacted by any FE-2 stressors near WFF. Any impacts, if realized, would likely be limited to short-term startle reactions, and marine wildlife would be expected to return to normal behaviors within minutes.

Elevated Sound Level Impacts. Impacts of elevated SPLs on marine wildlife species can vary from temporary behavioral effects to physical injury or even death. As analyzed for previous STARS launches at PMRF (U.S. Navy 2008), noise from launches and launch related activity may startle nearby wildlife, but this startle reaction would be of short duration. The brief noise peaks produced by missiles are comparable to levels produced by thunder at close range (120 dB to 140 dB peak; U.S. Navy 2008).

The offshore waters where marine wildlife reside would be subject to much lower SPLs as sound pressures attenuate with distance from the launch site. Based on injury and disturbance thresholds for marine species discussed in **Section 4.2.2.2.1**, marine wildlife would not be injured from elevated SPLs. Any behavioral disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause mobile marine wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended.

Direct Contact. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations. The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact along the flight corridor, potentially in offshore waters (U.S. Navy 2008). In the event of a launch mishap, some fish near the surface could be injured or killed by larger pieces of debris. Given the abundance of marine mammals and sea turtles nearshore, it is unlikely that debris would contact these organisms in the unlikely event that it entered the ocean. It is also unlikely that the smaller pieces of sinking debris would have sufficient velocity to harm individual marine mammals or fish.

No impacts to EFH are expected for normal flight operations as debris is not expected to enter the marine environment. The chances of a launch mishap which might introduce debris into EFH are very low, and any debris would likely be small and widely scattered.

Exposure to Hazardous Chemicals. Within offshore waters, the potential ingestion of contaminants by fish and other marine species would be remote because of atmospheric dispersion of the emission cloud, the diluting effects of the ocean water, and the relatively small area of the habitat that would be affected. Results of monitoring conducted following a STARS launch from KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions (U.S. Navy 2008). The program included surveys of representative birds and mammals for both prelaunch and post-launch conditions. Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals would not cause injury because it is inert and not absorbed into the skin (U.S. Navy 2008). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions (U.S. Navy 1998).

In the unlikely event of an early flight failure over offshore waters, scattered pieces of burning propellant could enter coastal water and potentially affect wildlife or EFH closer to shore. Concentrations of toxic materials might occur in the shallow waters near WFF and would have a chance of being ingested by feeding animals. However, the potential for a launch mishap is very low, and in most cases the errant missile would be moving at a rapid rate such that pieces of propellant and other toxic debris would strike the water further downrange. The debris would also be small and widely scattered, which would reduce the possibility of ingestion.

4.4.2 Airspace (WFF)

4.4.2.1 Airspace at WFF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to airspace. Therefore, no significant impacts to airspace would occur with implementation of the No Action Alternative.

4.4.2.2 Airspace at WFF – Proposed Action

The U.S. Navy SSP FE-2 flight test would be similar to previous missile tests conducted at WFF, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be within the installation's current envelope covered by previous NEPA documents that are incorporated by reference into the 2019 PEIS. Both military and non-military entities have been sharing the use of the airspace that encompasses R-6604 A-E and FACSFAC VACAPES for more than 30 years. Military, commercial, and general aviation activities have established an operational co-existence consistent with federal, state, and local plans and policies and compatible with each interest's varying objectives. (NASA 2019b)

Through close coordination with the FAA, WFF and FACSFAC VACAPES ensure that hazardous activities are carefully scheduled to avoid conflicts with civilian activities and that safety standards are maintained while allowing the maximum amount of civilian access to overland and overwater airspace.

Conditions under which general aviators or civilian pilots would need to request permission to enter R-6604 A-E or W-386 when active would remain unchanged. Flight monitoring at WFF ATC, WFF Range Control Center, Washington ARTCC, and FACSFAC VACAPES would continue. NOTAMs and NTM that are broadcast by the FAA and U.S. Coast Guard, when needed for operations in R-6604 A-E and W-386, would also remain unchanged. Therefore, implementation of the Proposed Action would have no impact on airspace management resources in R-6604 A-E or W-386.

4.4.3 Public Health and Safety (WFF)

The safety and environmental health analysis contained in the respective sections addresses issues related to the health and well-being of military and civilian personnel and the general public on or near WFF. Additionally, this section addresses the environmental health and safety risks to children.

4.4.3.1 Public Health and Safety at WFF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to public health and safety. Therefore, no significant impacts would occur with implementation of the No Action Alternative.

4.4.3.2 Public Health and Safety at WFF – Proposed Action

The FE-2 flight test would include the launch of a STARS booster from WFF. The STARS booster falls within current operational missions and activities documented envelopes. Current WFF procedures would ensure protection of public, NASA personnel, contractors, and civilians. In accordance with the WFF Range Safety Manual, mission specific safety plans would be prepared by WFF's Ground and Flight Safety Groups to address all potential ground and flight hazards related to the FE-2 mission. Risks to human health and safety would be thoroughly addressed and managed by the Ground Safety Plan and Flight Safety Plan. Hazard arcs would be established to minimize the potential hazards associated with the operations of the launch range.

In accordance with existing procedures, NTMs and NOTAMs would continue to be published at least 24 hours prior to launch. USACE would activate the offshore Danger Zone, FAA Washington ARTCC would redirect flights away from R-6604, and launches would be coordinated with VACAPES FACSFAC. In addition, WFF would coordinate with law enforcement agencies and utilize its own surveillance assets (e.g., aircraft, ships, and cameras) to ensure that the general public remains clear of designated danger zones during launch operations.

Based on past analysis and following current procedures, implementation of the Proposed Action would not result in significant impacts to public health and safety.

4.4.4 Hazardous Materials and Wastes (WFF)

The hazardous materials and wastes analysis contained in the respective sections addresses issues related to the use and management of hazardous materials and wastes as well as the presence and management of specific cleanup sites at WFF.

4.4.4.1 Hazardous Materials and Wastes at WFF – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change associated with hazardous materials and wastes. Therefore, no significant impacts would occur with implementation of the No Action Alternative.

4.4.4.2 Hazardous Materials and Wastes at WFF – Proposed Action

The flight test would include the FE-2, using a STARS booster, launching from WFF. Similar boosters have been launched at WFF, and hazardous materials and wastes would be managed as for those launches. The FE-2 would use similar hazardous materials and produce similar hazardous waste. This launch is included in the overall number of missile launches analyzed in the Programmatic EA and Final Programmatic EIS (NASA 2005, 2018). Hazardous material usage and waste generation would continue to be managed by WFF in accordance with current procedures. All hazardous wastes would continue to be managed in accordance with standard procedures to protect human health and the environment. NASA would be responsible for identifying, containing, labeling, and accumulating the hazardous wastes in accordance with all applicable federal, state, and local regulations. All hazardous wastes generated from FE-2 operations would be transported by a licensed contractor to a treatment storage and/or disposal facility. Because the NEPA analyses of similar booster launches concluded with a FONSI and the conditions at SNL/KTF have not changed, implementation of the Proposed Action would not result in significant impacts with hazardous materials and wastes.

In accordance with EO 13045, *Protection of Children from Environmental Health and Safety Risks*, the Navy has determined that, since the majority of the FE-2 flight test would be conducted on DOD property and then in the open ocean, the FE-2 flight test has no environmental health and safety risks that may disproportionately affect children.

4.5 Atlantic Broad Ocean Area

4.5.1 Air Quality (Atlantic BOA)

Effects on air quality are based on estimated direct and indirect emissions associated with the action alternatives. The ROI for the over-ocean flight corridor is the global upper atmosphere over the Atlantic BOA along the flight path from outside the launch area at WFF to outside the Atlantic BOA impact area. During flight, the emissions within the over-ocean flight corridor from the FE-2 flight test have the potential to affect air quality in the global upper atmosphere.

Estimated emissions from a proposed federal action are typically compared with the relevant national and state standards to assess the potential for increases in pollutant concentrations.

4.5.1.1 Air Quality in the Over-Ocean Flight Corridor – No Action Alternative

Under the No Action Alternative, the FE-2 flight test would not occur and there would be no change to baseline air quality. Therefore, no significant impacts to air quality or air resources would occur with implementation of the No Action Alternative.

4.5.1.2 Air Quality in the Over-Ocean Flight Corridor – Proposed Action

Air Quality

For all alternatives, the FE-2 vehicle would launch from WFF and travel along a predetermined flight corridor over the Atlantic BOA before payload descent for impact at the Atlantic BOA impact area.

The FE-2 vehicle would launch from WFF with rocket emissions occurring in the over-ocean flight corridor as propellant is burned until exhausted from the rocket motor boosters. The active flight time over the ROI would be measured in minutes. Exhaust emissions would contain both chlorine compounds and free chlorine, produced primarily as hydrogen chloride at the nozzle.

Approximately 5.6 tons of aluminum oxide and 1.9 tons of nitrogen oxides (**Table 3-7**) are released over a period of minutes. The aluminum oxide is emitted as solid particles and can activate chlorine in the atmosphere. Chlorine and hydrogen chloride would have a tropospheric lifetime long enough to eventually mix with the stratosphere. Both aluminum oxide and nitrogen oxides are of concern with respect to stratospheric ozone depletion. Nitrogen oxide contributes to catalytic gas phase ozone depletion and the exact magnitude of ozone depletion that can result from a buildup of aluminum oxide over time has not yet been determined quantitatively. However, following the FE-2 flight test, the majority of aluminum oxide would be removed from the stratosphere through dry deposition and precipitation.

The production of nitrogen oxide species from solid rocket motors is dominated by high-temperature “afterburning” reactions in the exhaust plume. As the temperature of the exhaust decreases with increasing altitude, less nitrogen oxide is formed. On a global scale, the quantity of nitrogen oxide emissions from a single STARS vehicle would represent a very small fraction of nitrogen oxide species generated. Additionally, diffusion and winds would disperse the NO_x species. No significant effect on ozone levels from nitrogen oxide is expected.

Emissions of hydrogen chloride and aluminum oxide from a single launch of a STARS booster (**Table 3-7**) would be substantially less than those that were released by a single Space Shuttle launch, and on a global scale the level of emissions would not be statistically significant. Because the emissions of hydrogen chloride, aluminum oxide, and nitrogen oxides from a launch of a STARS booster would be relatively small compared to emissions released on a global scale, the large air volume over which these emissions are spread, and the dispersion of the emissions by stratospheric winds, a single launch of a STARS booster should not have a significant impact on stratospheric ozone. Therefore, impacts from single launch of a STARS vehicle for the FE-2 flight test would not be expected to have a significant impact on the upper atmosphere.

STARS rocket motor emissions from the FE-2 flight test would not have a significant impact on stratospheric ozone depletion. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that any incremental effects on the global atmosphere would be discountable and insignificant.

Impacts of the FE-2 flight test launch on global warming, climate change, and ozone depletion in the atmosphere have also been considered as part of cumulative impacts in **Section 5.0**.

Greenhouse Gases and Climate Change within Over-Ocean Flight Corridor

Carbon dioxide is the only GHG identified in the Kyoto Protocol that would be emitted during the FE-2 flight test. Because of the solid propellant used, the launch would release only 0.4 ton of carbon dioxide. This does not include a small number of support ocean vessels, aircraft, and other equipment that would be used along the flight path, and in the Atlantic BOA impact area to support the terminal phase preparations and operations, which would be limited and temporary. The availability of GHG emission factors for vessels and some aircraft is limited. Therefore, GHG emissions from those sources were not quantified in this analysis. The amount of emissions that would be released, however, is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time associated with conducting the FE-2 flight test activities. This limited amount of emissions would not likely contribute to global warming or climate change to any discernible extent.

Therefore, implementation of the FE-2 flight test would not result in significant impacts to GHGs and climate change in the over-ocean flight corridor.

4.5.2 Biological Resources (Atlantic BOA)

Potential environmental consequences of the Proposed Action on biological resources are evaluated based on the best available information about species distributions and in the context of the regulatory setting discussed in **Chapter 3.0**.

4.5.2.1 Biological Resources in the Atlantic BOA – No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.5.2.2 Biological Resources in the Atlantic BOA – Alternative Action

The Proposed Action is evaluated for the potential impacts on marine biological resources in the Atlantic Ocean flight corridor, booster drop zones, and payload impact zone of the ROI. Potential impacts of the Action in this area include elevated SPLs, direct contact from launch vehicle and payload components, exposure to hazardous chemicals, and increased human and vessel activity. The potential for the Proposed Action to adversely impact biological resources including those special-status species described in **Section 3.5.2** is evaluated in this section.

4.5.2.2.1 Potential Stressors in the Atlantic BOA

The following stressors have the potential to impact biological resources in the Atlantic BOA ROI:

Exposure to Elevated Sound Pressure Levels

The Proposed Action has the potential to result in elevated SPLs both in-air and underwater in the BOA. The primary elements of the Proposed Action that would result in elevated SPLs in the BOA are: (1) sonic booms, (2) splashdown of vehicle components, and (3) payload impact. Maximum SPLs expected for these elements are as described in **Sections 4.2.2.2.1** and **4.3.1**. General characteristics of sound, effects of sound on marine organisms, and effect thresholds for marine species are presented in **Section 4.2.2.2.1**. Methods for estimating sound level effects in the Atlantic BOA ROI are the same as for the Pacific BOA (**Section 4.2.2.2.1**).

Maximum SPLs for sonic booms across most of the Atlantic flight path (145 dB re 1 μPa) do not exceed the PTS, TTS, or behavioral thresholds for cetaceans or pinnipeds. At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 175 dB near the impact. At the point of impact, the sonic boom footprint would narrow to about 46 km (25 nm) at this peak pressure. For the entire FE-2 flight path, affect areas for sonic booms were calculated at various acoustic intensities (U.S. Navy 2019). Approximately 2.4 km^2 (0.9 mi^2) of ocean surface would be exposed to SPLs up to 170 dB, 45 km^2 (17 mi^2) to SPLs up to 160 dB, and 474 km^2 (183 mi^2) to SPLs up to 150 dB.

Direct Contact

The Proposed Action would result in spent rocket motors and payload components splashing down into the BOA of the Atlantic Ocean. These falling components would directly impact aquatic habitats and have the potential to directly contact marine organisms. Spent rocket motors from the three stages of the FE-2 launch vehicle would splash down into the BOA (**Figure 3-9**). The size of components and direct contact areas for these individual components are the same as for the Pacific (**Sections 4.2.2.2.1** and **4.3.2.3.2**). Methods for estimating direct contact effects are the same as for the Pacific BOA (**Section 4.2.2.2.1**) with the exception that species density data were derived from the NMSDD for the Atlantic Fleet Training and Testing Area (U.S. Navy 2017b).

Vessel Strike and Increased Human Activity

The Proposed Action has the potential to increase ocean-going vessel traffic in the Action Area. The Action would result in vessel traffic in the BOA for on-board sensor placement along the flight path (**Figure 2-10**). A series of sensors would be ground based or onboard vessels along the flight path. All of these sensors are existing programs and would be scheduled for use based on availability. In addition to these sensors, up to 12 self-stationing LIDSS rafts as described in **Section 4.3.2.2.1** may be deployed from a ship in the payload impact area. Post -test operations would include collection of LIDSS rafts and vessel transit through the Atlantic BOA.

Marine organisms have the potential to be affected by vessel strike primarily by being at the surface when a vessel travels through an area. Organisms at the surface are at risk of being struck by the vessel or their propellers. Organisms that are not found at the sea surface have the potential of being struck when a vessel drops anchor or if a vessel runs aground.

Exposure to Hazardous Chemicals

The Proposed Action has the potential to introduce hazardous chemicals into the Action Area. Any substances of which the launch vehicle or payload is constructed or that are contained within the launch vehicle or payload and are not consumed during FE-2 flight or spent motor jettison (**Table 2-1 and Table 2-2**) would fall into the BOA. The chemicals introduced into the marine environment and the potential consequences to marine organisms are the same as in the Pacific BOA (**Sections 4.2.2.2.1** and **4.3.2.3.1**). The release of such contaminants could harm marine organisms that come in contact with or ingest these chemicals.

In an evaluation of the effects of rocket systems that are deposited in seawater, NASA concluded that the release of hazardous materials carried onboard launch vehicles would not significantly impact marine life (NASA 2019b). Materials would be rapidly diluted in the seawater and, except for the immediate vicinity of the debris, would not be found at concentrations that produce adverse effects (U.S. Navy 2008). Overall, larger and heavier vehicle components would sink fairly quickly to the ocean floor. Ocean floor depths in the BOA are so deep that consultation organisms would likely not be in contact with these materials. Any chemicals that do leak into the water column would be quickly diluted by ocean currents and the very large volume of ocean water.

4.5.2.2.2 Consequences for Biological Resources in the Atlantic BOA

Marine Vegetation in the Atlantic BOA

Within the Atlantic BOA, the FE-2 flight test flight is not expected to have a discernible or measurable impact on marine vegetation because of its abundance, wide distribution, and the protective influence of the mass of the ocean around them. While some individual phytoplankton and/or macro-algae would likely be affected by FE-2 component splashdown, FE-2 activities are not expected to alter marine vegetation communities, population structure, or overall abundance or distribution of marine vegetation species.

Marine Wildlife in the Atlantic BOA

Within the Atlantic BOA, the FE-2 flight test flight is not expected to have a discernible or measurable impact on benthic or planktonic invertebrates because of their abundance, their wide distribution, and the protective influence of the mass of the ocean around them. The potential exists, however, for impacts to larger vertebrates in the open ocean area, particularly those that must come to the surface to breathe (e.g., marine mammals and sea turtles) or that feed at the surface (e.g., seabirds). Potential stressors to such species could occur from exposure to elevated noise (sonic booms and splashdown pressures), direct contact from falling components, vessel strike or disturbance from human activity, and exposure to hazardous chemicals released into the water.

Marine Mammals. Overall, marine mammals are not expected to be significantly impacted by any FE-2 stressors in the Atlantic BOA. Any impacts, if realized, would likely be limited to short-term startle reactions, and marine mammals would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: Elevated SPLs from sonic booms are not expected to impact marine mammals in the Atlantic BOA as maximum SPLs for sonic booms across the Atlantic flight path (175 dB re 1 μPa) do not exceed the PTS, TTS, or behavioral thresholds for any marine mammal.

Elevated SPLs from FE-2 component splashdown are not expected to impact marine mammals in the Atlantic BOA, as the calculated chances of a marine mammal being exposed to sounds loud enough to cause temporary or permanent injury are extremely low (**Table 4-9**). Splashdown SPLs in the BOA do not exceed the PTS or TTS thresholds for cetaceans with mid-frequency hearing (25 species). For cetaceans with low-frequency hearing, elevated sound levels only exceed the TTS threshold for splashdown of the spent stage 1 motor. There is a 1 in $4.8x10^7$ to 1 in 9.2 $x10^9$ chance (depending on the species) of a cetacean with low-frequency hearing (7 species) being exposed to SPLs great enough to cause TTS (**Table 4-9**). Cetaceans with high-frequency hearing (3 species) also have a slight risk of being affected by elevated SPLs from splashdown of FE-2 launch vehicle components in the BOA. Splashdown of both the stage 1 and 2 motors may generate SPLs loud enough to exceed the PTS and TTS thresholds in these animals, and the stage 3 motor and nose fairings may generate SPLs that exceed the TTS for cetaceans with high-frequency hearing. Overall, there is a 1 in $2.3x10^5$ chance that a cetacean with high-frequency hearing would be exposed to SPLs high enough to elicit PTS and a 1 in 5.7 $x10^4$ chance of TTS exposure for cetaceans with high-frequency hearing (**Table 4-9**). Cetaceans with high-frequency hearing include only harbor porpoises, and pygmy and dwarf sperm whales.

Table 4-9. Estimated Number of Marine Mammal and Sea Turtle Exposures to Acoustic Impacts and Direct Contact from FE-2 Component Splashdown in the Atlantic BOA.

Common Name	Scientific Name	Functional Hearing Group	Number of Exposures to Elevated SPLs			Number of Exposures to Direct Contact
			PTS	TTS	Behavioral Disturbance	
Baleen Whales						
Minke whale	*Balaenoptera acutorostrata*	LFC	-	2.05E-08	-	9.66E-06
Sei whale	*B. borealis*	LFC	-	1.20E-08	-	2.54E-06
Bryde's whale	*B. edeni*	LFC	-	4.67E-10	-	3.64E-06
Blue whale	*B. musculus*	LFC	-	1.09E-10	-	4.76E-07
Fin whale	*B. physalus*	LFC	-	1.36E-08	-	4.11E-06
North Atlantic right whale	*Eubalaena glacialis*	LFC	-	6.95E-10	-	9.44E-08
Humpback whale	*Megaptera novaeangliae*	LFC	-	1.26E-09	-	3.66E-05
Beaked Whales						
Northern bottlenose whale	*Hyperoodon ampullatus*	MFC	-	-	-	3.18E-07
Beaked Whale Group		MFC	-	-	-	1.43E-04
Sowerby's beaked whale	*Mesoplodon bidens*	MFC				
Blainville's beaked whale	*M. densirostris*	MFC				
Gervais' beaked whale	*M. europaeus*	MFC				
Ture's beaked whale	*M. mirus*	MFC				
Cuvier's beaked whale	*Ziphius cavirostris*	MFC				
Delphinids						
Common dolphin	*Delphinus delphis*	MFC	-	-	-	3.26E-04
Pygmy killer whale	*Feresa attenuata*	MFC	-	-	-	7.42E-05
Pilot Whale Group		MFC	-	-	-	2.23E-03
Short-finned pilot whale	*Globicephala macrorhynchus*	MFC				
Long-finned pilot whale	*G. melas*	MFC				
Risso's dolphin	*Grampus griseus*	MFC	-	-	-	5.89E-05
Fraser's dolphin	*Lagenodelphis hosei*	MFC	-	-	-	1.07E-04
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	MFC	-	-	-	4.39E-05
White-beaked dolphin	*L. albirostris*	MFC	-	-	-	4.06E-09
Killer whale	*Orcinus orca*	MFC	-	-	-	6.03E-07
Melon-headed whale	*Peponocephala electra*	MFC	-	-	-	4.58E-04
False killer whale	*Pseudorca crassidens*	MFC	-	-	-	1.26E-04
Pantropical spotted dolphin	*Stenella attenuata*	MFC	-	-	-	3.52E-04
Clymene dolphin	*S. clymene*	MFC	-	-	-	7.51E-04
Striped dolphin	*S. coeruleoalba*	MFC	-	-	-	1.70E-04

Common Name	Scientific Name	Functional Hearing Group	Number of Exposures to Elevated SPLs			Number of Exposures to Direct Contact
			PTS	TTS	Behavioral Disturbance	
Atlantic spotted dolphin	*S. frontalis*	MFC	-	-	-	7.03E-04
Spinner dolphin	*S. longirostris*	MFC	-	-	-	8.93E-04
Rough-toothed dolphin	*Steno bredanensis*	MFC	-	-	-	2.37E-04
Bottlenose dolphin	*Tursiops truncatus*	MFC	-	-	-	1.05E-03
Porpoises						
Harbor porpoise	*Phocoena*	HFC	4.23E-06	1.69E-05	-	1.98E-05
Sperm Whales						
Kogia Group		HFC	1.41E-07	5.70E-07	-	4.77E-05
Pygmy sperm whale	*Kogia breviceps*	HFC				
Dwarf sperm whale	*K. sima*	HFC				
Sperm whale	*Physeter macrocephalus*	MFC	-	-	-	1.54E-04
Pinnipeds						
Seal Group		PHO	6.28E-12	2.50E-11	-	1.20E-09
Gray seal	*Halichoerus grypus*	PHO				
Harbor seal	*Phoca vitulina*	PHO				

Abbreviations: HFC = high-frequency hearing cetacean, LFC = low-frequency hearing cetacean, MFC = mid-frequency hearing cetacean, PHO = phocid pinniped.
Note: Densities used for analyses listed in Table 3-17.

Seals have a similarly low chance of being affected physically by the elevated SPLs generated by falling FE-2 components in the BOA (**Table 4-9**). Gray and harbor seals only have the potential to occur in motor drop zone 1. In this area, splashdown of the spent stage 1 motor would have the potential to exceed the PTS threshold for seals out to 1 m (3 ft) and would have the potential to exceed the TTS threshold out to 2 m (6 ft). Resulting chances of a seal of either species being exposed are 1 in 1.6×10^{11} of being exposed to SPLs above the PTS threshold and 1 in 4.0×10^{10} for TTS (**Table 4-9**).

<u>Direct contact:</u> Direct contact from splashdown of vehicle components is not expected to impact marine mammals in the BOA as the calculated chances of a marine mammal being injured are so low as to be discountable. The estimated chance of a marine mammal being exposed to direct contact from falling FE-2 components in the Atlantic BOA is between 1 in 448 and 1 in 246,000,000 depending on individual species or group (**Table 4-9**). The pilot whale group had the highest chance of exposure to direct contact from FE-2 components (1 in 448) in the Atlantic because of their relatively high density in the BOA of the payload impact area. Bottlenose dolphins also have a higher chance of exposure (1 in 956) due to their relatively high abundance in the Atlantic ROI, especially in nearshore areas (**Table 4-9**). While we have included all possible species in these analyses, it is important to note that many of these species are extremely unlikely to occur in the BOA of the Action Area during certain times of the year. Even when totaled across cetacean species, the estimated chance of any cetacean exposure to direct contact is only 1 in 125 (**Table 4-9**). The model does not account for animal movement or avoidance behaviors. The

exposure estimates were modeled based on conservative assumptions including the assumption that animals are at the surface 100% of the time and likely result in an overestimation of probability of effect.

The estimated chance of a seal (gray or harbor) exposure to direct contact from falling FE-2 components is 1 in 836,000,000 (**Table 4-9**).

Vessel strike and increased human activity: Marine mammals in the Atlantic BOA are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors and LIDSS rafts. While cetaceans and seals breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in the Action Area. Given that marine mammal density in this area is low and seasonal, the chances of a marine mammal being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Exposure to hazardous chemicals: Hazardous material release in the Atlantic BOA is not likely to adversely impact marine mammals. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle and payload components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and marine mammals are not likely to occur. Due to the low density and patchy distribution of marine mammals in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Sea Turtles. Overall, sea turtles are not expected to be significantly impacted by any FE-2 stressors in the Atlantic BOA. Any impacts, if realized, would likely be limited to short-term startle reactions, and sea turtles would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: Elevated SPLs from sonic booms are not expected to impact sea turtles in the BOA as maximum SPLs for sonic booms in the BOA (175 dB re 1 μPa) do not exceed the PTS or TTS thresholds for sea turtles. There is a potential for behavioral disruption in sea turtles near the payload impact point. An estimated maximum of 45 km^2 (17 mi^2) would be subject to sonic boom SPLs of 160 dB. No density estimates were available for sea turtles in the Atlantic BOA outside of the U.S. EEZ. It is possible that a small number of turtles would be exposed to SPLs high enough to induce behavioral disturbance near the payload impact point; however, sea turtle densities are likely very low in this open-ocean area.

Elevated SPLs from vehicle component splashdown and payload impact are not expected to significantly impact sea turtles in the BOA as maximum SPLs do not exceed the physical injury thresholds for sea turtles. The SPLs from FE-2 component splashdown and payload impact have the potential to cause behavioral disturbance in sea turtles. The total area (for all components) with SPLs above the behavioral disturbance threshold for turtles is 2.1 km^2 (0.8 mi^2). While no density estimates are available for sea turtles in the stage 2 and 3 drop zone or the payload impact area, the NMSDD (U.S. Navy 2017b) contains reliable density data for sea turtles in the stage 1 motor drop zone. Based on these density estimates, the calculated chances of a sea turtle being exposed to sounds loud enough to cause behavioral disturbance in the stage 1 motor drop zone is 1 in 2 for the five turtle species combined (**Table 4-9**). Leatherback turtles have a 1 in 24 chance of being exposed to sounds loud enough to cause behavioral disturbance, loggerheads a 1 in 3 chance, Kemp's ridleys a 1 in 61 chance, and unidentified or other species or hardshell turtles a 1 in 11 chance (**Table 4-9**). As with marine mammals, it is important to note that this model does not account for seasonal differences in abundance, and it assumes that sea turtle are at the surface 100% of the time. Model assumptions likely resulted in overestimation of effect and should be considered maximum estimates of effect.

Direct contact: Direct contact from splashdown of vehicle components and payload impact is not expected to impact sea turtles in the Atlantic BOA. As described above, reliable density estimates for sea turtles in the Atlantic BOA are only available for the stage 1 motor drop zone. The estimated chance of a sea turtle exposure to direct contact from the falling stage 1 motor is 1 in 14,100 for all five sea turtle species combined (**Table 4-9**). As with cetaceans, it is important to note some of the drawbacks of this model that may lead to overestimation of effect. The model assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components. The model is based on the best available density data. Since many density studies of turtles are conducted in nearshore areas, density estimates in deep ocean areas are largely unknown. While density estimates are not available for the stage 2 and 3 motor drop zone or the payload impact area, sea turtle densities are expected to be low and distributions variable across seasons.

Vessel strike and increased human activity: Sea turtles in the Atlantic BOA are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors and LIDSS rafts. While sea turtles breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels, and they may already be used to some vessel traffic in the Action Area. Given that sea turtle density in this area is low and seasonal, the chances of a sea turtle being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Exposure to hazardous chemicals: Hazardous material release in the Atlantic BOA is not likely to adversely impact sea turtles. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle and payload components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and turtles are not likely to occur. Due to the low density and patchy distribution of sea turtles in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Loggerhead critical habitat: The pelagic *Sargassum* designated critical habitat for the loggerhead turtle overlaps the stage 1 motor drop zone (**Figure 3-10**). This critical habitat area allows *Sargassum* growth in concentrations that support adequate prey abundance and cover for young loggerhead turtles (79 FR 39856 [July 10, 2014]). The FE-2 Action has the potential to affect loggerhead critical habitat through direct contact or introduction of hazardous chemicals from stage 1 splashdown. Given the small area of critical habitat within the splashdown zone, the small area which would be subject to direct contact from stage 1 (28 m^2 or 81 ft^2), and the low chances of the booster falling into the critical habitat area, it is not likely that splashdown of the stage 1 motor would alter critical habitat for loggerhead turtles.

Birds. Overall, seabirds are not expected to be significantly impacted by any FE-2 stressors in the Atlantic BOA. Any impacts, if realized, would likely be limited to short-term startle reactions and seabirds would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: Seabirds might be exposed to elevated sound levels from sonic boom, vehicle component splashdown, or payload impact. Elevated SPLs from sonic booms would exceed PTS threshold for birds only near payload impact where sound pressure levels would be above 140 dB re 20 µPA over an area less than 2.4 km^2 (0.9 mi^2). While density of foraging seabirds in this open-ocean area is unknown, it is likely densities would be very low and it is unlikely that seabirds would be in the area with SPLs above the PTS threshold. For vehicle component splashdown, only the stage 1 motor creates in-water SPLs above the injury threshold for birds and this only over an area of 12 m^2 (14 yd^2). Given the low density and patchy distribution of seabirds in the ROI, it is very unlikely that a seabird would be in the area with SPLs above the underwater injury threshold. Elevated sound pressure levels from payload impact would only exceed the PTS threshold for birds out to 18 m (59 ft) from the point of impact. Due to the likely low density and patchy distribution of seabirds foraging in these areas, birds are not expected to be in this area or be exposed to SPLs loud enough to cause physical damage.

It is possible that birds would be exposed to SPLs lower than the PTS threshold but high enough to cause behavioral disturbance. While birds might be temporarily startled by these sounds, any behavioral or physiological response is likely to be very brief as the duration of the elevated SPLs from sonic booms and splashdowns are on the order of less than a second. If any behavioral disturbance was realized it would likely be in the form of alert behaviors, minor behavioral changes, or flight response (U.S. Navy 2015). No adverse impacts to birds in or near the impact location are expected due to elevated SPLs from sonic booms or component splashdown.

Direct contact: Direct contact from splashdown of vehicle components and payload impact is not expected to impact seabirds in the BOA. Given the small direct contact affect area and the low and patchy distribution of seabirds in the Atlantic BOA, it is very unlikely that a seabird would be subject to direct contact from FE-2 components.

Vessel strike and increased human activity: Seabirds in the Atlantic BOA are not expected to be impacted by human activity and vessel traffic. Only a small number of vessel trips would be required in this area to position onboard sensors and LIDSS rafts. While seabirds may rest on the ocean surface, they are very mobile animals which can fly away from approaching vessels and have even been known to follow vessels to feed on prey in the wake of vessels. Given that seabird density in this area is low and seasonal, the chances of a seabird being impacted by human disturbance or being struck by a vessel are considered so low as to be discountable.

Exposure to hazardous chemicals: Hazardous material release in the Atlantic BOA is not likely to adversely impact seabirds. The area affected by the dissolution of chemicals would be relatively small because of the size of the launch vehicle components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and components would sink to the ocean bottom, where depths in the BOA reach thousands of feet and seabirds and their prey are not likely to occur. Due to the low density and patchy distribution of seabirds in the BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Fish. Overall, fish are not expected to be significantly impacted by any FE-2 stressors in the Atlantic BOA. Any impacts, if realized, would likely be limited to short-term startle reactions, and fish would be expected to return to normal behaviors within minutes.

Elevated sound level impacts: The maximum SPLs for sonic booms in the Atlantic BOA (175 dB) do not exceed the PTS or TTS thresholds for fish. There is a potential for behavioral disruption in fish, over an area of 474 km^2 (183 mi^2) near the payload impact point. Fish in the BOA have the potential to be exposed to SPLs high enough to exceed the injury threshold (TTS threshold) up to 40 m (131 ft) from splashdown and to levels above the behavioral disruption threshold out to 2.5 km (1.4 nm). The SPLs from payload impact do not exceed the PTS for fish but may expose fish to SPLs above the TTS threshold out 1.8 m (5.9 ft) from payload impact. Due to the low densities and patch distribution of many fish species along the projected flight path and the fact that fish occur at some depth below the water surface, it is very unlikely that these organisms would be physically injured by FE-2 activities. The affect areas above assume that organisms are at the surface of the water. Just as SPL dissipates with distance from a sound source, sound levels also decrease with water depth. There are no known reliable density estimates for fish species in the deep ocean waters of the Atlantic BOA. Most fish species likely have very low densities in these deep-water areas with patchy distributions. At least some fish are likely to be exposed to elevated SPLs above the behavioral disturbance threshold; however, it is likely that the effects would be temporary behavioral effects due to the short duration (less than 1 second) of potential exposure to elevated noise from a splashdown. There is no reason to expect that there would be significant or lasting effects or that animal behaviors would not return to normal within minutes.

Direct contact: Direct contact from payload debris is not expected to impact fish in the offshore impact zones. While density information for fish species in the deep waters of the Atlantic BOA are not available, most adult fish are expected to have overall low densities and patchy distributions in these deep waters. Therefore, it is unlikely that fish would be significantly impacted by direct contact from payload impact.

Vessel strike and disturbance from human activity: A small number of vessel trips would be required to position onboard sensors and LIDSS rafts. Fish present in the Atlantic BOA are not likely to be impacted by vessel strike or human activity. Fish species do not need to surface to breathe air, are not known to frequent the ocean surface, and are highly mobile animals capable of avoiding vessels. Human activity and vessel operation is not expected to injure or significantly alter the natural behavioral patterns of fish in or near the offshore impact locations.

Exposure to hazardous chemicals: Hazardous material release in the Atlantic BOA is not likely to adversely impact fish. The area affected by the dissolution of chemicals would be relatively small because of the size of the vehicle and payload components and the minimal amount of residual materials they contain. Any chemicals introduced to the water column would be quickly diluted and dispersed and payload debris would sink to the ocean bottom. Due to the low density and patchy distribution of fish in the deep waters of the Atlantic BOA, the likelihood of an animal coming into contact with hazardous materials from FE-2 is extremely low.

Essential Fish Habitat. Only the stage 1 spent motor drop zone occurs in the U.S. EEZ, the only portion of the ROI where EFH is designated. While EFH for a large number of marine species has been designated in this area for a variety of life stages, it is unlikely that the splashdown of the stage 1 motor would significantly alter any EFH. Given the relatively small contact area (28 m^2 or 81 ft^2) of the stage 1 motor and the small chance of the motor directly contacting any given EFH, it is unlikely that FE-2 activities would significantly impact EFH.

4.6 Summary of Potential Impacts to Resources and Impact Avoidance and Minimization

A summary of the potential impacts associated with each of the action alternatives and the No Action Alternative and impact avoidance are presented in **Tables 4-10** and **4-11**, respectively. Minimization measures for each alternative are presented in **Tables 4-12** and **4-13**, respectively.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
PMRF	Air Quality	There would be no change to baseline air quality and, therefore, no significant impacts to air quality or air resources would occur with implementation of the No Action Alternative.	The Navy FE-2 flight test would result in temporary air emissions during the liftoff of the STARS booster. The quantities of combustion products aluminum oxide, carbon monoxide, carbon dioxide, and hydrogen chloride generated by the entire first stage burn of the STARS booster are relatively minor amounts that are dispersed within a short time after liftoff. The minor amounts of combustion products would result in only very minor short-term impacts to air quality. The FE-2 flight test would have the potential to incrementally contribute to global emissions of GHGs. However, no significant impacts are anticipated.
PMRF	Water Resources	There would be no change to baseline water resources, and therefore, no significant impacts to water resources from implementation of the No Action Alternative.	Sampling and analyses of soil and water prior to and following previous STARS launches did not indicate impacts. Perchlorate analytical results indicated levels were within guidelines. The Proposed Action would not result in significant impacts to water resources.
PMRF	Biological Resources	There would be no change to biological resources, and therefore, no significant impacts to biological resources from implementation of the No Action Alternative.	Based on prior analyses, and the effects of current and past missile launch activities, the potential impacts of the Proposed Action on terrestrial biological resources are expected to be minimal. No ground clearing or construction is expected and no long-term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on PMRF and critical habitat for the ohai and lau`ehu would not be affected by the action. The launch site at KTF is in an area that has routine human activity, equipment operation, and launch activity. Terrestrial species at PMRF are already habituated to high levels of noise associated with ongoing activities at this facility. Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions. Marine species at PMRF are likely already habituated to high levels of noise associated with ongoing activities at this facility. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
PMRF	Airspace	There would be no change to airspace use or control, and therefore, no impacts to airspace from implementation of the No Action Alternative.	The U.S. Navy SSP FE-2 flight test would be similar to previous missile tests, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be minimal. The advanced planning and coordination with the FAA regarding: scheduling of special use airspace, and coordination of the proposed FE-2 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace.
PMRF	Noise	There would be no change to noise sources, and therefore, no impacts from noise resulting from implementation of the No Action Alternative.	Launch of missiles is a routine activity from SNL/KTF. The STARS booster has been previously launched at SNL/KTF, and noise levels for the FE-2 flight test would be the same as for previous STARS launches and would not result in significant impacts to the noise environment.
PMRF	Public Health and Safety	With only one less launch from SNL/KTF, there would be no significant change to public health and safety. No significant impacts to public health and safety would result from the No Action Alternative.	Launch of the FE-2 from the same site as previous STARS booster launches would have a similar potential health and safety impact as described for the No Action Alternative. The proposed solid propellants would be similar to past launches and would follow the same health and safety procedures developed under existing plans. Implementation of the Proposed Action would not result in significant impacts to public health and safety.
PMRF	Hazardous Materials and Wastes	There would be no change to hazardous materials and wastes, and, therefore, no significant impacts from hazardous materials and wastes that would result from implementation of the No Action Alternative.	The FE-2 flight test launch would use similar hazardous materials and produce similar hazardous waste as previous STARS launches. The FE-2 launch fits within the overall number of missile launches proposed in the HRC EIS/OEIS. Hazardous material usage and waste generation would continue to be managed by PMRF under appropriate state and federal requirements. Implementation of the Proposed Action would not result in significant impacts from hazardous materials and wastes.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
Over-Ocean Flight Corridor	Air Quality	Under the No Action Alternative, the FE-2 flight test would not occur and there would be no change to baseline air quality in the over-ocean flight corridor. No significant impacts to air quality or air resources would occur with implementation of the No Action Alternative	Under the Proposed Action, following the FE-2 flight test, the majority of aluminum oxide would be removed from the stratosphere through dry deposition and precipitation. Emissions from a STARS vehicle launch would be relatively small compared to all emissions released on a global scale. The large air volume over which the STARS emissions are spread, and the dispersion of the STARS emissions by stratospheric winds would reduce potential impacts. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that any incremental effects on the global atmosphere would be discountable and insignificant. The Proposed Action would not have a significant impact on stratospheric ozone or on the upper atmosphere The amount of GHG emissions that would be released from activities associated with a single FE-2 flight test is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time for conducting the single FE-2 flight test activities. This limited amount of emissions would not likely contribute to global warming and climate change to any discernible extent. Implementation of the Proposed Action would not result in significant impacts to air quality or GHG emissions.
Over-Ocean Flight Corridor	Biological Resources	There would be no change to biological resources, and therefore, no significant impacts to biological resources from implementation of the No Action Alternative.	*Marine Wildlife*: Noise: Sonic booms overpressures would not exceed PTS, TTS, or behavioral disturbance thresholds for organisms in the BOA and therefore no adverse impacts from sonic booms are expected. Splashdown pressures would exceed PTS thresholds for cetaceans with high frequency hearing and the physical injury threshold for seabirds. These pressures would also exceed TTS thresholds for cetaceans with high and low frequency hearing, Hawaiian monk seals, birds, and fish. These organisms may also be exposed to SPLs high enough to cause behavioral disturbance. While effects of elevated SPLs are possible, based on species abundance and distribution in the BOA, the chances of this occurring are likely very low. Any effects of elevated SPLs are likely to be temporary, behavioral modifications with no lasting effects. Therefore no significant impacts from elevated SPLs are expected. Direct Contact: The chances of and FE-2 component directly contacting a marine mammal are very low (1 in 19,500 total for all species). The chances of direct contact with a sea turtle are also extremely low (1 in 710,000). Direct contact would not be expected to adversely impact cetaceans, sea turtles, birds, fish or EFH in the BOA. Hazardous Chemicals: the release of hazardous materials carried onboard a launch vehicle would not significantly impact marine life. Hazardous materials would be rapidly diluted in the seawater and. larger and heavier vehicle components would sink fairly quickly to the ocean floor to depths where consultation organisms would likely not be in contact with these materials.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
			Increased Human and Vessel Activity: Vessel traffic is common in this area and the increase in human activity and vessel traffic in the BOA would be expected to be minimal; these activities would not be expected to impact marine resources including threatened and endangered species or EFH.
USAKA, RMI Illeginni Islet	Cultural Resources	There would be no change to cultural resources under the No Action Alternative. Therefore, no impacts would occur to biological resources with implementation of the No Action Alternative	Archaeological surveys have not found indigenous cultural materials or evidence of subsurface deposits on the Islet. The Cold War-era properties potentially eligible for listing on the RMI NRHP are in the central and eastern portions of the Islet. Because a land impact would not occur in proximity to known or potential cultural resources on Illeginni Islet, implementation of the Proposed Action would not result in significant impacts to cultural resources.
USAKA, RMI Illeginni Islet	Biological Resources	There would be no change to biological resources under the No Action Alternative. Therefore, no impacts would occur to biological resources with implementation of the No Action Alternative	*Terrestrial Vegetation*: Terrestrial vegetation in the payload impact zone at Illeginni Islet is vegetation of previously disturbed habitat and is predominantly managed vegetation. Therefore, no adverse impacts to terrestrial vegetation are expected. *Terrestrial Wildlife*: Noise: It is likely that birds would be exposed to SPLs high enough to cause behavioral disturbance, and any behavioral or physiological response is likely to be very brief and no adverse impacts to birds on or near Illeginni Islet are expected due to elevated SPLs. Direct Contact: While direct contact from payload debris may impact any birds in the impact zone, very few birds are expected to be within this area and the chances of direct contact are low. The U.S. Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-2 activities may but are not likely to adversely affect nesting sea turtles (U.S. Navy 2019). USFWS has concurred with this determination (Appendix A). Vessel Strike: No adverse impacts to birds are expected from vessels transiting to and from Illeginni Islet. Exposure to Hazardous Chemicals: Hazardous chemicals are not expected to impact birds at Illeginni Islet. Human Disturbance: Disturbance from human activities and equipment operation has the potential to impact birds, especially nesting seabirds on Illeginni Islet; however, any disturbance is not expected to have a significant, long term impact. Disturbance from human activities and equipment operation may but is not likely to adversely impact nesting sea turtles, sea turtle nests, and/or sea turtle nesting habitat.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
USAKA, RMI Illeginni Islet	Biological Resources (Cont.)		*Marine Wildlife:* Noise: The maximum SPLs for sonic booms and payload impact at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans or, sea turtles, or fish. Payload impact would result in SPLs above the injury threshold for fish but only out to 2.2 m from impact; therefore, injury to fish is unlikely. There is a potential for behavioral disruption in sea turtles and fish near the payload impact point. While there is a chance that up to 17 green sea turtles and 6 hawksbill turtles may be exposed to SPLs high enough to elicit behavioral response, any response is expected to be temporary and turtles would be expected to return to normal behavior within minutes. Any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would quickly return to normal. Therefore, no lasting adverse impacts are expected from elevated SPLs. Direct Contact: Payload impact is not expected to adversely affect cetaceans or sea turtles in the water through direct contact. Payload impact may adversely impact a very small, but indeterminable, number of larval fish, coral, or mollusks. The number of larvae potentially affected is likely to be trivially small relative to their population sizes and the effects are considered discountable. Based on analyses of a worst-case scenario of a shoreline impact, direct contact from payload debris may also affect up to 5,692 coral colonies, 79 individual mollusks, and 100 juvenile and 8 adult humphead wrasses. NMFS has been provided these analyses in a Biological Assessment and they concluded that 10,404 coral colonies, 4 top shell snails, 63 clams, and 108 humphead wrasses could experience mortality from the payload impact on the shoreline (NMFS 2019a; Appendix C). NMFS also concluded that the potential loss of these adult coral and mollusk species is not expected to eliminate them from Illeginni Islet or to appreciable reduce the likelihood of their survival and recovery (NMFS 2019a; Appendix C). Vessel Strike: Marine wildlife has the potential to be impacted by vessel strike primarily by being at the surface when a vessel travels through an area. Due to species characteristics, abundance, and distribution, and mitigation measures, no adverse impacts due to vessel strike are expected. Hazardous Chemicals: Post-flight cleanup of the impact area would include recovery/cleanup off all visible floating debris. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish or sea turtles in the area.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
USAKA, RMI Illeginni Islet	Biological Resources (Cont.)		Hazardous chemicals have the potential to impact sea turtle nests and nesting. USFWS has been provided a Biological Assessment with the conclusion that hazardous chemicals are not likely to affect sea turtles, and has concurred with that determination in a Letter of Concurrence (Appendix A). Human Disturbance: Cetaceans, sea turtles in the water, and most fish are unlikely to be adversely impacted by increased human activity or equipment operation at Illeginni Islet. In shallow waters near Illeginni Islet, corals, mollusks, and reef- associated fish have the potential to be disturbed by shallow water debris recovery and/or backfill operations. NMFS has been provided a Biological Assessment and the findings of their Final Biological Opinion are included in Appendix C
USAKA, RMI Illeginni Islet	Noise	There would be no change to noise levels in the ROIs. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.	While meteorological conditions can influence peak SPLs, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB. At the point of impact, the sonic boom footprint would narrow and duration for sonic boom overpressures are expected to average 75 to 270 ms. Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area. Mission vessel personnel may be required to use hearing protection. Noise levels during pre-test and post-flight activities at the pre- determined target site would occur in an unpopulated area without resident receptors. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.
USAKA, RMI Illeginni Islet	Public Health and Safety	There would be no change to public health and safety under the No Action Alternative.	In case of an anomaly, the payload FTS would cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. For impact, there are no resident populations in proximity to Illeginni Islet. NOTAMs and NTM would be issued to clear traffic from caution areas prior to the test. There would be no significant impacts to public health and safety from the Proposed Action.
USAKA, RMI Illeginni Islet	Hazardous Materials and Wastes	Under the No Action Alternative, there would be no change to hazardous materials and waste at Illeginni Islet.	Hazardous materials used in the payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, depleted uranium, beryllium, or radioactive materials would be carried on the payload. Flight test personnel would ensure all visible debris is removed from the impact site, and that all equipment and materials are recovered from Illeginni Islet. Any hazardous waste resulting from FE-2 flight test activities on Illeginni Islet would be disposed of in accordance with the UES. No significant impacts would occur from the Proposed Action.
USAKA, RMI Offshore Waters	Cultural Resources	There are no known cultural resources within either of the BOA deep water impact locations.	There are no known cultural resources within either of the BOA deep water impact locations. No impacts would occur to cultural resources from the either Alternative Action location.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
USAKA, RMI Offshore Waters	Biological Resources		*Terrestrial Wildlife:* While no terrestrial habitat exists in the offshore waters, seabirds may forage in these areas. Based on likely seabird density and distribution in these areas, it is unlikely that seabirds would be exposed to SPLs high enough to cause injury or behavioral disturbance, direct contact, hazardous chemicals, vessel traffic, or human disturbance. Therefore seabirds are unlikely to be adversely impacted. *Marine Wildlife:* Noise: The maximum SPLs for sonic booms and payload impact at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans or sea turtles. Payload impact would result in SPLs above the injury threshold for fish but only out to 2.2 m from impact; therefore injury to fish is unlikely. There is a potential for behavioral disruption in sea turtles and fish near the payload impact point. While there is a 1 in 57 chance that a sea turtle would be exposed to SPLs high enough to elicit behavioral response, any response is expected to be temporary and turtles would be expected to return to normal behavior within minutes. Any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would quickly return to normal. Therefore, no lasting adverse impacts are expected from elevated SPLs. Direct Contact: The total chance (all species combined) of a cetacean being directly contacted by payload impact in deep ocean waters is 1 in 684. There is a 1 in 98,310 chance that a sea turtle would be impacted by direct contact. Based on these chances, it is unlikely that a cetacean or sea turtle would be significantly impacted by direct contact from payload impact. Direct contact may adversely impact a very small, but indeterminable, number of larval fish, coral, or mollusks. The number of larvae potentially affected is likely to be trivially small relative to their population sizes and the effects are considered discountable. Vessel Strike: Marine wildlife has the potential to be impacted by vessel strike primarily by being at the surface when a vessel travels through an area. Due to species characteristics, abundance, and distribution, and mitigation measures, no adverse impacts due to vessel strike are expected. Hazardous Chemicals: Post-flight cleanup of the impact area would include recovery/cleanup off all visible floating debris. Considering the small quantities of hazardous materials contained in the payload and the dilution and mixing capabilities of the ocean and lagoon waters, the materials released during payload impact should be of little consequence to any cetaceans, fish or sea turtles in the area. Human Disturbance: Cetaceans, sea turtles in the water, and fish are unlikely to be adversely impacted by increased human activity or equipment operation at Illeginni Islet.

Table 4-10. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 1 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 1
USAKA, RMI Offshore Waters	Noise	There would be no change to the noise environment and, therefore, no impacts from noise.	While meteorological conditions can influence peak SPLs, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB. At the point of impact, the sonic boom footprint would narrow and duration for sonic boom overpressures are expected to average 75 to 270 ms. Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area. Mission vessel personnel may be required to use hearing protection. Noise levels during pre-test and post-flight activities at the predetermined target site would occur in an unpopulated area without resident receptors. Therefore, no significant impacts would occur from noise with implementation of the Proposed Action.
USAKA, RMI Offshore Waters	Public Health and Safety	There would be no change to the Public Health and Safety and, therefore, no resulting impacts.	In case of an anomaly, the payload FTS would cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. For impact, there are no resident populations in proximity to either Offshore Waters location. NOTAMs and NTM would be issued to clear traffic from caution areas prior to the test. There would be no significant impacts to public health and safety from the Proposed Action.
USAKA, RMI Offshore Waters	Hazardous Materials and Wastes	There would be no change to the Hazardous Materials and Wastes, and, therefore, no impacts would occur.	Hazardous materials used in the payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, depleted uranium, beryllium, or radioactive materials would be carried on the payload. Any hazardous waste resulting from FE-2 flight test activities from vessels or equipment would be disposed of in accordance with the UES. No significant impacts would occur from the Proposed Action.

Table 4-11. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 2

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 2
WFF	Biological Resources	There would be no change to biological resources, and therefore, no significant impacts to biological resources from implementation of the No Action Alternative.	*Terrestrial Vegetation*: No ground clearing or construction is expected for the Proposed Action. The launch would take place at a previously disturbed, previously used, and previously analyzed location. Compliance with relevant Navy policies and procedures during this launch event should continue to minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. Terrestrial vegetation is not expected to be significantly impacted. *Terrestrial Wildlife:* Noise: Terrestrial wildlife are not likely to be physically injured by launch noise. Behavioral disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause birds and other mobile wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended. Direct Contact: Terrestrial wildlife are not expected to be impacted by direct contact during normal flight operations. Hazardous Chemicals: No significant short or long-term impacts to terrestrial wildlife are expected from launches at WFF. Artificial Lighting: Launches are not expected to take place at night and lights are not expected to be turned on at night for any FE-2 activities. If program activities are required to occur at night during the sea turtle nesting season, the U.S. Navy would minimize lighting and coordinate these activities through WFF to avoid disorienting hatchling sea turtles with artificial lights. Given the limited time frame of launch activities, sea turtles hatchlings and other terrestrial wildlife species are not likely to be significantly impacted by artificial lighting from FE-2 activities. *Marine Wildlife:* Noise: Noise from launches and launch related activity may startle nearby wildlife, but this startle reaction would be of short duration. Based on injury thresholds, marine wildlife would not be injured from elevated SPLs. Any behavioral disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts.

Table 4-11. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 2 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 2
WFF			Direct Contact: No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations. Hazardous Chemicals: Within offshore waters, the potential ingestion of contaminants by fish and other marine species would be remote because of atmospheric dispersion of the emission cloud, the diluting effects of the ocean water, and the relatively small area of the habitat that would be affected. No impacts on marine wildlife due to hazardous chemicals are expected during normal flight operations.
WFF	Airspace	There would be no change to baseline Airspace management, and therefore, no impacts to airspace from implementation of the No Action Alternative.	There would be no impacts to airspace management beyond what has been analyzed in previous NEPA documents. Launch of the FE-2 would include flight monitoring at WFF ATC, WFF Range Control Center, Washington ARTCC, and FACSFAC VACAPES. NOTAMs and NTM that are broadcast by the FAA and U.S. Coast Guard, when needed for operations in R-6604 A-E and W-386, would also remain unchanged. Therefore, implementation of the Proposed Action would have no impact on airspace management resources in R-6604 A-E or W-386.
WFF	Health & Safety	Daily operations would continue as is and current protocols for continued human health and safety would not change.	FE-2 launch activities would follow established protocols at WFF and would involve risks to safety similar to previously analyzed missile launch activities. WFF would implement protective measures to ensure risks to personnel and the general public from these operations are minimized. Therefore, implementation of the Proposed Action would have no significant impact on health and safety.
WFF	Hazardous Materials & Waste	There would be no change to baseline Hazardous Materials and Waste management, and therefore, no impacts to from implementation of the No Action Alternative.	Types of hazardous materials, substances, and hazardous waste would be like those used or generated during similar missile launch operations at WFF and would continue to be managed according to standard procedures. All hazardous wastes would continue to be managed in accordance with standard procedures to protect human health and the environment. No significant impacts are anticipated.

Table 4-11. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 2 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 2
Over-Ocean Flight Corridor and BOA Impact Area	Air Quality	Under the No Action Alternative, the FE-2 flight test would not occur and there would be no change to baseline air quality in the over-ocean flight corridor. No impacts to air quality or air resources would occur with implementation of the No Action Alternative.	Under the Proposed Action, following the FE-2 flight test, the majority of aluminum oxide would be removed from the stratosphere through dry deposition and precipitation. Emissions from a STARS vehicle launch would be relatively small compared to all emissions released on a global scale. The large air volume over which the STARS emissions are spread, and the dispersion of the STARS emissions by stratospheric winds would reduce potential impacts. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that any incremental effects on the global atmosphere would be discountable and insignificant. The Proposed Action would not have a significant impact on stratospheric ozone or on the upper atmosphere. The amount of GHG emissions that would be released from activities associated with a single FE-2 flight test is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time for conducting the single FE-2 flight test activities. This limited amount of emissions would not likely contribute to global warming and climate change to any discernible extent. Implementation of the Proposed Action would not result in significant impacts to air quality or GHG emissions.
Over-Ocean Flight Corridor and BOA Impact Area	Biological Resources	There would be no change to biological resources, and therefore, no impacts to biological resources from implementation of the No Action Alternative.	*Marine Vegetation:* The FE-2 flight test flight is not expected to have a discernible or measurable impact on marine vegetation because of its abundance, wide distribution, and the protective influence of the mass of the ocean around them. While some individual phytoplankton and/or macro-algae would likely be affected by FE-2 component splashdown, FE-2 activities are not expected to alter marine vegetation communities, population structure, or overall abundance or distribution of marine vegetation species. *Marine Wildlife:* Noise: Sonic booms overpressures would not exceed PTS or TTS thresholds for marine mammals, sea turtles, or fish in the BOA. Sonic boom sound pressure would exceed the injury threshold for seabirds but given seabird density and distribution in the BOA, physical injury is unlikely. Therefore, no adverse impacts from sonic booms are expected. Splashdown pressures would exceed PTS thresholds for cetaceans with high frequency hearing (3 species), seals (2 species) and the physical injury threshold for seabirds. These pressures would also exceed TTS thresholds for cetaceans with high and low frequency hearing, seals, birds, and fish. These organisms may also be exposed to SPLs high enough to cause behavioral disturbance. While effects of elevated SPLs are possible, based on species abundance and distribution in the BOA, the chances of this occurring are likely very low. Any effects of elevated SPLs are likely to be temporary, behavioral modifications with no lasting effects. Therefore, no significant impacts from elevated SPLs are expected.

Table 4-11. Potential Impacts Associated with the No Action Alternative and the Proposed Action Alternative 2 (Continued)

Location	Resource Area	No Action Alternative	Navy SSP FE-2 Alternative 2
Over-Ocean Flight Corridor and BOA Impact Area	Biological Resources		Direct Contact: The chances of and FE-2 component directly contacting a marine mammal are very low. Even when summed across all components and all species, there is a 1 in 125 chance of a cetacean being exposed to direct contact and a 1 in 836,000,000 chance of a seal being exposed. For the stage 1 motor, the chances of direct contact with a sea turtle are also extremely low (1 in 14,100). Direct contact would not be expected to adversely impact cetaceans, sea turtles, loggerhead turtle critical habitat, birds, fish or EFH in the BOA. Hazardous Chemicals: the release of hazardous materials carried onboard a launch vehicle and payload would not significantly impact marine life. Hazardous materials would be rapidly diluted in the seawater and. larger and heavier vehicle components would sink fairly quickly to the ocean floor to depths where consultation organisms would likely not be in contact with these materials. Increased Human and Vessel Activity: Vessel traffic is common in this area and the increase in human activity and vessel traffic in the BOA would be expected to be minimal; these activities would not be expected to impact marine resources including threatened and endangered species or EFH.

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
PMRF					
	Transportation, handling, and storage of rocket motors and other ordnance would occur in accordance with DOD, Navy, and U.S. DOT policies and regulations	Safeguard the materials from fire or other mishap	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, and U.S. DOT policies and regulations	Navy SSP, USAF
	Shipments would be inspected for species of plants and animals alien to the environment at Hawai`i	Prevent the introduction of alien species of plants and animals at Hawai`i and the RMI	Determine the rate of successful prevention, identifying the need for treatment applications, as necessary	Recordkeeping of all inspections and outcomes	Navy SSP
	Sandia National Laboratories (SNL) personnel at KTF would conduct range responsibilities	Ensure appropriate launch preparation, including explosive safety, support to PMRF range safety and inter-range coordination	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, and other applicable policies and regulations	SNL
	Publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs) prior to launch	Provide safety and warning to personnel, including private citizens and commercial entities, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, and DOE policies and regulations	Navy SSP, SNL
	Check launch pad area for safe access after vehicle liftoff	Ensure worker safety for post-launch inspection, clean-up, and maintenance	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, and DOE policies and regulations	SNL

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
Pacific Over-Ocean Flight Corridor – FE-2 Alternative 1					
	Payload's flight path would avoid flying over the Northwestern Hawaiian Islands	Avoid impacts to protected species and habitats	Determine that actual flight path complies	Recordkeeping and reporting in accordance with DOD, Navy, and DOE range and flight safety policies and regulations, USFWS regulations, and the ESA and MMPA	Navy SSP, SNL
	During travel in the BOA, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes. Vessel operators would adjust speed based on expected animal locations, densities, and or lighting and turbidity conditions when possible.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to USASMDC, who would then inform NMFS and USFWS.	Recordkeeping and reporting to the appropriate authorities	Navy SSP, RTS
	Computer-monitored destruct lines, based on no-impact lines, are pre- programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with DOD, Navy, and DOE range and flight safety policies and regulations	Navy SSP, SNL

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location					
	Computer-monitored destruct lines, based on no-impact lines, are pre- programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DOD, Navy, and RTS range and flight safety policies and regulations	Navy SSP, RTS
	Pre-flight monitoring by qualified personnel would be conducted on Illeginni Islet for sea turtles or sea turtle nests. On-site personnel would report any observations of sea turtles or sea turtle nests on Illeginni Islet to appropriate test and USAG-KA personnel to provide to USFWS.	Avoid impacts to sea turtles and sea turtle nests	Determine the rate of successful compliance and incident prevention or occurrence	For at least 8 weeks preceding the FE-2 launch, Illeginni Islet would be surveyed by pre-test personnel for sea turtles, sea turtle nesting activity, and sea turtle nests on a bi-weekly basis. If possible, personnel would inspect the area within two days of the launch. If sea turtles or sea turtle nests are observed near the impact area, observations would be reported to appropriate test and USAG-KA personnel for consideration in approval of the launch and reported to USFWS. Recordkeeping and reporting in accordance with UES, DOD, Navy, and USFWS regulations	RTS/USAG-KA, Navy SSP

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	RTS would conduct range responsibilities	Ensure appropriate launch preparation, including explosive safety, support to Navy SSP and inter-range coordination	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, and RTS applicable policies and regulations	RTS
	During travel to and from impact zones, including Illeginni Islet, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to the USAG-KA Environmental Office and USASMDC, who would then inform NMFS and USFWS. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas would also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.	If personnel observe sea turtles or marine mammals in potential impact zones, sightings would be reported to appropriate test and USAG-KA personnel for consideration in launch planning, recordkeeping and reporting in accordance with UES, DOD, Navy, and RTS policies and regulations.	Navy SSP, RTS

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous material releases would comply with the emergency procedures set out in the KEEP and the UES.	Avoid introduction of hazardous chemicals into terrestrial and marine environments.	Determine the rate of successful compliance and incident prevention	Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport, recordkeeping of all incidents and outcomes	Navy SSP, RTS
	All equipment and packages shipped to USAG-KA would undergo inspection prior to shipment.	Prevent the introduction of alien species of plants and animals to Kwajalein Atoll	Determine the rate of successful prevention, identifying the need for treatment applications, as necessary	Recordkeeping of all inspections and outcomes	Navy SSP
	Sensor rafts would not be located in waters less than 4 m (13 ft) deep.	To avoid impacts on coral heads off Illeginni Islet	Determine the rate of successful compliance and incident prevention	Recordkeeping of deployments and outcomes	Navy SSP, LLNL
	FTS on the payload would include a failsafe operation	Further ensure the safety of the Marshall Islands and avoid debris falling on inhabited areas or any protected area, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, and RTS policies and regulations	Navy SSP, SNL, RTS

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	Payload impact would be in the non-forested area, place scarecrows, Mylar flags, helium-filled balloons, and strobe lights or tarp coverings on or near equipment and the impact area	Avoid affecting the bird habitat	Determine the rate of successful compliance and incident prevention or occurrence	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS, and RMIEPA policies and regulations	Navy SSP, RTS
	The impact area would be searched for seabird nests, including eggs and chicks, prior to pre-flight activity. Any discovered seabird nest would be covered with an A-frame structure to protect eggs or chicks and to warn project personnel	Avoid impacts to seabirds, especially black- naped terns	Post-test monitoring to observe impacts to seabirds, especially black-napped terns, their nests, eggs, or chicks	Results of monitoring would be reported to USAG-KA Environmental and to USFWS	
	Debris recovery and site cleanup would be performed for land or shallow water impacts.	To minimize long-term risks to terrestrial and marine life	Comparison of recovered debris to known materials in the payload	All visible project- related debris would be recovered during post-flight operations, including debris in shallow lagoon or shallow ocean waters by range divers. In all cases, recovery and cleanup would be conducted in a manner to minimize further impacts on biological resources. Protected marine species including invertebrates would be avoided or effects to them would be minimized, which may include movement of these organisms out of the area likely to be affected.	RTS, Navy SSP

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	Should any missile components or debris impact areas of sensitive biological resources (i.e., sea turtle nesting habitat or coral reef), a USFWS or NMFS biologist would be allowed to provide guidance and/or assistance in recovery operations to minimize impacts on such resources	Minimize impacts on terrestrial and marine biological resources	Determine whether components or debris impact sensitive resources, determine if a USFWS or NMFS biologist was contacted and allowed to provide guidance	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies and regulations	Navy SSP
	Should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work would be delayed until such species leave the area or were out of harm's way.	Avoid impacts to terrestrial and marine wildlife	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting with UES, DOD, Navy, RTS, USFWS, and RMIEPA policies and regulations	Navy SSP
	Evacuation of nonessential personnel and sheltering all other personnel remaining within the Mid-Atoll Corridor; publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs); perform radar and visual sweeps of the hazard area immediately prior to test flights	Provide safety and warning to personnel, including native Marshallese citizens, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, and RTS policies and regulations	Navy SSP, RTS
	Ordnance personnel survey of impact site, removal of residual explosive materials, manual cleanup and removal of debris including hazardous materials, backfill impact crater, dive team or ROV survey and debris recovery for deeper water lagoon impact	Ensure post-test personnel safety, avoid impacts to terrestrial and marine vegetation and wildlife	Determine the rate of successful compliance and incident prevention with appropriate disposition of recovered materials	Recordkeeping in accordance with UES, DOD, Navy, and RTS policies and regulations	RTS

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	Inspect reef, reef flat, or shallow waters within 24 hours if inadvertently impacted, assess damage, decide on any mitigation measures	Avoid or minimize impacts to marine vegetation and wildlife	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS and RMIEPA policies and regulations	RTS, Navy SSP, possibly NMFS/USFWS
	Ensure that all relevant personnel associated with this project are fully briefed on the BMP and the requirement to adhere to them for the duration of this project.	Ensure awareness of and application of BMP for the duration of the FE-2 flight test	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP
	In the event the payload land impact affects the reef at Illeginni Islet, personnel shall secure or remove from the water any substrate or coral rubble from the ejecta impact zone that may become mobilized by wave action as soon as possible. Ejecta greater than six inches in any dimension shall be removed from the water or positioned such that it would not become mobilized by expected wave action, including replacement in the payload crater.	Avoid impacts to marine wildlife, determine impacts to reef and disposition of ejecta	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	If possible, coral fragments greater than 6 inches in any dimension shall be positioned on the reef such that they would not become mobilized by expected wave action, and in a manner that would enhance its survival; away from fine sediments with the majority of the living tissue (polyps) facing up. UES consultation coral fragments that cannot be secured in-place should be relocated to suitable habitat where it is not likely to become mobilized.				
	In the event the payload land impact affects the reef at Illeginni Islet, the USASMDC shall require its personnel to reduce impacts on top shell snails. Rescue and reposition any living top shell snails that are buried or trapped by rubble. Relocate to suitable habitat, any living top shell snails that are in the path of any heavy equipment that must be used in the marine environment.	Avoid impacts to marine wildlife	Post-test monitoring to observe impacts to reef and top shell snails, and determine disposition of ejecta	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	In the event the payload land impact affects the reef at Illeginni Islet, personnel shall be required to reduce impacts on clams. Rescue and reposition any living clams that are buried or trapped by rubble. Relocate to suitable habitat, any living clams that are in the path of any heavy equipment that must be used in the marine environment.	Avoid impacts to marine wildlife	Post-test monitoring to observe impacts to reef and living clams, and determine disposition of ejecta	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Appropriately qualified personnel shall be assigned to record all suspected incidences of take of any UES- consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Identification or refutation of all suspected incidences of take	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Digital photography shall be utilized to record any UES- consultation species found injured or killed in or near the ocean target areas and/or at Illeginni Islet. As practicable: 1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.	Ensure accuracy of data collection and applicability to incidences of take	Photo-documentation prepared as per NMFS guidance	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	In the event of an inadvertent payload impact in deeper lagoon or ocean-side waters (up to 55 m [180 ft] deep) an ROV video or dive inspection would be conducted to evaluate the presence of coral reef development and/or UES consultation species on the deep lagoon bottom. If UES consultation species were found at a lagoon bottom impact site, NMFS would be notified and debris recovery efforts would be coordinated with NMFS.	Avoid impacts to marine wildlife	Post-test monitoring to observe impacts to UES consultation species.	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Appropriately qualified personnel shall be assigned to record all suspected incidences of take of any UES- consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Identification or refutation of all suspected incidences of take	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	In the event the payload impact affects the reef at Illeginni Islet, personnel shall survey the ejecta field for impacted corals, top shell snails, and clams within 60 days of completing post- test clean-up and restoration. Also be mindful for any other UES- consultation species that may have been affected.	Avoid impacts to marine wildlife; ensure accuracy of data collection and applicability to incidences of take	Post-test monitoring to observe impacts to reef and identified organisms, including UES consultation species	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Illeginni Islet – FE-2 Alternative 1 Preferred Impact Location (Cont.)					
	Within 60 days of completing post-test clean-up and restoration, provide photographs and records to the USAG-KA Environmental Office. USAG-KA and NMFS biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible to assess impacts on consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Submittal of photographs and records within 60 days of completing post-test clean-up and restoration	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Within 6 months of completion of the action, U.S. Navy SSP shall provide a report to USAG-KA to forward to NMFS. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.	Ensure compliance with UES and NMFS Biological Opinion Terms and Conditions	Submittal of report within 6 months of completing the action	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Prepare a project specific NPA and DEP	Ensure UES compliance	Complete the NPA and DEP prior to occurrence of the Proposed Action	Final DEP authorized with UES Appropriate Agencies' signatures prior to occurrence of the Proposed Action	Navy SSP

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Southwest or Northeast Offshore Waters – FE-2 Alternative 1 Alternate Impact Locations					
	Computer-monitored destruct lines, based on no-impact lines, are pre-programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DOD, Navy, and RTS range and flight safety policies and regulations	Navy SSP, RTS
	Raft would have running lights and station- keeping; no intentional ocean dumping should the instrumentation raft be inadvertently struck during the conduct of the mission; possible use of scarecrows, Mylar flags, helium-filled balloons, and strobe lights.	Maritime safety; compliance with international policy; visual deterrents to avoid inadvertent impacts to birds that might be on the raft	Determine the rate of successful compliance and incident prevention or occurrence	Recordkeeping and reporting in accordance with UES, DOD, Navy, and RTS range and flight safety policies and regulations	Navy SSP, RTS, LLNL
	FTS on the payload would include a failsafe operation to further ensure the safety of the Marshall Islands	Further ensure the safety of the Marshall Islands and avoid debris falling on inhabited areas or into any protected area, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, and RTS policies and regulations	Navy SSP, RTS
	Visible debris on the water surface would be recovered and removed	Avoid physical impacts to marine life	Collection of any visible debris on the water surface or documentation of the lack of visible debris	All visible project- related debris on the water surface would be recovered during post-flight operations. In all cases, recovery and cleanup would be conducted in a manner to minimize further impacts on biological resources. Recordkeeping and reporting in accordance with UES, DOD, Navy, and RTS, policies and regulations	RTS/USAG-KA, Navy SSP

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Southwest or Northeast Offshore Waters – FE-2 Alternative 1 Alternate Impact Locations (Cont.)					
	Evacuation of nonessential personnel and sheltering all other personnel remaining within the Mid-Atoll Corridor; publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs); a fact sheet describing the project and the environmental controls would be prepared and would be provided at locations on Ebeye and Kwajalein Islet; perform radar and visual sweeps of the hazard area immediately prior to test flights.	Provide safety and warning to personnel, including native Marshallese citizens, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, and RTS policies and regulations	Navy SSP, RTS
	Ordnance personnel survey of impact site, removal of residual explosive materials, manual cleanup and removal of surface floating debris including hazardous materials	Ensure post-test personnel safety, avoid impacts to marine vegetation and wildlife	Determine the rate of successful compliance and incident prevention with appropriate disposition of recovered materials	Recordkeeping in accordance with UES, DOD, Navy, and RTS policies and regulations	RTS
	Prepare a project specific NPA and DEP	Ensure UES compliance	Complete the NPA and DEP prior to occurrence of the Proposed Action	Final DEP authorized with UES Appropriate Agencies' signatures prior to occurrence of the Proposed Action	Navy SSP

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Southwest or Northeast Offshore Waters – FE-2 Alternative 1 Alternate Impact Locations					
	During travel to and from impact zones, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes. Vessel operators would adjust speed based on expected animal locations, densities, and or lighting and turbidity conditions.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to the USAG-KA Environmental Office and USASMDC, who would then inform NMFS and USFWS. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas would also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.	If personnel observe sea turtles or marine mammals in potential impact zones, sightings would be reported to appropriate test and USAG-KA personnel for consideration in launch planning.	Navy SSP, RTS
	Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm marine life. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous material releases would comply with the emergency procedures set out in the KEEP and the UES.	Avoid introduction of hazardous chemicals into marine environments.	Determine the rate of successful compliance and incident prevention	Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport, recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, and RMIEPA policies and regulations	Navy SSP

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Southwest or Northeast Offshore Waters – FE-2 Alternative 1 Alternate Impact Locations					
	Should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work would be delayed until such species leave the area or were out of harm's way.	Avoid impacts to terrestrial and marine wildlife.	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, NMFS, USFWS, and RMIEPA policies and regulations	Navy SSP, RTS
	Ensure that all relevant personnel associated with this project are fully briefed on the BMP and the requirement to adhere to them for the duration of this project.	Ensure awareness of and application of BMP for the duration of the FE-2 flight test	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP
	Appropriately qualified personnel shall be assigned to record all suspected incidences of take of any UES- consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Identification or refutation of all suspected incidences of take	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Digital photography shall be utilized to record any UES- consultation species found injured or killed in or near the ocean target areas and/or at Illeginni Islet. As practicable: 1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.	Ensure accuracy of data collection and applicability to incidences of take	Photo-documentation prepared as per NMFS guidance	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA

Table 4-12. Impact Avoidance and Minimization Measures – FE-2 Alternative 1 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility
USAKA, RMI Southwest or Northeast Offshore Waters – FE-2 Alternative 1 Alternate Impact Locations (Cont.)					
	Within 60 days of completing post-test clean-up and restoration, provide photographs and records to the USAG-KA Environmental Office. USAG-KA and NMFS biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible to assess impacts on consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Submittal of photographs and records within 60 days of completing post-test clean-up and restoration	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA
	Within 6 months of completion of the action, U.S. Navy SSP shall provide a report to USAG-KA to forward to NMFS. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.	Ensure compliance with UES and NMFS Biological Opinion Terms and Conditions	Submittal of report within 6 months of completing the action	Recordkeeping and reporting in accordance with UES, DOD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	U.S. Navy SSP, USAG-KA

Table 4-13. Impact Avoidance and Minimization Measures – FE-2 Alternative 2

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility	Estimated Completion Date
WFF – FE-2 Alternative 2						
	Transportation, handling, and storage of rocket motors and other ordnance would occur in accordance with DOD, NASA, Navy, and U.S. DOT policies and regulations	Safeguard the materials from fire or other mishap	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, and U.S. DOT policies and regulations	Navy SSP, USAF. NASA	Within 1 year after the FONSI/FONSH is signed
	SNL and NASA personnel at WFF would conduct range responsibilities	Ensure appropriate launch preparation, including explosive safety, support to WFF range safety and inter-range coordination	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, NASA, and other applicable policies and regulations	SNL, NASA	Within 1 year after the FONSI/FONSH is signed
	Publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs) prior to launch	Provide safety and warning to personnel, including private citizens and commercial entities, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DOD, Navy, and NASA policies and regulations	NASA, Navy SSP, SNL	Within 1 year after the FONSI/FONSH is signed
	Check launch pad area for safe access after vehicle liftoff	Ensure worker safety for post-launch inspection, clean-up, and maintenance	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with NASA, DOD, Navy, and DOE policies and regulations	NASA	Within 1 year after the FONSI/FONSH is signed

Table 4-13. Impact Avoidance and Minimization Measures – FE-2 Alternative 2 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility	Estimated Completion Date
Atlantic Over-Ocean Flight Corridor – FE-2 Alternative 2						
	Payload's flight path would avoid flying over the Bahamas	Avoid impacts to protected species and habitats	Determine that actual flight path complies	Recordkeeping and reporting in accordance with DOD, Navy, and DOE range and flight safety policies and regulations, USFWS regulations, and the ESA and MMPA	NASA, Navy SSP, SNL	Within 1 year after the FONSI/FONSH is signed
	During travel in the BOA, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes. Vessel operators would maneuver and adjust speed to maintain a 460 m (500 yard) mitigation zone around whales and a 180 m (200 yard) zone around other marine mammals when possible.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to OPNAV(N45) and USASMDC, who would then inform NMFS and USFWS.	Recordkeeping and reporting to the in accordance with NASA, DOD, and Navy policies and regulations.	Navy SSP	Within 1 year after the FONSI/FONSH is signed
	Computer-monitored destruct lines, based on no-impact lines, are pre-programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with NASA, DOD, Navy, and DOE range and flight safety policies and regulations	NASA, Navy SSP, SNL	Within 1 year after the FONSI/FONSH is signed

Table 4-13. Impact Avoidance and Minimization Measures – FE-2 Alternative 2 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility	Estimated Completion Date
Atlantic BOA Impact Area – FE-2 Alternative 2						
	Computer-monitored destruct lines, based on no-impact lines, are pre-programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with NASA and DOD, range and flight safety policies and regulations	NASA, Navy SSP	Within 1 year after the FONSI/FONSH is signed
	NASA would conduct range responsibilities	Ensure appropriate launch preparation, including explosive safety, support to Navy SSP and inter-range coordination	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with NASA, DOD, and Navy applicable policies and regulations	NASA	Within 1 year after the FONSI/FONSH is signed
	During travel to and from impact zones, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to the NASA Environmental Office and USASMDC, who would then inform NMFS and USFWS. Navy aircraft pilots otherwise flying in the vicinity of the impact and test support areas would also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.	If personnel observe sea turtles or marine mammals in potential impact zones, sightings would be reported to appropriate test and NASA personnel for consideration in launch planning, recordkeeping and reporting in accordance with NASA, DOD, and Navy policies and regulations.	NASA, Navy SSP	Within 1 year after the FONSI/FONSH is signed

Table 4-13. Impact Avoidance and Minimization Measures – FE-2 Alternative 2 (Continued)

Location	Measure	Anticipated Benefit	Evaluating Effectiveness	Implementing and Monitoring	Responsibility	Estimated Completion Date
Atlantic BOA Impact Area – FE-2 Alternative 2 (Cont.)						
	Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of WFF. Hazardous material releases would comply with the emergency procedures set out in the WFF and NASA regulations.	Avoid introduction of hazardous chemicals into terrestrial and marine environments.	Determine the rate of successful compliance and incident prevention	Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport, recordkeeping of all incidents and outcomes	Navy SSP	Within 1 year after the FONSI/FONSH is signed
	Publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NTMs) prior to launch	Provide safety and warning to personnel, including private citizens and commercial entities, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with NASA, DOD, and Navy policies and regulations	Navy SSP, NASA	Within 1 year after the FONSI/FONSH is signed
	FTS on the payload would include a failsafe operation	Further ensure the safety of the Bahamas and avoid debris falling on inhabited areas or any protected area, ensure compliance with Space System Software Safety Engineering protocols and U.S. range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with NASA, DOD, and Navy, policies and regulations	Navy SSP, NASA	Within 1 year after the FONSI/FONSH is signed

5.0 Cumulative Impacts

This chapter (1) defines cumulative impacts; (2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts; (3) analyzes the incremental environmental impacts the Proposed Action may have with other actions; and (4) evaluates cumulative impacts potentially resulting from these interactions.

5.1 Definition of Cumulative Impacts

The approach taken in the analysis of cumulative impacts follows the objectives of NEPA, CEQ regulations, and CEQ guidance. Cumulative impacts are defined in 40 CFR Section 1508.7 as the impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

To determine the scope of environmental effects, agencies shall consider cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact document.

In addition, CEQ and USEPA have published guidance addressing implementation of cumulative impact analyses—Guidance on the Consideration of Past Actions in Cumulative Effects Analysis (CEQ 2005) and Consideration of Cumulative Impacts in USEPA Review of NEPA Documents (USEPA 1999). CEQ guidance entitled Considering Cumulative Impacts Under NEPA (CEQ 1997) states that cumulative impact analyses should:

> "…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions...identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Cumulative impacts are most likely to arise when a relationship or synergism exists between a Proposed Action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or in close proximity to the Proposed Action would be expected to have more potential for a relationship than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative impacts, the analysis needs to address the following three questions.

- Does a relationship exist such that affected resource areas of the Proposed Action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?

- If one or more of the affected resource areas of the Proposed Action and another action could be expected to interact, would the Proposed Action affect or be affected by impacts of the other action?
- If such a relationship exists, does an assessment reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

5.2 Scope of Cumulative Impacts Analysis

The scope of the cumulative impacts analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur. For this EA/OEA, the study area would include those areas previously identified in **Chapter 4.0** for each resource area. The time frame for cumulative impacts centers on the timing of the Proposed Action, in this case a single launch and flight test. It also includes the time it might take for effects from the flight test to develop, such as dissolution of tungsten in the soil.

Another factor influencing the scope of cumulative impacts analysis involves identifying other actions to consider. Beyond determining that the geographic scope and time frame for the actions interrelate to the Proposed Action, the analysis employs the measure of “reasonably foreseeable” to include or exclude other actions. For the purposes of this analysis, public documents prepared by federal, state, and local government agencies form the primary sources of information regarding reasonably foreseeable actions. Documents used to identify other actions include notices of intent for EISs and EAs, management plans, land use plans, and other planning related studies.

5.3 Past, Present, and Reasonably Foreseeable Actions

This section focuses on past, present, and reasonably foreseeable future projects at and near SNL/KTF, the Pacific over-ocean flight corridor, and RTS, Kwajalein Atoll for Alternative 1 and WFF, the Atlantic over-ocean flight corridor, and the BOA impact area for Alternative 2. In determining which projects to include in the cumulative impacts analysis, a preliminary determination was made regarding the past, present, or reasonably foreseeable action. Projects included in this cumulative impact analysis are listed in **Tables 5-1** and **5-2** and briefly described in the following subsections.

Table 5-1. NEPA Analyses Performed for Actions Considered in Cumulative Impacts Evaluation Alternative 1

Location	Action	Level of NEPA Analysis Completed
Pacific Missile Range Facility (PMRF)	Past Actions	
	Strategic Target System Launches	EIS/ROD
	Navy Testing and Training	EIS/OEIS/ROD
	Present and Reasonably Foreseeable Future Actions	
	Navy Testing and Training	EIS/OEIS/ROD
	Advanced Hypersonic Weapon Flight Testing	EA/FONSI
	U.S. Air Force Air-Launched Rapid Response (ARRW)	EA/FONSI (Expected)
Over-Ocean Flight Corridor	Past Actions	
	Minuteman III Flight Testing	EA/FONSI
	Advanced Hypersonic Weapon Flight Testing	EA/FONSI
	Present and Reasonably Foreseeable Future Actions	
	Minuteman III Flight Testing	(S)EA/FONSI
	U.S. Air Force ARRW	EA/FONSI (Expected)
USAKA, RMI Illeginni Islet	Past Actions	
	Minuteman III Reentry Vehicle Impacts	EA/FONSI
	U.S. Navy Strategic Systems Programs (SSP) Flight Experiment-1 (FE-1)	EA/FONSI
	Present and Reasonably Foreseeable Future Actions	
	U.S. Air Force ARRW	EA/FONSI (Expected)
USAKA, RMI Offshore	Past Actions	
	Minuteman III Reentry Vehicle Impacts at Kwajalein Missile Impact Scoring System (KMISS)	EA/FONSI
	Present and Reasonably Foreseeable Future Actions	
	Minuteman III Reentry Vehicle Impacts at KMISS	EA/FONSI

Abbreviations: EA = Environmental Assessment; EIS = Environmental Impact Statement; FONSI = Finding of No Significant Impact; NEPA = National Environmental Policy Act; OEIS = Overseas Environmental Impact Statement; ROD = Record of Decision, S = Supplemental

Table 5-2. NEPA Analyses Performed for Actions Considered in Cumulative Impacts Evaluation Alternative 2

Location	Action	Level of NEPA Analysis Completed
Wallops Flight Facility (WFF)	Past Actions	
	Site-Wide Environmental Assessment, WFF	EA/FONSI
	Orbital/Sub-Orbital Program EA	EA/FONSI
	Expansion of the WFF Launch Range	EA/FONSI
	EA for Launch of NASA Routine Payloads	EA/FONSI
	U.S. Navy Atlantic Fleet Training and Testing	EIS/OEIS
	Present and Reasonably Foreseeable Future Actions	
	Orbital/Sub-Orbital Program EA	EA/FONSI
	EA for Launch of NASA Routine Payloads	EA/FONSI
	U.S. Navy Testing of Hypervelocity Projectiles and an Electromagnetic Railgun	EA/FONSI
	U.S. Navy Atlantic Fleet Training and Testing	EIS/OEIS
	NASA WFF Site-wide Programmatic EIS	Final EIS
	U.S. Navy/Army JLC	EA/FONSI (Expected)
Over-Ocean Flight Corridor	Past, Present and Reasonably Foreseeable Future Actions	
	Virginia Capes Range Complex Final EIS/OEIS	Final EIS
	U.S. Navy Atlantic Fleet Training and Testing	EIS/OEIS
	NASA WFF Site-wide Programmatic EIS	Final EIS
	U.S. Navy/Army JLC	EA/FONSI (Expected)
Broad Ocean Area Impact	Past, Present and Reasonably Foreseeable Future Actions	
	U.S. Navy/Army JLC	EA/FONSI (Expected)

Abbreviations: EA = Environmental Assessment; EIS = Environmental Impact Statement; FONSI = Finding of No Significant Impact; NEPA = National Environmental Policy Act; OEIS = Overseas Environmental Impact Statement; ROD = Record of Decision

5.3.1 Past Actions

5.3.1.1 Past Actions Alternative 1

There have been fewer than 10 STARS launches in the last 25 years from KTF. The Advanced Hypersonic Weapon program had a single payload that previously impacted at Illeginni Islet following a launch using a STARS booster from SNL/KTF. The most recent STARS launch from SNL/KTF with an impact at Illeginni Islet was in 2017 for FE-1. Other past actions have included testing and training for Navy and other Government agencies. Actions have included RDT&E activities in the HRC, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises.

MMIII ICBM missile reentry vehicles have routinely impacted at KMISS and Illeginni Islet in the past. An EA with a FONSI was completed for MMIII modifications in 2004, and a Supplemental EA is in process for additional missile configuration updates (2019). Both beryllium and depleted uranium remain in the soil at Illeginni Islet from MMIII land impacts.

Kwajalein Echo Pier repairs improved the ability to receive and ship goods and mission-related items at USAKA. The KMISS refurbishment replaced cabling and hydrophones to re-establish the accuracy required for ICBM testing and improve data collection for other programs that may have impacts within the KMISS area.

5.3.1.2 Past Actions Alternative 2

Past actions include launch and related NASA operations at WFF and non-NASA actions nearby that have been covered by numerous EAs and most recently in the Final WFF Site-wide Programmatic EIS. Numerous orbital and suborbital launches have been conducted each year from WFF.

5.3.2 Present and Reasonably Foreseeable Actions

5.3.2.1 Present and Reasonably Foreseeable Future Actions Alternative 1

MMIII ICBM missile reentry vehicles are planned to impact at KMISS; land impacts are no longer proposed for that program.

The actions associated with testing and training for Navy and other Government agencies are still occurring and are expected to occur well into the future. The actions that include RDT&E activities in the HRC, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises are also still occurring and are expected to continue. The U.S. Air Force Air-Launched Rapid Response Weapon (ARRW) flight test is expected to be similar to FE-1 and FE-2 with a launch from SNL/KTF and impact at Illeginni Islet.

5.3.2.2 Present and Reasonably Foreseeable Future Actions Alternative 2

Present and reasonably foreseeable launches include a maximum of 18 orbital-class launches per year from MARS Launch Complex 0 distributed among several launch pads, and up to 60 launches of sounding rockets/suborbital rockets. The U.S. Navy/Army JLC is expected to be similar to FE-1 and FE-2 and could launch from Wallops with an impact in the BOA.

Military readiness training and research, development, testing, and evaluation activities are conducted within the Atlantic Fleet Training and Testing study area (U.S. Navy 2018a). As it relates to this EA, the Atlantic Fleet Training and Testing study area includes the VACAPES Range Complex.

5.4 Cumulative Impact Analysis

For most resources included for analysis, quantifiable data are not available, and a qualitative analysis was undertaken. In addition, where an analysis of potential environmental effects for future actions has not been completed, assumptions were made regarding cumulative impacts related to this EA/OEA where possible. The analytical methodology presented in **Chapter 4.0**, which was used to determine potential impacts to the various resources analyzed in this document, was also used to determine cumulative impacts.

5.4.1 Pacific Missile Range Facility

5.4.1.1 Description of Geographic Study Area

The study area includes SNL/KTF and PMRF on the western coast of Kauai in the Hawaiian Islands. SNL/KTF has been an active rocket launching facility since 1962. Most of these launches are targeted to various areas of the South Pacific, including USAKA in the RMI.

5.4.1.2 Relevant Past, Present, and Future Actions

The launching of missiles both from PMRF and ships offshore would continue as part of the RDT&E and training mission of PMRF. Several DOD branches would continue to launch missiles that are similar in size and potential impacts as the FE-2 and STARS booster.

5.4.1.3 Cumulative Impact Analysis

The advanced planning and coordination with the FAA regarding scheduling of special use airspace, and coordination of the proposed FE-2 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace. The FE-2 flight test is a discrete event. Therefore, implementation of the Proposed Action would not result in cumulative impacts to airspace.

PMRF and SNL/KTF SOPs would be followed for launch site preparation, booster handling, and all hazardous operations. PMRF Missile Flight Analysis, Ground Safety, Range Safety, Ocean Clearance, Transportation Safety, and Fire and Crash Safety procedures would be followed to ensure the safety of workers and members of the public. The FE-2 flight test is a discrete event. Therefore, implementation of the Proposed Action would not result in cumulative impacts to health and safety.

Impacts from the FE-2 launch when combined with various planned KTF launches per would not create cumulative impacts to air quality because of the limited quantity and prompt dispersion of exhaust products.

Based on previous analysis and sampling for exhaust constituents, the Proposed Action activities, when added to other planned launces at KTF would not adversely affect water resources. Therefore, implementation of the Proposed Action would not result in cumulative impacts to water resources.

Proposed Action activities should have negligible cumulative impact to terrestrial and marine biological resources at PMRF. The test vehicle launch is a discrete, one-time event, and no interaction is expected between launch activities of the proposed action and other past, present, or future actions. The ROI consists of a previously disturbed area, and there is no evidence of bioaccumulation or long-term impacts of chemicals associated with launches from PMRF. While the potential exists for disturbance from human activity to result in cumulative impacts to terrestrial wildlife, the launch site at PMRF is in an area of routine human activity, and the limited amount and time frame of human activity for the Proposed Action is not expected to contribute to any cumulative impacts. As discussed in **Section 4.1.3**, Newell's shearwaters have the potential to be impacted by artificial lighting from various activities and given the small population size of this species, any affects are important to consider. The Proposed Action is not likely to impact Newell's shearwaters or other bird species and is not expected to contribute to cumulative impacts to Newell's shearwaters.

KTF supports a variety of occasional missile launches that produce high-intensity, short-duration sound events. Data collected in the nearest town of Kekaha indicated that levels were no louder than noise generated from passing vehicles on a nearby highway. No noise-sensitive land uses are affected by existing noise levels. The FE-2 launch when combined with other discrete missile launch events would not result in cumulative noise impacts.

No past, present, or reasonably foreseeable actions has been identified that might interact with the affected resource areas of the Proposed Action and result in significant impacts.

5.4.2 Pacific Ocean Flight Corridor

5.4.2.1 Description of Geographic Study Area

The over-ocean flight corridor between KTF and RTS is the geographic study area for cumulative impacts from FE-2 and other relevant past, present, and future actions. There has been no known significant change in air quality or biological resources within the over-ocean flight corridor.

5.4.2.2 Relevant Past, Present, and Future Actions

MMIII ICBM missile testing between Vandenberg AFB, California, and RTS has occurred and will continue to occur on an annual basis. Up to four MMIII missile flight tests would be conducted annually through 2030, and four Fuze Modernization flight tests would occur over a 4-year period. EAs with FONSIs were prepared for the MMIII missile testing in 2001 and 2004. An additional Supplemental EA is in process for the Modification and Fuze Modernization flight tests through 2030. The trajectory for these flights partially overlaps the over-ocean flight corridor between KTF and RTS.

In November 2011, the USASMDC/ARSTRAT performed a test flight of the Advanced Hypersonic Weapon concept. The test vehicle was launched from the KTF to RTS. The flight path for this flight test was the same as the over-ocean flight corridor between KTF and RTS for FE-2. In October of 2017 the U.S. Navy SSP performed the FE-1 flight test with essentially the same over-ocean flight corridor between KTF and RTS.

5.4.2.3 Cumulative Impact Analysis

Although there have been several missile flight tests within the same or part of the same over-ocean flight corridor as FE-2, most of these flight test used the STARS boosters or a launch vehicle of comparable size. As shown in **Section 4.2.1.2**, the STARS booster is relatively small, and on a global scale the level of emissions from each STARS booster would not be statistically significant. Because the emissions of hydrogen chloride, aluminum oxide, and nitrogen oxides from each launch of a STARS booster would be relatively small, the air volume over which these emissions are spread is large, the emissions are dispersed by stratospheric winds, and the length of time between discrete launches is measured in months or years, these missile flight tests within the over-ocean flight corridor would not have a significant cumulative impact. Therefore, cumulative impacts from the FE-2 flight test and the other evaluated flight tests would not be expected to have a significant impact on the upper atmosphere or stratospheric ozone depletion.

Impacts to biological resources within the over-ocean flight corridor for past and future missile flight tests were not identified as being significant. As with the Proposed Action, the potential for impacts from noise or direct contact from boosters or other missile components for these past, present, and future activities was extremely low given the size of the area, the size of missile components, and the low densities of marine species across the corridor. None of these actions are expected to interact to produce cumulative effects for biological resources.

No past, present, or reasonably foreseeable actions have been identified in the over-ocean flight corridor that might interact with the affected resource areas of the FE-2 Proposed Action and result in significant cumulative impacts.

5.4.3 U.S. Army Kwajalein Atoll

5.4.3.1 Illeginni Islet

5.4.3.1.1 Description of Geographic Study Area

The northwest end of Illeginni Islet is the geographic study area for cumulative impacts from FE-2 and other relevant past, present, and future actions. There has been no significant change in cultural resources, biological resources, noise, public health and safety, and hazardous materials and wastes at Illeginni Islet. Although there is beryllium and depleted uranium in the soil at Illeginni Islet from past MMIII reentry vehicles impacts, analytical results from 2013 indicate the levels are below USEPA residential regulatory limits. (Robison et al. 2013) However, results from 2018 (LLNL 2018) showed some samples exceeded the 1.8 mg/kg RSL. The U.S. Army Public Health Command Fish Study (USAPHC 2014) noted that "unacceptable cancer risk for Marshallese adults at Illeginni [harbor] is attributable to the pesticide, chlordane." Chlordane is a pesticide used to treat wood and wood structures for control of pests, particularly termites, and is not associated with previous missile flight tests impacting at Illeginni Islet.

Soils and groundwater at Illeginni Islet were analyzed for tungsten in September 2018. Results of these tests indicate the tungsten level in soils is below both the Residential and Commercial RSLs. Tungsten levels in soils following FE-2 are not expected to increase substantially and are expected to remain below the RSLs. The tungsten level in groundwater is above the RSL for potable water. However, the groundwater at Illeginni Islet is not potable.

5.4.3.1.2 Relevant Past, Present, and Future Actions

MMIII ICBM missile testing between Vandenberg AFB, California, and RTS has occurred and will continue to occur on an annual basis. Up to four MMIII missile flight tests would be conducted annually through 2030, and four Fuze Modernization flight tests would occur over a 4-year period. In 2016, USAFGSC determined that land impacts at Illeginni Islet would no longer occur. EAs with FONSIs were prepared for the MMIII missile testing in 2001 and 2004. An additional Supplemental Environmental Assessment is in process for the Modification and Fuze Modernization flight tests through 2030. Past reentry vehicles impacts occurred on Illeginni Islet; future reentry vehicles impacts would only occur at KMISS. For past flight tests, the impact crater was screened for debris and all other visible debris from around the impact was manually recovered and disposed of in accordance with the UES.

The Preferred Alternative impact at Illeginni Islet is the same for FE-2 as it was for FE-1.

5.4.3.1.3 Cumulative Impact Analysis

MMIII ICBM missile testing from Vandenberg AFB, California, to Illeginni Islet has occurred in the past. Beryllium and depleted uranium from past MMIII reentry vehicles impacts remain in the soil at Illeginni Islet; analytical results indicate the levels are below USEPA residential regulatory limits (Robison et al. 2013). No future MMIII impacts are planned for Illeginni Islet. MMIII flight tests have been and will continue to be conducted in accordance with biological opinions from NMFS and USFWS, in addition to program specific DEPs and the UES.

The Advanced Hypersonic Weapon flight was conducted in accordance with the Illeginni Impacts DEP and the UES. Payload impacts were less than those of the MMIII reentry vehicles (USASMDC/ARSTRAT 2011). There was no significant impact to resources at Illeginni Islet from the Advanced Hypersonic Weapon flight test.

A 2008 study of geochemical parameters influencing tungsten mobility in soils (Bednar et al. 2008) found that dissolved tungsten reached equilibrium in soil after approximately 48 hours and mobility decreased by approximately one-half within a 4-month period. The “long term known impact or potential risk” is not conclusively identified in peer reviewed literature. Based on the quantities of tungsten in FE-1 and planned for FE-2, the bench study and model results indicate levels of tungsten in Illeginni Islet soil would be below the USEPA Residential RSLs (LLNL 2017) for soil from the end of the flight test to 25 years out, the period for which the model was run.

Soil sampling prior to and after FE-1 shows tungsten concentrations were all below the Residential RSL of 63 mg/kg and well below the Commercial RSL of 930 mg/kg. FE-2 is not expected to result in an increased tungsten level above the RSLs. Although the groundwater at Illeginni Islet shows tungsten levels above the RSL, the groundwater is not potable under the UES standards. With the reasonably foreseeable land use at Illeginni Islet as a test range and with the groundwater not being potable, further risk-based analysis is not planned at this time. If the land use would change, the site would be evaluated under the UES Restoration requirements to determine if the new land use required institutional controls or remediation.

The ARRW test with airborne drop and ignition, and termination impact on Illeginni Islet would have the potential for cumulative impacts. The ARRW would carry tungsten similar to that planned for FE-2. The addition of the tungsten from ARRW with that of FE-1 and FE-2 has the potential for increased levels of tungsten in the soils and groundwater. Based on the modeling results and the soil sampling and analysis, the concentration of tungsten in the soil would still be below residential and industrial RSLs. The concentration of tungsten in the groundwater may exceed Residential RSLs; however, this area is not designated as potable drinking water.

The FE-2 Proposed Action is not expected to have significant or lasting impacts on terrestrial biological resources at Illeginni Islet. With the possible exception of tungsten accumulation, discussed above, no interactions are expected which would lead to cumulative impacts to terrestrial biological resources. As with MMIII and FE-1, the FE-2 Proposed Action has the potential to affect marine biological resources including seven consultation coral species, three consultation mollusk species, and the humphead wrasse. Marine habitats would not be targeted; however, the worst-case of scenario of a shoreline strike for any of these actions has the potential to affect marine biological resources. While each of these actions has the potential to affect marine biological resources, there would be no interactive effects that would result in additional impacts to marine resources greater than those analyzed for an individual action. Therefore, FE-2 is not expected to contribute to any cumulative biological resource impacts.

No other past, present, or reasonably foreseeable actions have been identified at Illeginni Islet that might interact with the affected resource areas of the FE-2 Proposed Action and result in significant cumulative impacts.

5.4.3.2 Offshore Waters – Southwest and Northeast

5.4.3.2.1 Description of Geographic Study Area

The Offshore Waters impact alternatives are in deep ocean regions southwest of Illeginni Islet and within the KMISS area southeast of Gagan Islet. MMIII ICBM missile testing between Vandenberg AFB, California, and RTS has occurred.

5.4.3.2.2 Relevant Past, Present, and Future Actions

MMIII ICBM missile testing between Vandenberg AFB, California, and KMISS has occurred and will continue to occur annually. KMISS is the selected site for all future impacts for MMIII.

The KMISS refurbishment replaced failing cabling and hydrophones to re-establish the accuracy required for ICBM testing and improve data collection for programs that may have impacts within the KMISS area. At depth, the ocean bottom consists of soft silt sediment which, when disturbed, tends to rapidly settle from the water column due to a high composition of sand. Biological resource impacts were managed through consultation and coordination with NMFS and USFWS. Although one alternative impact location for the FE-2 flight test is within the KMISS, the Preferred Alternative is to impact on land.

5.4.3.2.3 Cumulative Impact Analysis

The KMISS refurbishment improved data collection for programs that may have impacts within the KMISS area. Although this contributes to the success of missile flight testing, the environmental impact of cable and hydrophone replacements in deep waters would not contribute to cumulative impacts from two U.S. Navy SSP flight experiments. Biological resource impacts from the refurbishment were managed through consultation and coordination with NMFS and USFWS. The bench study and model results (LLNL 2017) indicate very slow dissolution and passivation (i.e., natural chemical encapsulation) of tungsten from FE-1 and FE-2 may occur in sea water. Although one alternative impact location for the FE-2 flight test is within the KMISS, the Preferred Alternative is to impact on land.

While the effects of tungsten alloys in ecosystems are largely unknown, as noted in the USEPA Technical Fact Sheet for tungsten (2014), with no known studies of marine ecosystems, there are some studies that indicate tungsten exposure may have health impacts. However, all parts would be expected to sink to the sea floor. Considering the small quantities of hazardous materials contained in the batteries and the dilution and mixing capabilities of the ocean waters, the battery materials released during payload impact should be of little consequence.

No past, present, or reasonably foreseeable actions have been identified in the KMISS or southwest BOA that might interact with the affected resource areas of the FE-2 Proposed Action and result in significant cumulative impacts.

5.4.4 NASA Wallops Flight Facility

5.4.4.1 Description of Geographic Study Area

The geographic study area includes the missile receiving, assembly, and launch facilities analyzed in **Chapter 4.0**.

5.4.4.2 Relevant Past, Present, and Future Actions

The Proposed Action identified in the WFF Site Wide Programmatic EIS would result in a maximum of 18 orbital-class launches per year from MARS Launch Complex 0 distributed among several launch pads. Site improvements would include minor modifications to the boat dock on the north end of Wallops Island, construction of a payload processing facility, construction of a dedicated payload fueling facility, construction of new roads and minor upgrades to existing roads, and minor interior modifications to launch support facilities. Additional launches of sub-orbital and sounding rockets would also occur. The U.S. Navy FE-3 flight test is expected to be similar to FE-1 and FE-2 and could launch from Wallops with an impact in the BOA although specific information is currently not available.

5.4.4.3 Cumulative Impact Analysis

Proposed Action activities are expected to have negligible cumulative impact to terrestrial and marine biological resources at WFF. The test vehicle launch is a discrete, one-time event, and no interaction is expected between launch activities of the proposed action and other past, present, or future actions. The ROI consists of a previously disturbed area, and there is no evidence of bioaccumulation or long-term impacts of chemicals associated with launches from WFF. While the potential exists for disturbance from human activity to result in cumulative impacts to terrestrial wildlife, the launch site at WFF is in an area of routine human activity and the limited amount and time frame of human activity for the Proposed Action is not expected to contribute to any cumulative impacts.

With the recent expansion of R-6604 and ongoing coordination with air traffic control agencies for each launch, negligible cumulative impacts to airspace are anticipated from the single FE-2 launch and flight test.

Negligible cumulative impacts to health and safety are anticipated from the single FE-2 launch and flight test. Expansion of the existing permanent danger zone as proposed by the USACE would further increase safety.

Established procedures for the managing of hazardous materials, toxic substances, and hazardous waste at WFF would continue to be followed. Any potential increase in the amount of hazardous materials used or hazardous waste generated would continue to be managed using existing procedures, resulting in negligible cumulative impacts to hazardous material / hazardous waste management.

5.4.5 Atlantic Broad Ocean Area

5.4.5.1 Description of Geographic Study Area

Includes the missile flight corridor, booster drop zones, and impact areas analyzed in **Chapter 4.0**.

5.4.5.2 Relevant Past, Present, and Future Actions

The U.S. Navy Atlantic Fleet Training and Testing EIS/OEIS evaluated the potential environmental effects associated with military readiness training and research, development, testing, and evaluation activities conducted within the VACAPES Range Complex. The EIS/OEIS was prepared to renew and combine current regulatory permits and authorizations; address evolving training and testing requirements; update existing analyses with the best available science and most current acoustic analysis methods to evaluate the potential effects of training and testing activities on the marine environment; and obtain those permits and authorizations necessary to support force structure changes and emerging and future training and testing requirements, including those associated with the introduction of new ships, aircraft, and weapons systems (U.S. Navy 2018a).

In its November 2013 Record of Decision (ROD), the Navy selected to implement the EIS/OEIS Proposed Action Alternative 2 which added additional types of training and testing activities, adjusted the location and levels of current activities, and allowed for range enhancements and infrastructure requirements (U.S. Navy 2018a). The Atlantic Fleet Training and Testing EIS/OEIS will be renewed every 5 years; the next phase will cover years 2019 to 2024. The Navy released the Atlantic Fleet Training and Testing Final EIS/OEIS in September 2018 (U.S. Navy 2018a).

Launch vehicles discussed in the Atlantic Fleet Training and Testing EIS/OEIS include booster drops and missile flights within the flight corridor used for FE-2.

The U.S. Navy FE-3 flight test is expected to be similar to FE-1 and FE-2 and could launch from Wallops with an impact in the BOA although specific information is currently not available.

5.4.5.3 Cumulative Impact Analysis

There have been and will continue to be several missile flight tests within the same or part of the same broad ocean area as FE-2. These flight tests use boosters and launch vehicles smaller, comparable, and larger than the FE-2 STARS boosters and launch vehicle. As shown in **Section 4.2.1.2**, the STARS booster is relatively small and on a global scale the level of emissions from the STARS booster would not be statistically significant. Because the emissions of hydrogen chloride, aluminum oxide, and nitrogen oxides from this single launch of a STARS booster would be relatively small, the air volume over which these emissions are spread is large, the emissions are dispersed by stratospheric winds, and the length of time between discrete launches similar in size to the FE-2 are measured in weeks, these missile flight tests within the broad ocean area flight corridor would not have a significant cumulative impact. Therefore, cumulative impacts from the FE-2 flight test and the other evaluated flight tests would not be expected to have a significant impact on the upper atmosphere or stratospheric ozone depletion.

Impacts to biological resources within the broad ocean area for the referenced missile flight tests were not identified as being significant. The potential for impacts from noise or direct contact from boosters or other missile components was extremely low given the size of the area, the size of missile components, and the low densities of marine mammals across the corridor. The FE-2 flight test is not expected to significantly impact marine biological resources, and no interactions between this and past, present, or future actions have been identified. The potential for impacts from noise or direct contact from boosters or payload components for the FE-2 action is extremely low given the size of the area, the size of components, and the low densities of marine organisms across the BOA. No interactions that would produce cumulative effects for biological resources are expected.

There are no significant impacts anticipated on the broad ocean area from hazardous materials and waste for the FE-2 flight test. No other activities have been identified within the broad ocean area that would combine or interact with the FE-2 flight test to result in cumulative impact related to hazardous materials and waste.

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6.0 Other Considerations Required by NEPA

6.1 Consistency with Other Federal, State, and Local Laws, Plans, Policies, and Regulations

In accordance with 40 CFR Section 1502.16(c), analysis of environmental consequences shall include discussion of possible conflicts between the Proposed Action and the objectives of federal, regional, state, and local land use plans, policies, and controls. **Table 6-1** identifies the principal federal and state laws and regulations that are applicable to the Proposed Action and indicates if the Proposed Action would be in compliance with these laws and regulations.

6.1.1 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898)

An Environmental Justice analysis is included in this document to comply with the intent of EO 12898, and U.S. Army and DOD guidance. The EO states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." In addition, the EO requires that minority and low-income populations be given access to information and opportunities to provide input to decision making on federal actions.

This EA has identified no human health, environmental, or other effects by the Proposed Action that would result in disproportionately high or adverse effect on minority or low income-populations in the areas evaluated. The Proposed Action activities also would be conducted in a manner that would not exclude persons from participating in, deny persons the benefits of, or subject persons to discrimination because of their race, color, national origin, or socioeconomic status.

6.1.2 Federal Actions to Address Protection of Children from Environmental Health Risks and Safety Risks (EO 13045, as Amended by EO 13229 and 13296)

This EA has not identified any environmental health and safety risks that may disproportionately affect children, in compliance with EO 13045, as amended by EO 13229 and 13296.

Table 6-1. Principal Federal and State Laws Applicable to the Proposed Action

Federal, State, Local, and Regional Land Use Plans, Policies, and Controls	Status of Compliance
National Environmental Policy Act (NEPA) (42 USC Section 4321 et seq.); CEQ NEPA implementing regulations (40 CFR Parts 1500-1508; Navy procedures for Implementing NEPA (32 CFR Part 775 and OPNAVINST 5090.1E)	Compliant
Clean Air Act (42 USC Section 7401 et seq.)	Compliant
Clean Water Act (33 USC Section 1251 et seq.)	Compliant
Coastal Zone Management Act (16 USC Section 1451 et seq.)	Compliant
National Historic Preservation Act (Section 106, 16 USC Section 470 et seq.)	Compliant
Endangered Species Act (16 USC Section 1531 et seq.)	Compliant
Marine Mammal Protection Act (16 USC Section 1361 et seq.)	Compliant
Migratory Bird Treaty Act (16 USC Sections 703-712)	Compliant
Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 USC Section 1801 et seq.)	Compliant
U.S. Public Law 108-188, Compact of Free Association Amendments Act of 2003	Compliant
Executive Order 11988, Floodplain Management	Compliant
Executive Order 12088, Federal Compliance with Pollution Control Standards	Compliant
Executive Order 12114, Environmental Effects Abroad of Major Federal Actions	Compliant
Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations	Compliant
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	Compliant
Executive Order 13089, Coral Reef Protection	Compliant
Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management	Compliant
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	Compliant
Executive Order 13696, Planning for Federal Sustainability in the Next Decade	Compliant

6.2 Coastal Zone Management

The federal CZMA of 1972 establishes a federal–state partnership to provide for the comprehensive management of coastal resources. Coastal states and territories develop site-specific coastal management programs based on enforceable policies and mechanisms to balance resource protection and coastal development needs. The Hawai`i CZM program lays out the policy to guide the use, protection, and development of land and ocean resources within the state's coastal zone. Under the Act, federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination or a Negative Determination. Any federal agency proposing to conduct or support an activity within or outside the coastal zone that will affect any land or water use or natural resource of the coastal zone is required to do so in a manner consistent with the CZMA or applicable state coastal zone program to the maximum extent practicable. However, federal lands, which are "lands the use of which is by law subject solely to the discretion of…the Federal Government, its officers, or agents," are statutorily excluded from the state's "coastal zone."

However, if the proposed federal activity affects coastal resources or uses beyond the boundaries of the federal property (i.e., has spillover effects), the CZMA Section 307 federal consistency requirement applies. As a federal agency, the Navy is required to determine whether its proposed activities would affect the coastal zone. This takes the form of either a Negative Determination or a Consistency Determination.

Military testing and training at PMRF have been included in a list of U.S. Navy de minimis activities under the CZMA. The Hawai`i CZM Program determined the listed activities "are expected to have insignificant direct or indirect (cumulative and secondary) coastal effects and should not be subject to further review by the Hawai`i CZM program." (Mayer 2009).

Appendix G of the NASA WFF Site-wide PEIS provides the Commonwealth of Virginia with NASA's Consistency Determination under CZMA Section 307(c)(1) and Title 15 CFR Part 930, Subpart C, for implementation of the Proposed Action analyzed in the NASA WFF Site-wide PEIS. The information in this Consistency Determination is provided pursuant to 15 CFR Section 930.39. The FE-2 flight test is well within the impacts envelope for all resources analyzed and is within the NASA Consistency Determination.

6.3 Relationship Between Short-Term Use of the Environment and Long-Term Productivity

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one site reduces future flexibility in pursuing other options, or that using a parcel of land or other resources often eliminates the possibility of other uses at that site.

Operations related to FE-2 would not significantly impact the long-term natural resource productivity in any of the Proposed Action areas. The Proposed Action would not result in any impacts that would significantly reduce environmental productivity or permanently narrow the range of beneficial uses of the environment.

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Ebeye, MH

U.S. Army Corps of Engineers, Honolulu District (USACE)
Ft. Shafter, HI

U.S. Army Garrison–Kwajalein Atoll (USAG-KA)
USAG-KA Directorate of Public Works
APO AP

US Environmental Protection Agency (USEPA), Region IX
Pacific Islands Office
San Francisco, CA

U.S. Fish and Wildlife Service (USFWS)
Pacific Islands Fish and Wildlife Office
Honolulu, HI

LIBRARIES AND REPOSITORIES

Grace Sherwood Library
Kwajalein, MH

Roi-Namur Library
Roi-Namur, MH

Republic of the Marshall Islands Environmental Protection Authority
Office Lobby
Delap, Majuro, MH

Republic of the Marshall Islands Environmental Protection Authority
Office Lobby
Ebeye, MH

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10.0 Persons Contacted List

The following agencies/people were contacted during the development of this EA/OEA:

USFWS – Dan A. Polhemus, PhD

NMFS – Steven P. Kolinski, PhD

USEPA – Mr. John McCarroll

USACE – Mr. Kanalei Shun

RMIEPA – Ms. Moriana Phillip

USAKA-RTS – Mr. Derek Miller

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A

Agency Correspondence

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

REPLY TO
ATTENTION OF

Environmental Division 7 August 2019

Grace Sherwood Library
P.O. Box 23
APO, AP 96555

SUBJECT: Draft Environmental Assessment / Overseas Environmental Assessment for the Navy Flight Experiment-2 (FE-2) and Draft Finding of No Significant Impact / Finding of No Significant Harm

TO WHOM IT MAY CONCERN:

Please provide space in your library or offices for public access to the enclosed *Environmental Assessment / Overseas Environmental Assessment for the Navy Flight Experiment-2 (FE-2) and Draft Finding of No Significant Impact / Finding of No Significant Harm (FONSI/FONSH)*. The Draft Environmental Assessment/Overseas Environmental Assessment and Draft FONSI/FONSH are also available on the internet at www.FE-2-EAOEA.com.

The public comment period is from August 11, 2019 to September 12, 2019. Comments should be emailed or postmarked no later than September 12, 2019. Email comments to Comments@FE-2-EAOEA.com, or mail comments to:

U.S. Army Space and Missile Defense Command/Army Forces Strategic Command
Attn.: SMDC-EN (Mr. Mark Hubbs) P.O. Box 1500, Huntsville, AL 35807-3801

Sincerely,

HASLEY.DAVID.C.1230984308 Digitally signed by HASLEY.DAVID.C.1230984308 Date: 2019.07.24 13:32:27 -05'00'

DAVID C. HASLEY
UES Co-Chairperson

Enclosure

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

REPLY TO
ATTENTION OF

Environmental Division 7 August 2019

Roi-Namur Library
P.O. Box 23
Roi-Namur, Marshall Islands
APO, AP 96555

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UES Co-Chairperson

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

REPLY TO
ATTENTION OF

Environmental Division 22 August 2019

Republic of the Marshall Islands Environmental Protection Authority
Attn: Ms. Moriana Phillip
General Manager
P.O. Box 1322
Majuro, MH 96960-1322

Dear Ms. Phillip:

The U.S. Army Space and Missile Defense Command / Army Forces Strategic Command (USASMDC/ARSTRAT) is assisting the Office of the Under Secretary of Defense for Research and Engineering, which has designated the Department of the Navy (U.S. Navy) Strategic Systems Programs (SSP) as the lead agency for the Proposed Action for Flight Experiment-2 (FE-2).

The U.S. Navy SSP proposes to conduct a developmental flight test as described in the attached Environmental Assessment / Overseas Environmental Assessment (EA/OEA). The U.S. Navy, along with the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) as cooperating agencies, and with the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) as participating agency, has prepared the EA/OEA in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and Navy regulations for implementing NEPA. The Proposed Action entails one experimental flight test to take place within the first half of fiscal year (FY) 2020 after the Finding of No Significant Impact / Finding of No Significant Harm (FONSI/FONSH) is signed, if approved.

Please find enclosed the Draft FE-2 EA/OEA and Draft FONSI/FONSH, provided for your review and comment between August 26 and September 26, 2019. A comment form is also enclosed for your use in recording your comments, corrections, or suggestions. Your comments are due by September 26, 2019.

A copy of the Draft EA/OEA and Draft FONSI/FONSH is also being provided for the office lobby.

A Notice of Availability of the Draft EA/OEA and Draft FONSI/FONSH will be published in the local newspapers in Kwajalein and the Republic of the Marshall Islands on or before August 24, 2019. The documents will also be available at public libraries in Kwajalein and Republic of the Marshall Islands Environmental Protection Authority office in Ebeye. Additionally, the Draft EA/OEA and Draft FONSI/FONSH is accessible on the internet at www.FE-2-EAOEA.com.

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I am also providing a transmittal letter, the Draft EA/OEA and Draft FONSI/FONSH, for comment, to Dr. Steve Kolinski, National Marine Fisheries Services; Mr. Kawa Jatios, RMI Environmental Protection Authority Ebeye; Mr. Derek Miller, USAKA/RTS Environmental Management Office; Mr. Kanalei Shun, U.S. Army Corps of Engineers; Dr. Dan Polhemus, U.S. Fish and Wildlife Service; and Mr. John McCarroll, U.S. Environmental Protection Agency.

If you have any questions or concerns, please contact Mr. Mark Hubbs, Environmental Protection Specialist, USASMDC/ARSTRAT, Environmental Division, (256) 955-2608, or email him at mark.e.hubbs.civ@mail.mil. Email your comments to him or postmark written comments by 26 September 2019 to Mark Hubbs, USASMDC/ARSTRAT, ATTN: SMDC-EN, P.O. Box 1500, Huntsville, AL 35807-3801.

Sincerely,

HASLEY.DAVID.C.1230984308 Digitally signed by HASLEY.DAVID.C.1230984308 Date: 2019.08.22 14:00:35 -05'00'

DAVID C. HASLEY
UES Co-Chairperson

Enclosure

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

REPLY TO
ATTENTION OF

Environmental Division 22 August 2019

Republic of the Marshall Islands Environmental Protection Authority
Attn: Mr. Damiee Riklon
P.O. Box 5223
Ebeye, MH 96970

Dear Mr. Damiee Riklon:

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If you have any questions or concerns, please contact Mr. Mark Hubbs, Environmental Protection Specialist, USASMDC/ARSTRAT, Environmental Division, (256) 955-2608, or email him at mark.e.hubbs.civ@mail.mil. Email your comments to him or postmark written comments by 26 September 2019 to Mark Hubbs, USASMDC/ARSTRAT, ATTN: SMDC-EN, P.O. Box 1500, Huntsville, AL 35807-3801.

Sincerely,

DAVID C. HASLEY
UES Co-Chairperson

Enclosure

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

REPLY TO
ATTENTION OF

SMDC-ENE 22 August 2019

MEMORANDUM FOR U.S. Army Kwajalein Atoll–Reagan Test Site, Environmental Management Office/Mr. Derek Miller

SUBJECT: Draft Environmental Assessment/Overseas Environmental Assessment for the Navy Flight Experiment-2 (FE-2) and Draft Finding of No Significant Impact / Finding of No Significant Harm

1. The U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) is assisting the Office of the Under Secretary of Defense for Research and Engineering, which has designated the Department of the Navy (U.S. Navy) Strategic Systems Programs (SSP) as the lead agency for the Proposed Action for Flight Experiment-2 (FE-2).

2. The U.S. Navy SSP proposes to conduct a developmental flight test as described in the attached Environmental Assessment / Overseas Environmental Assessment (EA/OEA). The U.S. Navy, along with the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) as cooperating agencies, and with the U.S. Army Space and Missile Defense Command / Army Forces Strategic Command (USASMDC/ARSTRAT) as participating agency, has prepared the EA/OEA in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and Navy regulations for implementing NEPA. The Proposed Action entails one experimental flight test to take place within the first half of fiscal year (FY) 2020 after the Finding of No Significant Impact/Finding of No Significant Harm (FONSI/FONSH) is signed, if approved.

3. Please find enclosed the Draft FE-2 EA/OEA and Draft FONSI/FONSH, provided for your review and comment between August 26 and September 26, 2019. A comment form is also enclosed for your use in recording your comments, corrections, or suggestions. Your comments are due by September 26, 2019.

4. A copy of the Draft EA/OEA and Draft FONSI/FONSH is also being provided for Mr. Gus Aljure.

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Enclosure

DAVID C. HASLEY
UES Co-Chairperson

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

REPLY TO
ATTENTION OF

SMDC-ENE 22 August 2019

MEMORANDUM FOR U.S. Army Corps of Engineers, Honolulu District, CEPOH-PP-E/Mr. Kanalei Shun, Building 252, Fort Shafter, HI 96858-5440

SUBJECT: Draft Environmental Assessment/Overseas Environmental Assessment for the Navy Flight Experiment-2 (FE-2) and Draft Finding of No Significant Impact / Finding of No Significant Harm

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DAVID C. HASLEY
UES Co-Chairperson

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

REPLY TO
ATTENTION OF
Environmental Division

22 August 2019

Dr. Steven P. Kolinski
National Marine Fisheries Service
Pacific Island Regional Office
NOAA IRC NMFS PIRO HCD
1845 Wasp Blvd., Building 176
Honolulu, HI 96818

Dear Dr. Kolinski:

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DAVID C. HASLEY
UES Co-Chairperson

Enclosure

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

REPLY TO
ATTENTION OF
Environmental Division

22 August 2019

Dr. Dan Polhemus
U.S. Fish and Wildlife Service
Pacific Island Fish and Wildlife Office
300 Ala Moana Blvd., Room 3-122
Honolulu, HI 96850

Dear Dr. Polhemus:

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I am also providing a transmittal letter, the Draft EA/OEA and Draft FONSI/FONSH, for comment, to Mr. Derek Miller, USAKA/RTS Environmental Management Office; Ms. Moriana Phillip, RMI Environmental Protection Authority Majuro; Mr. Kawa Jatios, RMI Environmental Protection Authority Ebeye; Mr Kanalei Shun, U.S. Army Corps of Engineers; Dr. Dan Polhemus, U.S. Fish and Wildlife Service; and Mr. John McCarroll, U.S. Environmental Protection Agency.

If you have any questions or concerns, please contact Mr. Mark Hubbs, Environmental Protection Specialist, USASMDC/ARSTRAT, Environmental Division, (256) 955-2608, or email him at mark.e.hubbs.civ@mail.mil. Email your comments to him or postmark written comments by 26 September 2019 to Mark Hubbs, USASMDC/ARSTRAT, ATTN: SMDC-EN, P.O. Box 1500, Huntsville, AL 35807-3801.

Sincerely,

HASLEY.DAVID.C.1230984308 Digitally signed by HASLEY.DAVID.C.1230984308 Date: 2019.08.22 14:04:27 -05'00'

DAVID C. HASLEY
UES Co-Chairperson

Enclosure

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

REPLY TO
ATTENTION OF
Environmental Division

22 August 2019

John McCarroll
U.S. Environmental Protection Agency, Region IX
Pacific Island Office
75 Hawthorne Street (CED-6)
San Francisco, CA 94105

Dear Mr. McCarroll:

The U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) is assisting the Office of the Under Secretary of Defense for Research and Engineering, which has designated the Department of the Navy (US Navy) Strategic Systems Programs (SSP) as the lead agency for the Proposed Action for Flight Experiment 2 (FE-2).

The US Navy SSP proposes to conduct a developmental flight test as described in the attached Environmental Assessment (EA)/Overseas Environmental Assessment (OEA). The US Navy, along with the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) as cooperating agencies, and with the US Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) as participating agency, has prepared the EA/OEA in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and Navy regulations for implementing NEPA. The Proposed Action entails one experimental flight test to take place within the first half of fiscal year (FY) 2020 after the Finding of No Significant Impact/Finding of No Significant Harm (FONSI/FONSH) is signed, if approved.

Please find enclosed the Draft FE-2 EA/OEA and Draft FONSI/FONSH, provided for your review and comment between August 26 and September 26, 2019. A comment form is also enclosed for your use in recording your comments, corrections, or suggestions. Your comments are due by September 26, 2019.

A Notice of Availability of the Draft EA/OEA and Draft FONSI/FONSH will be published in the local newspapers in Kwajalein and the Republic of the Marshall Islands on or before August 11, 2019. The documents will also be available at public libraries in Kwajalein and Republic of the Marshall Islands Environmental Protection Authority offices in Majuro and Ebeye. Additionally, the EA/OEA and Draft FONSI/FONSH is accessible on the internet at www.FE-2-EAOEA.com.

The Draft EA/OEA and Draft FONSI/FONSH examines the continuing collection of data on a developmental payload by testing one such flight experiment concept. Specifically, the FE-2 would continue to develop, integrate, and flight test a payload system to demonstrate the maturity of key technologies. FE-2 would help further establish aerodynamic, thermal, and structural limits of the payload system. Data collected would be utilized to improve the models that predict the performance of the payload system. The Proposed Action would also provide an opportunity to observe the FE-2 missile and payload system from launch-to-impact and record all data that is transmitted throughout the flight path.

The project areas for the Proposed Action include two primary locations, one with sites in the Pacific Ocean and one on the east coast with sites in the Atlantic Ocean. The Pacific locations analyzed in this EA/OEA are the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawai`i; the U.S. Army Kwajalein Atoll (USAKA); the Ronald Reagan Ballistic Missile Defense Test Site (RTS), Republic of the Marshall Islands (RMI); and the Broad Ocean Area (BOA) in the Pacific. The east coast locations include the NASA Wallops Flight Facility (WFF), Virginia; and the Atlantic BOA.

I am also providing a transmittal letter, the Draft EA/OEA and Draft FONSI/FONSH, for comment, to Dr. Steve Kolinski, National Marine Fisheries Services; Ms. Moriana Phillip, RMI Environmental Protection Authority Majuro; Mr. Kawa Jatios, RMI Environmental Protection Authority Ebeye; Mr. Kanalei Shun, U.S. Army Corps of Engineers; Dr. Dan Polhemus, U.S. Fish and Wildlife Service; and Mr. Derek Miller, USAKA/RTS Environmental Management Office.

If you have any questions or concerns, please contact Mr. Mark Hubbs, Environmental Protection Specialist, USASMDC/ARSTRAT, Environmental Division, (256) 955-2608, or email him at mark.e.hubbs.civ@mail.mil. Email your comments to him or postmark written comments by 26 September 2019 to Mark Hubbs, USASMDC/ARSTRAT, ATTN: SMDC-EN, P.O. Box 1500, Huntsville, AL 35807-3801.

Sincerely,

HASLEY.DAVID.C.1230984308 Digitally signed by HASLEY.DAVID.C.1230984308 Date: 2019.08.22 14:05:03 -05'00'

DAVID C. HASLEY
UES Co-Chairperson

Enclosure

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawaii 96850

Mark Hubbs
Environmental Engineer
U.S. Army Space and Missile Defense Command/
Army Forces Strategic Command (USASMDC/ARSTRAT)
PO Box 1500
Huntsville, AL 35807-3801

July 29, 2019

Dear Mr. Hubbs:

The U.S. Fish and Wildlife Service (Service) received your request for concurrence for nesting sea turtle and listed birds dated June 14, 2019 for flight tests of Flight Experiment-2 (FE-2). In addition, we received your biological assessment and request for concurrence on the consultation of four species of birds (*Pterodroma sandwichensis*, *Phoebastria albatrus*, *Puffinus auricularis newelli*, and *Oceanodroma castro*) and five species of sea turtles (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*). The NPA includes up to four impacts within 2 years associated with the ARRW testing to demonstrate and collect data on key technologies, such as thermal control, precision navigation, guidance, control, and enabling capabilities of the ARRW vehicle and development payload during hypersonic flight.

The Biological Assessment (BA) analysis of possible effects to Newell's shearwater (*Puffinus auricularis newelli*) in the broad ocean area (BOA) are explained and demonstrate very unlikely effects to individual birds. In the event that a listed seabird was in the splashdown area of the broad ocean area (BOA), the bird would probably exhibit a startle reflex, which would not likely adversely affect the individual. Similarly, the possibility of direct contact with a listed seabird is remote. Within the impact area, we consider the only sea turtles potentially present to be the Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricata*). The others (*Caretta caretta*, *Dermochelys coriacea*, and *Lepidochelys olivacea*) have not been sighted around or on Illeginni and would therefore would not likely be subject to any adverse affect.

Conservation Measures

The following conservation measures are provided based on the information provided within the January 29, 2019 BA as well as the previous consultation for the U.S. Navy Strategic Systems Programs' Flight Experiment-1 (FE-1) on Green and Hawksbill sea turtles and Newell's Shearwater. The following avoidance and minimization measures are considered part of the project description:

- If personnel observe sea turtles in or near potential impact zones, sightings will be reported to appropriate test and USAG-KA personnel for consideration in launch planning.
- Vessel and equipment operations will not involve any intentional discharges of fuel, toxic waters, or plastics and other solid wastes that could harm terrestrial or marine life.
- Hazardous materials will be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous waste incidents will comply with the emergency procedures set out in the Kwajalein Environmental Emergency Plan (KEEP) and the UES.
- All equipment and packages shipped to USAG-KA will undergo inspection prior to shipment to prevent the introduction of alien species into Kwajalein Atoll.
- Pre-flight monitoring by qualified personnel will be conducted on Illeginni Islet for sea turtles or sea turtle nests. For at least 8 weeks preceding the test launch, Illeginni Islet will be surveyed by pre-test personnel for sea turtles, sea turtle nesting activity, and sea turtle nests on a bi-weekly basis. If possible personnel will inspect the area within two days of the launch. If sea turtles or sea turtle nests are observed near the impact area, observations will be reported to appropriate test and USAG-KA personnel for consideration in approval of the launch and to NMFS and the Service.
- Personnel will report any observations of sea turtles or sea turtle nests on Illeginni to appropriate test and USAG-KA personnel to provide to NMFS and USFWS.
- Debris recovery and site cleanup will be performed on land. Recovery and cleanup will be conducted in a manner to minimize further impacts on biological resources.
- At Illeginni Islet, should any missile components or debris impact areas of sensitive biological resources, a Service or NMFS biologist will be allowed to provide guidance and or/or assistance in recovery operations to minimize impacts on such resources.
- Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel will be reported to the USAG-KA Environmental Office and USASMDC, who will then inform NMFS and the Service. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas will also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.
- As soon as practical following payload impact at Illeginni Islet, qualified biologists will be allowed to assist in recovering and rehabilitating any injured sea turtles found.
- During post-test recovery and cleanup, should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work will be delayed until such species were out of harm's way or leave the area.
- To minimize impacts during post-flight operations, the Service and NMFS will be allowed to provide guidance and/or assistance during recovery and cleanup at Illeginni Islet. In all cases, recovery and cleanup operations will be conducted in a manner to minimize further harm to biological resources.

Summary
After reviewing the new information provided, we have concluded that the location of the target site is clear of the shoreline, however, payload impact debris and ejecta could impact adjacent sandy shoreline. While Illeginni Islet has shoreline habitat that a sea turtle could successfully lay a nest, a significant portion of the habitat is submerged or inundated during high tide events; thus drowning any sea turtle nests that may be present. In addition, any turtle nesting or terrestrial activity sign that could identify any nesting or terrestrial behaviors would be washed away if they are below the high tide line.

Based on the proposed action, information provided in your January 29, 2019 BA, and the minimization measures included within this letter, it is not probable the proposed action will impact sea turtle(s), Newell's shearwater(s) (*Puffinus auricularis newelli*). Therefore, the Service has determined any effects are discountable and not likely to adversely affect the sea turtles (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*) and their nests, or the Newell's shearwater (*Puffinus auricularis newelli*). Therefore, the Service concurs with your determination that the proposed test flight may effect, but is not likely to adversely affect, the sea turtles (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*) and their nests and the Newell's shearwater (*Puffinus auricularis newelli*).

This letter does not cover any action taken at Kauai Test Facility (KTF) Pacific Missile Range Facility (PMRF). We recommend you working with the PMRF for any ESA issues associated with the launch. It is our understanding that they are currently covered under the Biological Opinion (2015-F-0227).

Unless the project description changes, or new information reveals that the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to Section 3-4.5 of the UES and Section of the ESA is necessary.

If you have questions regarding this concurrence, please contact Aquatic Ecosystem Conservation Program Coordinator Dan Polhemus (Dan_Polhemus@fws.gov or 808-792-9400). For specific comments on terrestrial resources, please contact Environmental Toxicologist Michael Fry (Michael_Fry@fws.gov or 808-792-9461). For specific comments on marine resoures, please contact Marine Biologist Tony Montgomery (Tony_Montgomery@fws.gov or 808-792-9456.

Sincerely,

Dan Polhemus
Aquatic Ecosystem Conservation Program Coordinator

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

REPLY TO
ATTENTION OF

June 14, 2019

Dan A. Polhemus, PhD
U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
P.O. Box 50088
Honolulu, Hawaii 96850

Dear Dr. Polhemus,

The U.S. Army Space and Missile Defense Command / Army Forces Strategic Command (USASMDC/ARSTRAT) is assisting the U.S. Navy Strategic Systems Programs (SSP), the action proponent, in evaluating the effects of flight tests of Flight Experiment-2 (FE-2). We have prepared a Biological Assessment (BA) to evaluate the effects of the Proposed Action on species protected under Section 3-4.5 of the U. S. Army Kwajalein Atoll Environmental Standards (UES), Section 7 (a)(2) of the U.S. Endangered Species Act (ESA), and in connection with Section 101 of the Marine Mammal Protection Act (MMPA). There is no affected critical habitat for any of the protected species in the Proposed Action Area.

As described in the enclosed BA, UES, ESA, and MMPA protected species occur or have the potential to occur in the Action Area. Based on analyses of all of the potential stressors resulting from the Proposed Action, we have concluded that the Proposed Action may affect and is likely to adversely affect some of these species and have initiated formal consultation with the National Marine Fisheries Service. These include one fish species, *Cheilinus undulatus*; three mollusk species, *Hippopus hippopus*, *Tectus niloticus*, and *Tridacna squamosa*; and seven coral species, *Acropora microclados*, *A. polystoma*, *Cyphastrea agassizi*, *Heliopora coerulea*, *Pavona venosa*, *Pocillopora meandrina*, and *Turbinaria reniformis*.

We have concluded that the Proposed Action may affect but is not likely to adversely affect 11 cetacean species, 2 sea turtle species, 3 fish species, 15 coral species, 2 mollusk species, and larval fish, coral, and mollusks near Illeginni Islet in the Republic of the Marshall Islands. These species include the sea turtle species *Chelonia mydas* and *Eretmochelys imbricata* both in water and on land.

We have concluded that the Proposed Action would have no effect on 25 cetacean species, 1 pinniped species, 1 seabird species, 5 sea turtle species, 4 fish species, and larval fish, coral, and mollusks in the broad ocean area (BOA) of the Action Area. These species include the Newell's shearwater (*Puffinus auricularis newelli*). We also concluded that the Proposed Action may affect but is not likely to adversely affect Newell's shearwaters at Kauai Test Facility (KTF), Pacific Missile Range Facility (PMRF).

Based on our conclusion that the Proposed Action may affect but is not likely to adversely affect nesting sea turtle and listed bird species, the USASMDC/ARSTRAT and U.S. Navy SSP requests U.S. Fish and Wildlife Services concurrence for our may affect but not likely to adversely affect determination for these species.

I am also providing copies of this letter and the BA to Ms. Moriana Phillip, Republic of the Marshall Islands Environmental Protection Authority; Dr. Steven Kolinski, National Marine Fisheries; Helene Takemoto, U.S. Army Corp of Engineers; and Mr. John McCarroll, U.S. Environmental Protection Agency.

Please contact Mark Hubbs, USASMDC/ARSTRAT, Environmental Division, regarding this consultation request at (256) 955-2608 or mark.e.hubbs.civ@mail.mil.

Sincerely,

for David Hasley
Chief, Environmental Division
U.S. Army Space and Missile Defense
Command/ Army Forces Strategic
Command

Enclosure

DEPARTMENT OF THE NAVY
DIRECTOR STRATEGIC SYSTEMS PROGRAMS
1250 10TH STREET SE, SUITE 3600
WASHINGTON NAVY YARD, DC 20374-5127

IN REPLY REFER TO

5090
Ser SP20161/100118007

MAR 0 8 2019

From: Director, Strategic Systems Programs
To: National Aeronautics and Space Administration, Wallops Flight Facility, Wallops Island, Virginia (Attn: Ms. Sheri Miller, Environmental Planning Lead)

Subj: COOPERATING AGENCY FOR ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT SUPPORTING FLIGHT EXPERIMENT MISSILE TESTING

Encl: (1) Flight Experiment-2 Navy Project Stick Chart

1. Strategic Systems Programs (SSP) is preparing an Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) to evaluate potential environmental impacts from the proposed testing of the Flight Experiment-2 (FE-2) missile. The National Aeronautics and Space Administration's (NASA) Wallops Flight Facility (WFF) has been identified as a potential launch site for the FE-2 missile test. Accordingly, per 40 CFR Part 1501 and Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, SSP requests NASA WFF to participate as a Cooperating Agency for the development of the FE-2 EA/OEA.

2. The proposed action consists of a flight test of the Intermediate Range Conventional Prompt Strike FE-2 launch vehicle. The FE-2 launch vehicle consists of a 3-stage Strategic Target System III booster system and an Intermediate Range Glide Body. The proposed flight test will take place within the first half of Fiscal Year 2020.

3. SSP will take the following actions to support interagency cooperation with NASA WFF:

a. Request your review of draft EA/OEAs and related National Environmental Policy Act (NEPA) documentation such as the finding of no significant impact and biological consultation documents.

b. Invite you to FE-2 environmental planning meetings and confer with your staff on regulatory agency consultations, including consultations that directly affect NASA WFF.

c. Include information within environmental documents that NASA WFF may need to meet its environmental responsibilities such as mitigation, permits and consultations for NASA WFF facilities and properties that will support the FE-2 flight test.

Subj: COOPERATING AGENCY FOR ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT SUPPORTING FLIGHT EXPERIMENT MISSILE TESTING

4. As a Cooperating Agency, SSP requests NASA WFF support SSP in the following:

a. Provide reviews and comments throughout the EA/OEA process, to include working drafts of the EA/OEA and other ancillary documents such as biological consultation documents.

b. Participate in meetings to discuss EA/OEA related issues.

c. Respond to SSP requests for information.

d. Assist SSP in determining appropriate avoidance, minimization and mitigation measures to incorporate into environmental documentation and permit applications.

e. Adhere to the overall schedule as set forth by SSP. Enclosure (1) provides the current FE-2 Navy Project Stick Chart identifying project milestones.

f. Provide formal, written response to this request, agreeing to the support listed in subparagraphs 4.a through 4.f.

5. The Navy views its relationship with NASA WFF as important to the successful completion of the NEPA process for the FE-2 EA/OEA. It is the Navy's goal to complete the NEPA process as expeditiously as possible, and the Navy believes that establishing a formal Cooperating Agency relationship with NASA WFF will help attain this goal. In the event that NASA WFF elects not to participate as a Cooperating Agency, the Navy welcomes NASA WFF's informal participation in the environmental planning process.

6. The SSP technical Point Of Contact (POC) for this action is Mr. Fred Chamberlain, (202) 433-7141, SP20161@ssp.navy.mil. Legal POCs are Mr. Jeremy Cohn, (202) 433-9773, Jeremy.Cohn@ssp.navy.mil and Mr. Paul Atelsek, (202) 433-9770, Paul.Atelsek@ssp.navy.mil.

FOR

STEVEN P. LANDAU
By direction

National Aeronautics and Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Reply to Attn of: 250.W

March 27, 2019

Mr. Steven P. Landau
Director Strategic Systems Programs
Department of the Navy
1250 10th Street SE
Suite 3600
Washington Navy Yard, DC 20374-5127

Dear Mr. Landau:

This letter is in response to the March 8, 2019, correspondence announcing the Navy's Strategic Systems Programs (SSP) intent to prepare an Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) for the proposed testing of the Flight Experiment-2 (FE-2) missile and requesting the National Aeronautics and Space Administration's (NASA's) participation in this process as a cooperating agency. NASA welcomes the opportunity to participate in the preparation of the EA and agrees to serve as a cooperating agency in the National Environmental Policy Act process since NASA possesses specialized expertise regarding the environmental resources potentially affected by the proposed action. Specifically, NASA will work with the Navy SSP to incorporate considerations related to Wallops Flight Facility operations at Wallops Island, Virginia.

If you have any questions or require additional information, please contact me at (757) 824-2327 or at Shari.A.Miller@nasa.gov.

Sincerely,

Shari A. Miller
Environmental Planning Lead

cc:
250/Ms. K. Finch
250/Mr. T. Meyer
800/Mr. D. Pierce
802/Mr. P. Smith
802/M. G. Letchworth
840/Mr. R. Jameson
840/Mr. S. Schisler
840/Mr. D. Voss

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

REPLY TO
ATTENTION OF

June 14, 2019

Steve Kolinski, PhD
National Marine Fisheries Service
Pacific Islands Regional Office
1845 Wasp Boulevard, Building 176
Honolulu, HI 96818

Dear Dr. Kolinski,

The U.S. Army Space and Missile Defense Command / Army Forces Strategic Command (USASMDC/ARSTRAT) is assisting the U.S. Navy Strategic Systems Programs (SSP), the action proponent, in evaluating the effects of flight tests of Flight Experiment 2 (FE-2). We have prepared a Biological Assessment (BA) to evaluate the effects of the Proposed Action on species protected under Section 3-4.5 of the U.S. Army Kwajalein Atoll Environmental Standards (UES), Section 7 (a)(2) of the U.S. Endangered Species Act (ESA), and in connection with Section 101 of the Marine Mammal Protection Act (MMPA). There is no affected critical habitat for any of the protected species in the Proposed Action Area.

As described in the enclosed BA, UES, ESA, and MMPA protected species occur or have the potential to occur in the Action Area. Based on analyses of all of the potential stressors resulting from the Proposed Action, we have concluded that the Proposed Action may affect and is likely to adversely affect some of these species. These include one fish species, *Cheilinus undulatus*; three mollusk species, *Hippopus hippopus*, *Tectus niloticus*, and *Tridacna squamosa*; and seven coral species, *Acropora microclados*, *A. polystoma*, *Cyphastrea agassizi*, *Heliopora coerulea*, *Pavona venosa*, *Pocillopora meandrina*, and *Turbinaria reniformis*.

We have concluded that the Proposed Action may affect but is not likely to adversely affect 11 cetacean species, 2 sea turtle species, 3 fish species, 15 coral species, 2 mollusk species, and larval fish, coral, and mollusks near Illeginni Islet in the Republic of the Marshall Islands. These species include the cetacean species *Balaenoptera acutorostrata*, *B. edeni*, *Delphinus delphis*, *Globicephala macrorhynchus*, *Orcinus orca*, *Peponocephala electra*, *Physeter macrocephalus*, *Stenella attenuata*, *S. coeruleoalba*, *S. longirostris*, and *Tursiops truncatus*; the sea turtle species *Chelonia mydas* and *Eretmochelys imbricata*; the fish species *Manta alfredi*, *M. birostris*, and *Sphyrna lewini*; the coral species *Acanthastrea brevis*, *Acropora aculeus*, *A. aspera*, *A. dendrum*, *A. listeri*, *A. speciosa*, *A. tenella*, *A. vaughani*, *Alveopora verrilliana*, *Leptoseris incrustans*, *Montipora caliculata*, *Pavona cactus*, *P. decussata*, *Turbinaria mesenterina*, and *T. stellulata*; and the mollusk species *Pinctada margaritifera* and *Tridacna gigas*.

We have concluded that the Proposed Action would have no effect on 25 cetacean species, 1 pinniped species, 1 seabird species, 5 sea turtle species, 4 fish species, and larval fish, coral, and mollusks in the broad ocean area (BOA) of the Action Area. These species include the cetacean species *Balaenoptera acutorostrata*, *B. boralis*, *B. edeni*, *B. musculus*, *B. physalus*, *Delphinus delphis*, *Feresa attenuata*, *Globicephala macrorhynchus*, *Grampus griseus*, *Indopacetus pacificus*, *Kogia breviceps*, *K. sima*, *Lagenodelphis hosei*, *Megaptera novaeangliae*, *Mesoplodon densirostris*, *Orcinus orca*, *Peponocephala electra*, *Physeter macrocephalus*, *Pseudorca crassidens*, *Stenella attenuata*, *S. coeruleoalba*, *S. longirostris*, *Steno bredanensis*, *Tursiops truncatus*, and *Ziphius cavirostris*; the pinniped species *Neomonachus schauinslandi*; the seabird species *Puffinus auricularis newelli*; the sea turtle species *Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*; and the fish species *Alopias superciliosus*, *Carcharhinus longimanus*, *Manta birostris*, and *Thunnus orientalis*.

Because of these potential effects to UES, ESA, and MMPA protected species, the USASMDC/ARSTRAT and U.S. Navy SSP would like to initiate formal consultation with the National Oceanic and Atmospheric Administration, National Marine Fisheries Service under Section 3-4.5 of the UES for potential effects in the Republic of the Marshall Islands to *Cheilinus undulatus*, *Hippopus hippopus*, *Tectus niloticus*, *Tridacna squamosa*, *Acropora microclados*, *A. polystoma*, *Cyphastrea agassizi*, *Heliopora coerulea*, *Pavona venosa*, *Pocillopora meandrina*, and *Turbinaria reniformis*.

I am also providing copies of this letter and the BA to Ms. Moriana Phillip, Republic of the Marshall Islands Environmental Protection Authority; Dr. Dan Polhemus, U.S. Fish and Wildlife Service; Helene Takemoto, U.S. Army Corps of Engineers; and Mr. John McCarroll, U.S. Environmental Protection Agency.

Please contact Mark Hubbs, USASMDC/ARSTRAT, Environmental Division, regarding this consultation request at (256) 955-2608 or mark.e.hubbs.civ@mail.mil.

Sincerely,

for

David Hasley
Chief, Environmental Division
U.S. Army Space and Missile Defense Command/ Army Forces Strategic Command

Enclosure

DEPARTMENT OF THE NAVY
DIRECTOR STRATEGIC SYSTEMS PROGRAMS
1250 10TH STREET SE, SUITE 3600
WASHINGTON NAVY YARD, DC 20374-5127

IN REPLY REFER TO

5090
Ser SP20161/071218005

AUG 3 0 2018

From: Director, Strategic Systems Programs
To: Department of Energy, National Nuclear Security Administration, Sandia Field Office, (Attn: Ms. Susan Lacy, Environmental Team Lead)

Subj: COOPERATING AGENCY FOR ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT SUPPORTING FLIGHT EXPERIMENT MISSILE TESTING

Encl: (1) Flight Experiment-2 Navy Project Stick Chart

1. Strategic Systems Programs (SSP) is preparing an Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) to evaluate potential environmental impacts from the proposed testing of the Flight Experiment-2 (FE-2) missile. SSP's FE-2 Program is currently supported by the Department of Energy (DOE), National Nuclear Security Administration (NNSA), Sandia Field Office (SFO). DOE NNSA SFO provides technology development support for the program and launch facilities. Accordingly, per 40 CFR Part 1501 and Council on Environmental Quality Cooperating Agency guidance, SSP requests DOE NNSA SFO participate as a Cooperating Agency for the development of the FE-2 EA/OEA.

2. The proposed action consists of a flight test of the Intermediate Range Conventional Prompt Strike FE-2 launch vehicle. The FE-2 launch vehicle consists of a 3-stage Strategic Target System III booster system and an Intermediate Range Glide Body. The proposed FE-2 flight test would take place within the first half of Fiscal Year 2020.

3. No direct writing or analysis by DOE NNSA SFO will be required. SSP will take the following actions to support interagency cooperation with DOE NNSA SFO:

a. Request your review of draft EA/OEAs and related National Environmental Policy Act (NEPA) documentation such as the Finding of No Significant Impact and biological consultation documents.

b. Invite you to FE-2 environmental planning meetings and confer with your staff on regulatory agency consultations, including consultations that directly affect DOE NNSA SFO.

c. Include information within environmental documents that DOE NNSA SFO may need to meet its environmental responsibilities such as mitigation, permits and consultations for DOE NNSA SFO facilities and properties that would support the FE-2 flight test.

4. As a Cooperating Agency, SSP requests DOE NNSA SFO support SSP in the following:

a. Provide reviews and comments throughout the EA/OEA process, to include working drafts of the EA/OEA and other ancillary documents such as biological consultation documents.

b. Participate in meetings to discuss EA/OEA related issues.

c. Respond to SSP requests for information.

d. Assist SSP in determining appropriate avoidance, minimization and mitigation measures to incorporate into environmental documentation and permit applications.

e. Adhere to the overall schedule as set forth by SSP. Enclosure (1) provides the current FE-2 Navy Project Stick Chart identifying project milestones.

f. Provide formal, written response to this request, agreeing to the support listed in subparagraphs 4.a through 4.f.

5. The Navy views its relationship with DOE NNSA SFO as important to the successful completion of the NEPA process for the FE-2 EA/OEA. It is the Navy's goal to complete the NEPA process as expeditiously as possible, and the Navy believes that establishing a formal Cooperating Agency relationship with DOE NNSA SFO will help attain this goal.

6. The SSP technical Point Of Contact (POC) for this action is Mr. Fred Chamberlain, (202) 433-7141, SP20161@ssp.navy.mil. Legal POCs are Mr. Jeremy Cohn, (202) 433-9773, Jeremy.Cohen@ssp.navy.mil and Mr. Paul Atelsek, (202) 433-9770, Paul.Atelsek@ssp.navy.mil.

STEVEN P. LANDAU
By direction

B

Comments and Responses on Draft EA/OEA

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COMMENT INCORPORATION SUMMARY

COMMENT INCORPORATOR Wes Norris, Karen Hoksbergen KFS, Glen Shonkwiler USASMDC	DATE 26 September 2019
COMMENTOR Karen Vitulano	ORGANIZATION OF COMMENTOR **EPA**
TITLE OF DOCUMENT Draft Environmental Assessment / Overseas Environmental Assessment for Navy Flight Experiment-2 (FE-2) and Draft Finding of No Significant Impact/Finding of No Significant Harm (FONSI/FONSH)	DATE OF DOCUMENT 11 July 2019

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES *(Exact wording of suggested change)*	INCORP.? *(Yes/No)*	HOW COMMENT WAS INCORPORATED *(If not incorporated, why?)*
1	2-19					The DEA states that "should the FE-2 impact in areas adjacent to the existing paved helipad at Illeginni Islet, soil containing residual concentrations of beryllium and depleted uranium from prior intercontinental ballistic missile (ICBM) flight tests could be scattered over the area" (p. 2-19). The DEA describes a bench study performed by the U.S. Navy to establish baseline uranium, beryllium, and tungsten concentrations in soil and groundwater for comparison to future sample results; and to establish whether current uranium, beryllium, and tungsten concentrations are sufficient to present an unacceptable risk to human health. This human health risk determination does not appear to be included in the DEA.	Yes	The 2017 bench study was performed to measure the dissolution rate of tungsten in a coralline soil environment and to estimate the average tungsten concentration in soil and the aqueous tungsten concentrations to support the FE-1 flight test. The 2018 LLNL report documents soil sampling, groundwater monitoring well installation, and groundwater sampling on Illeginni Island to determine whether groundwater on Illeginni is a prospective drinking water source for potential future inhabitants; to establish baseline uranium, beryllium, and tungsten concentrations in soil and groundwater for comparison to future sample results; and to establish whether current uranium, beryllium, and tungsten concentrations are sufficient to present an unacceptable risk to human health. The text of the Final EA will be updated to include the results of the 2018 LLNL report.
2	4-53					The DEA states that the results of groundwater samples after the first flight test (FE-1) showed tungsten levels (range 0.64 to 0.67 mg/L) substantially above the USEPA Regional	Yes	The 2019 sampling results will be included in the Final EA. The text of the Final EA will be updated to

Return comments by email to Mark Hubbs, mark.e.hubbs.civ@mail.mil by 12 September 2019

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES *(Exact wording of suggested change)*	INCORP.? *(Yes/No)*	HOW COMMENT WAS INCORPORATED *(If not incorporated, why?)*
						Screening Level (RSL) for tapwater of 0.016 mg/L; however, because the groundwater at Illeginni Islet is saline and not available year-round, it is not considered a viable source of potable water. Additional groundwater sampling is being conducted during 2019 at various locations on Illeginni Islet to verify the lack of groundwater availability and the salinity, and to test for metals including tungsten. The DEA states that the results of these tests will be incorporated into this document as soon as they are available (p. 4-53). **Recommendation**: Include the 2019 sampling results in the Final EA. While the DEA states that groundwater is not a viable source of drinking water, it is not clear if there is the potential for it to be used for drinking (e.g. existence of wells accessible to the public), nor is it clear if the groundwater basin could be or is being used for drinking water in other communities at Kwajalein where it could represent a migration risk and route of exposure. Discuss this in the Final EA. If the results indicate that groundwater would be a human health risk, identify institutional controls that would be implemented to ensure exposures via groundwater would not occur.		clarify that Illeginni is not a public location and there are no wells accessible to the public. The groundwater at Illeginni is not connected to the groundwater at any other island.
3	4-30					Regarding soil, the DEA states, "While the effects of tungsten remaining in the soil at Illeginni Islet are largely unknown, the impact area is largely a disturbed area where there would not likely be significant environmental effects" (p. 4-30). An unknown impact is not equivalent to no impact, and it is unclear how land disturbance alone leads to the conclusion that impacts would not be significant. **Recommendation** - Amend the justification that tungsten remaining in disturbed soils would not be a significant effect. Since much is unknown regarding impacts from tungsten in soils on	Yes	Text in this biological section has been modified to read – "… the impact area is a disturbed area which is primarily paved, mostly lacking vegetation, and is not suitable habitat for most wildlife species. It is unlikely that sensitive terrestrial wildlife would come in contact with remnant tungsten in the soil and remnant tungsten is not expected to impact vegetation or wildlife abundance or distribution on Illeginni Islet." As part of our ongoing actions at Illeginni we are sampling and monitoring for Tungsten to

COMMENT INCORPORATION SUMMARY

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						biological systems, to support a FONSI, we recommend a commitment to remedial actions, whether via phytoremediation or other methods. Include this remediation action in the list of mitigation measures on p. 4-31 and in Table 4-11. If soil will be remediated to Industrial RSLs only, identify institutional controls that would be implemented. At a minimum, these should include land use restrictions prohibiting any future residential land use and growing of food crops.		insure it doesn't exceed the industrial levels that are applicable for test and other personnel who might be on Illeginni. The USAKA Environmental Standards (UES) has restoration criteria that trigger when remediation is required. Reasonably foreseeable land use at Illeginni is as a test range which justify using industrial screening criteria as the trigger for a risk assessment. Remediation is risk based under the UES, and the absence of residents and any full-time presence even as a test range would most likely not trigger the risk-based criteria that would require a remediation. Use as a test range precludes residential usage (including the growing of food crops). No change in land use is expected while the Department of Defense retains control of the use of the island (current Military Use and Operating Rights Agreement extends to 2066). If the land use would change, the site would be evaluated under the UES Restoration requirements to determine if the new land use required institutional controls or remediation.
4	4-53, 5-9					The DEA states that "Sampling and analyses are also planned after the FE-2 flight test. If analyses of FE-2 post-flight test soil samples indicated tungsten levels above Residential RSLs, phytoremediation, using plants to draw up metals from the soil, would be considered, as suggested for consideration by the USEPA" (p. 4-53). The DEA states that if this remediation occurs, it would remediate tungsten in soil below the USEPA *Industrial* RSLs (p. 5-9). It is unclear why soil would not be remediated to below the Residential RSL. Additionally, this sampling and remediation commitment is not included in the mitigation measures listed on p. 4-31 nor in *Table*	No	This section will be modified to make it clear that the UES has restoration criteria that trigger when remediation is required. Reasonably foreseeable land use at Illeginni is as a test range which justifies using industrial screening criteria as the trigger for a risk assessment. Reasonably foreseeable land use also drives extent of remediation (whether to residential scenario or an industrial scenario). Remediation is risk based under the UES, and the absence of residents and any full-time presence even as a test range would most likely not trigger the risk-based criteria that

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COMMENT INCORPORATION SUMMARY

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES *(Exact wording of suggested change)*	INCORP.? *(Yes/No)*	HOW COMMENT WAS INCORPORATED *(If not incorporated, why?)*
						4-11- Impact Avoidance and Minimization Measures, which we assume will be included in, and used to support, the Finding of No Significant Impact (FONSI).		would require a remediation. Remediation while the site is still being used as a test range to residential criteria would be a waste of taxpayer funding and would only need to be repeated (to a risk based derived cleanup level for the expected foreseeable future use) once the range stops operating.
5	ES-2, 1-5					Page ES-2 states that environmental justice was not a resource evaluated in the DEA but page 1-5 states it was evaluated. The DEA concludes that Illeginni Islet currently has no resident population; therefore, there would be no disproportionate impacts (p. 3-57).	Yes	Text on page 1-5 has been modified. The word "analyzed" has been replaced with "considered". Numerous resource areas were considered in the EA but not all were evaluated or analyzed for impacts.
6	5-8					The Navy should consider whether potential impacts from tungsten contamination, which it acknowledges are largely unknown, could contribute to fish contamination which could further impact local subsistence fishers. The DEA identifies a fish study from 2014 that noted "unacceptable cancer risk for Marshallese adults at Illeginni [harbor] attributable to the pesticide, chlordane" (p. 5-8) but it is not clear whether tungsten was a metal evaluated in the fish study.	Yes	Tungsten was not evaluated in the 2014 fish study. Tungsten is known to bioaccumulate in plants and may bioaccumulate in animals. However, we do not know if it is in the ocean near Illeginni and if it is, we do not know at what concentrations or what form it may be in (which matters for organic uptake and retention). We also do not know if marine organisms (including fish) would bioaccumulate tungsten if it were present in the marine environment. Toxicity information for low dose chronic tungsten exposure is lacking in the scientific literature. Currently there are no health-based consumption values that would allow knowing quantities of tungsten in fish to be evaluated for their potential health impact. DoD is exploring performing toxicity testing on coral and marine species that would further knowledge in this area and might allow future addition of tungsten to fish studies
7	3-4, 3-46					The DEA cites to 2016 Final CEQ guidance on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews (p. 3-4, 3-46). This CEQ guidance was rescinded on	Yes	Text will be added to indicate that although the guidance was rescinded on April 5, 2017 the thresholds were used in this document.

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COMMENT INCORPORATION SUMMARY

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES *(Exact wording of suggested change)*	INCORP.? *(Yes/No)*	HOW COMMENT WAS INCORPORATED *(If not incorporated, why?)*
						April 5, 2017.		
8	4-12					Regarding emissions of stratospheric ozone depleters, the DEA states that "Both aluminum oxide and nitrogen oxides are of concern with respect to stratospheric ozone depletion" and states that. "the exact magnitude of ozone depletion that can result from a buildup of aluminum oxide overtime has not yet been determined quantitatively" (p. 4-12). We note that NASA has estimated the amount of ozone depletion in its NEPA documents1 The DEA also states that STARS emissions would be rapidly dispersed by stratospheric winds which would reduce potential impacts; however, the NASA document notes that emissions removed from the stratosphere by global atmospheric circulation takes about 3 years, which most would not consider rapid.	Yes	Text of the Final EA will be updated to include relative information from the NASA EA. Deleted the word "rapidly" The information and statements made in the FE-2 EA are still valid after considering the analysis in the NASA Routine Payload EA. A review of the NASA Routine Payload EA indicates "The impact of alumina and soot particulate, NOx and HOx emissions are less well understood than chlorine emissions. Laboratory and plume data suggest that the impact of alumina particulate is not substantial, although some uncertainty remains. For some plausible model assumptions, the global impact of alumina particulate is comparable to the chlorine impact (Jackman 1998)." This EA also states – "Additional modeling and observation results have been reported on rocket combustion emissions and plume wake chemistry since the previous Assessment, in which it was concluded that stratospheric accumulation of chlorine and alumina exhaust from current launch activities leads to small (less than 0.1 percent) global column ozone decreases. The new data support this conclusion (WMO 2006)."
9	3-5					Page 3-5 cites to a goal already passed - "by 2015, the Navy will cut in half the amount of petroleum used in Government vehicles through phased adoption of hybrid, electric, and flex fuel vehicles". Other citations are to 2020 targets. We recommend updating this section to indicate whether the 2015	No	Information is currently not available to indicate if the 2015 goal was achieved. Determination of the current progress toward the 2020 Navy targets are beyond the scope of this EA.

Return comments by email to Mark Hubbs, mark.e.hubbs.civ@mail.mil by 12 September 2019

COMMENT INCORPORATION SUMMARY

COMMENT INCORPORATOR Karen Hoksbergen	DATE 9-25-19
COMMENTOR Dr. Steven Kolinski	ORGANIZATION OF COMMENTOR **NOAA**
TITLE OF DOCUMENT Draft EA/OEA for Flight Experiment 2	DATE OF DOCUMENT

ITEM NO.	PAGE NO.	PARA-GRAPH	LIN E NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES *(Exact wording of suggested change)*	INCORP.? *(Yes/No)*	HOW COMMENT WAS INCORPORATED *(If not incorporated, why?)*
1	es1	1	1			fix typo “by the Office of the Officee of the…”	Yes	Text revised
2	es7	1	11			Ensure that the conclusion actually states the species will not be eliminated from Illeginni. The Jeopardy analysis is usually specific to USAKA, as required by the UES.	Yes	Text updated with conclusions from the biological opinion.
3	2-10	1-2	11-15			Suggest the batteries will keep the rafts on their individual stations for up to 2 weeks. Is this true? Please clarify (seems to contrast with Page 2-13, para 1, lines 3-4).	Yes	Revised text to clarify.
4	2-11 2-12 2-14	1 1 2 7	3-5 8-12 8-11 33-36			Sightings of sea turtles and marine mammals should be reported by the observer to a single central record location at USAG-KA and reported out to NMFS (marine) and USFWS (terrestrial) following project completion. Each sighting should include the approximate location (coordinates and/or reference to named islet), date, time and number of individuals seen, in addition to any information related to the type(s) of organisms observed (i.e. species if possible; dolphins, whales, sea turtles if not). This record keeping process should be noted within the EA and DEP to ensure such occurs (see Page 3-18, Para 3, lines 19-21, which indicates a similar process that is already being done specific to sea turtles at PMRF).	Yes	Revised to include suggested record keeping process in the EA and DEP. Example: “...would report any observations (including location, date, time, species or taxa, and number of individuals) to the USAG-KA Environmental Engineer who would maintain records of these observations and report sightings to NMFS and/or USFWS.” (Test relating to launch approval on pg 2-11 not changed).
5	2-20	4	24-29			Biological surveys have suggested reef development may be fairly prevalent along the deep lagoon bottom. UES consultation coral species have been noted at deep lagoon depths. The NMFS should be notified of inadvertent payload impacts in waters of the lagoon. ROV video and/or a dive inspection will be needed to determine UES consultation species presence and, if necessary, to support a supplemental consultation. Note, such	Yes	Added test such as: “Due to the potential presence of coral reef development on the deep lagoon bottom, NMFS would be notified of an inadvertent impact in lagoon waters and an ROV video or dive inspection would be conducted to evaluate the presence of UES consultation species. If UES consultation species were found at a lagoon bottom impact site, recovery efforts would be coordinated with

COMMENT INCORPORATION SUMMARY

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						corresponds with Page 2-21, para 3, line 12-13 and Page 2-23, Para 2, line 4-6.		NMFS.”
6	2-20	5	30-33			Similar to item 5, UES consultation benthic species presence is likely out to (and beyond) depths of 55 m on the ocean side of the atoll. ROV video and/or a dive inspection will be needed to determine UES consultation presence and, if necessary, to support a supplemental consultation. Such corresponds with Page 2-21, para 3, line 12-13 and Page 2-23, Para 2, line 4-6.	Yes	Added text specify inspection for UES consultation species.
7	3-11	4	19			Algae is the plural of alga. “Algaes” does not appear to be a word, but is used here in the document	Yes	Typo..Text revised.
8	3-59	1	2			UES DP 88 recently addressed that the UES Appendix 3-4C bird species are listed pursuant to the Migratory Bird Treaty Act (MBTA) [16 U.S.C. 703-712] rather than the Migratory Bird Conservation Act (MBCA) [16 U.S.C. 715]. This correction received a consensus vote for inclusion in the UES 16th ed.	Yes	Text revised to MBTA rather than MBCA.
9	3-59 4-33	4 3	39 38-39			Seagrass beds also occur outside the harbor at Illeginni Islet (down the slope fronting and to the side of the harbor entrance), as well as at Kwajalein Islet, Roi-Namur Iset, Ennylabegan Islet, with ephemeral distributions noted Gagan and Eniwetak Islets.	Yes	Text revised to include seagrass locations in and near the harbor entrance.
10	3-71	3	23-29			The EA should note that deep water invertebrates, including corals, have been noted in deep water habitats in other Pacific areas, including at Wake Island (corals observed down to approx. 2,600 m/8,500 ft. depths; see https://oceanexplorer.noaa.gov/okeanos/explorations/ex1606/dailyupdates/dailyupdates.html), and that efforts have not been made to determine species presence in deep offshore waters off Kwajalein Atoll. If coral species occurred in the deep water areas off Kwaj, they would likely be UES coordination species, assuming the impact occurred in RMI territorial waters. Note, benthic assemblages are noted for the Atlantic Alternative (Page 3-113, para 4, lines 31-40).	Yes	The following test added to this section: “Habitats these deep offshore areas may support a variety of pelagic and deep-water benthic invertebrates. Little information is known about species assemblages in the deep offshore waters of Kwajalein Atoll; however, deep water benthic communities have been documented around other island in the central Pacific including the Hawaiian Archipelago, Wake Island, and Johnston Atoll (Parrish and Baco 2007, Kelley et al. 2017, Kelley et al. 2018). Around Wake Atoll, large coral colonies with a diversity of deep-water coral and sponge species have been observed at depths of 1,400 to 1,500 m (4,600 - 5,000 ft; Kelley et al. 2017). In the Hawaiian Archipelago, deep water corals including members of several octocoral Families (Coralliidae, Isididae, Primnoidae, and Chrysogorgiidae) and antipatharian black corals have been observed in waters between 600 and

COMMENT INCORPORATION SUMMARY

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								1,800 m (2,000 -6,000 ft) deep (Parrish and Baco 2007). A diversity of corals, sponges, and other invertebrates have been found on crust substrate at depth of 1,000 to 2,500 m (3,300 - 8,200 ft) near Johnston Atoll (Kelley et al. 2018).The presence and potential composition of benthic communities in the ROI is unknown; however, if coral species occurred in the deep water impact areas within RMI waters, those species would likely be UES coordination species.”
11	4-88	Measure 2nd sentence			4-11	Terrestrial observations of turtles, evidence of turtle nesting activities or turtle nests should be reported to USFWS, not NMFS as indicated. Although NMFS would be interested in the information, we’ll stick to the in-water resources. Note, same correction needed for same row in Implementing and Monitoring column.	Yes	Corrected.
12	4-94 4-96	Row 3 Row 1			4-11	The measure for clams looks like it was inadvertently included in Table 4-11 twice. Some of the other rows may be similarly repeated.	Yes	Removed duplicated entries.

C

Formal Consultation Under the Environmental Standards for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands Biological Opinion

Formal Consultation under the Environmental Standards for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands

Biological Opinion

And Formal Consultation under Section 7 of the Endangered Species Act

Action Agencies: Department of the Navy, Strategic Systems Programs (SSP)
Department of the Army, U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) – Huntsville AL

Activity: Single Flight Experiment-2 (FE-2)

Consulting Agency: National Marine Fisheries Service, Pacific Islands Region

NMFS File No.: PIRO-2019-02607
PIRO Reference No.: I-PI-19-1782-AG

Approved By: [signature]

Michael D. Tosatto
Regional Administrator, Pacific Islands Region

Date Issued: 09/27/19

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Acronyms

ARSTRAT	Army Forces Strategic Command, US Army
BA	Biological Assessment
BOA	Broad Ocean Area
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DPS	Distinct Population Segment
DQA	Data Quality Act
ESA	Endangered Species Act
FR	Federal Register
kg	Kilogram
km	Kilometer
m	Meter
MAC	Mid-Atoll Corridor
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NLAA	Not Likely to Adversely Affect
nm	Nautical Miles
NMFS	National Marine Fisheries Service (aka NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Administration
PIRO	Pacific Islands Regional Office
PMRF	Pacific Missile Range Facility, Kauai
RMI	Republic of the Marshall Islands
ROV	Remotely Operated Vehicle
RTS	Ronald Reagan Ballistic Missile Test Site (aka Reagan Test Site)
SMDC	Space and Missile Defense Command, US Army
SSP	Strategic Systems Programs
UES	USAKA Environmental Standards
US	United States
USAF	U.S. Air Force
USAKA	U.S. Army Kwajalein Atoll
FWS	US Fish and Wildlife Service

1 Introduction

As described below, the proposed action involves launching a test missile (Flight Experiment-2, FE-2) from the Kauai Test Facility (KTF) located on the Pacific Missile Range (PMRF) in Hawaii which would travel across a broad ocean area (BOA) of the Pacific Ocean towards the Ronald Reagan Ballistic Missile Defense Test Site (Reagan Test Site [RTS]) at the US Army Kwajalein Atoll (USAKA), in the Republic of the Marshall Islands (RMI). The terminal end of the missile flight test would be at Illeginni Islet in Kwajalein Atoll. (Figure 1). FE-2 is the next incremental step in the developmental process after Flight Experiment 1 (FE-1), which was a very similar test flight conducted in 2017.

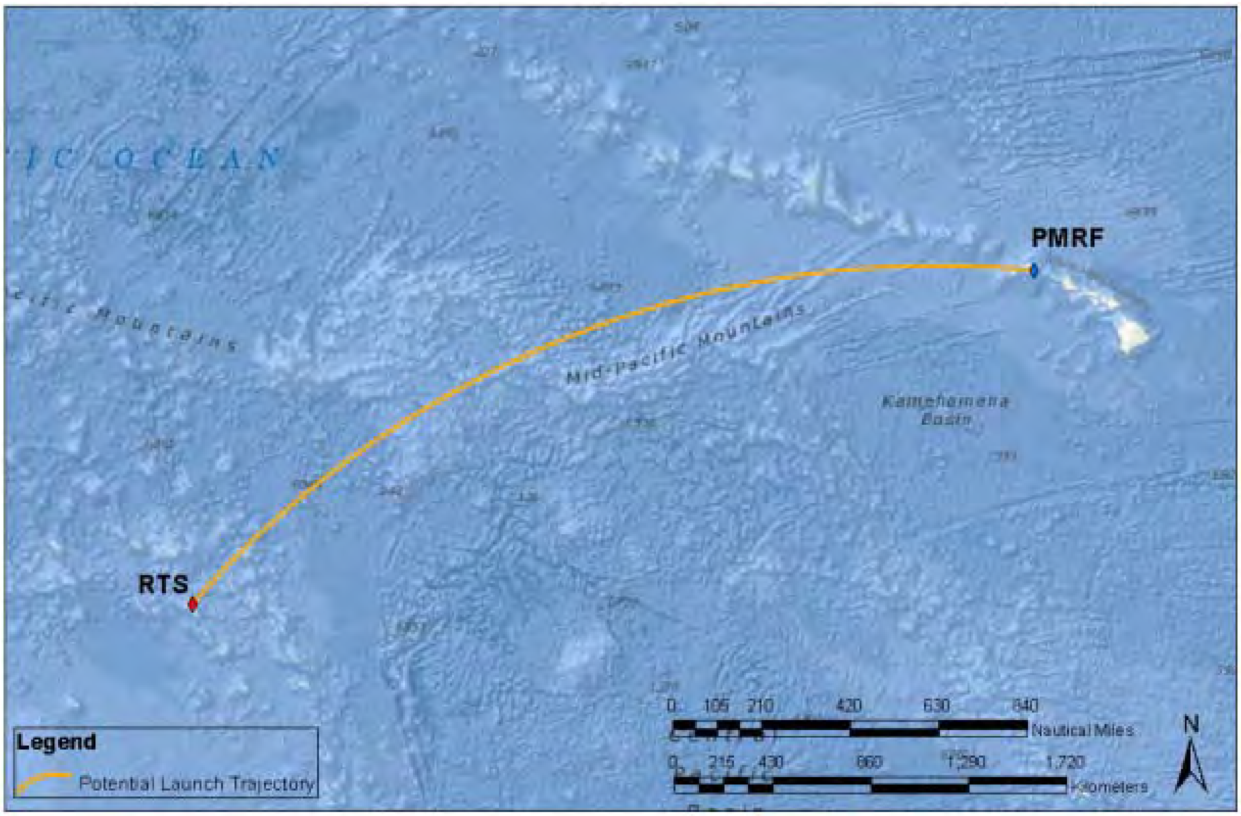

Figure 1. Flight Experiment-2 (FE-2) Representative Flight Path.

The Endangered Species Act (ESA) would apply for the portions of the action that would take place in and over United States (US) territory and international waters, but not for the portions of the action that would take place within the RMI. The Government of the RMI has agreed to allow the US Government to use certain areas of Kwajalein Atoll (collectively referred to as US Army Kwajalein Atoll or USAKA). “USAKA” is defined as “…the [USAKA]-controlled islands and the Mid-Atoll Corridor, as well as all USAKA-controlled activities within the [RMI], including the territorial waters of the RMI”. The USAKA controls 11 islets around the atoll. The relationship between the US Government and the Government of the RMI is governed by the Compact of Free Association (Compact), as Amended in 2003 (48 USC 1681). Section 161 of the Compact obligates the US to apply the National Environmental Policy Act of 1969 (NEPA) to its actions in the RMI as if the RMI were a part of the US. However, the ESA does not apply within the RMI. Instead, the Compact specifically requires the US Government to develop and apply environmental standards that are substantially similar to several US environmental laws, including the ESA and the Marine Mammal Protection Act (MMPA). The standards and procedures described in the Environmental Standards and Procedures for USAKA Activities in the RMI (aka USAKA Environmental Standards or UES, 15th Edition) were developed to satisfy that requirement. Therefore, the US Government must apply the UES to its activities within the RMI. Because the ESA and UES both apply to this action, this biological opinion was written in a manner that considers and complies with each of those standards, as applicable.

Section 7(a) (2) of the Endangered Species Act (ESA) of 1973, as amended (ESA; 16 U.S.C. 1536(a) (2)) requires each federal agency to insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" an ESA-listed species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS; for marine species or their designated critical habitat) or the U.S. Fish and Wildlife Service (FWS; for terrestrial and freshwater species or their designated critical habitat). Federal agencies are exempt from this formal consultation requirement if they have concluded that an action "may affect, but is not likely to adversely affect" ESA-listed species or their designated critical habitat, and NMFS or the FWS concur with that conclusion (50 CFR 402.14 (b)).

If an action is likely to adversely affect a listed species, the appropriate agency (either NMFS or FWS) must provide a Biological Opinion (Opinion) to determine if the proposed action is likely to jeopardize the continued existence of listed species (50 CFR 402.02). "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

Updates to the regulations governing interagency consultations (50 CFR part 402) will become effective on October 28, 2019 [84 FR 44976]. Because this consultation was pending and will be completed prior to that time, we are applying the previous regulations to the consultation. However, as the preamble to the final rule adopting the new regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." Thus, the updated regulations would not be expected to alter our analysis.

The United States Department of the Navy (U.S. Navy) Strategic Systems Programs (SSP) is the lead agency and action proponent for the Proposed Action. The U.S. Navy, along with the Department of Energy and the National Aeronautics and Space Administration (NASA) as Cooperating Agencies, and with the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) as a Participating Agency. The UES requires all parties of the U.S. Government involved in this project to consult or coordinate with the NMFS and the FWS to conserve species and habitats of special concern at USAKA. We will address the USASMDC/ARSTRAT exclusively in this document as the participating agency. Section 3.4 of the UES establishes the standards and procedures to be followed "…to ensure that actions taken at USAKA will not jeopardize the continued existence of these species or result in destroying or adversely changing the habitats on which they depend." Section 3.4 is derived primarily from the regulations implementing the ESA, other U.S. regulations, and wildlife protection statutes of the RMI. As such, the list of UES consultation species includes all species present in the RMI that are listed under the ESA (including those that are candidates or are proposed for listing), all marine mammals protected under the MMPA, and all species and critical habitats as designated under RMI law. However, no critical habitat has yet been designated in the RMI.

Under the UES, "the final biological opinion shall contain the consulting agency's opinion on whether or not the action is likely to jeopardize the continued existence of a species or to eliminate a species at USAKA, or to eliminate, destroy, or adversely modify critical habitats in the RMI" (UES at 3-4.5.3(e)). Although the UES does not specifically define jeopardy, the Compact clearly intends that the UES provide substantially similar environmental protections as the ESA. We interpret this to include adoption of the ESA definition of jeopardy, as described above, and this review relies upon the ESA definition of jeopardy to reach its final conclusions. This document represents our Opinion of the effects on marine species protected under the ESA and the UES that may result from the FE-2 flight test at the Reagan Test Site (RTS) at Kwajalein Atoll. This Opinion is based on the review of: the USASMDC/ARSTRAT June 13, 2019, Biological Assessment (BA) for the proposed action (SSP 2019); recovery plans for U.S. Pacific populations of ESA-listed marine mammals and sea turtles; published and unpublished scientific information on the biology and ecology of ESA-listed marine species, UES-consultation marine species, and other marine species of concern in the action area; monitoring reports and research in the region; biological opinions on similar actions; and relevant scientific and gray literature (see Literature Cited).

2 Consultation History

On March 2, 2017, the US Navy SSP consulted with NMFS on the effects of a near identical operation to the proposed action, the Flight Experiment 1 (FE-1). NMFS concluded in a biological opinion dated May 12, 2017 that the FE-1 would not jeopardize 59 marine ESA/UES consultation species (PIR-2017-10125; I-PI-17-1504-AG).

On June 14, 2019 we received from USASMDC/ARSTRAT, on behalf of the US Navy SSP, this consultation request stating that they had determined that the FE-2 flight test (the proposed action) may affect 65 marine ESA and/or UES consultation species (Table 1 and Table 2), and requested consultation for those species.

Table 1. Marine consultation species likely to be adversely affected by the proposed action

Scientific Name	Species	ESA	MMPA	CITES	RMI
	Fish				
Cheilinus undulatus	Humphead Wrasse			X	X
	Corals				
A. microclados	No Common Name			X	X
A. polystoma	No Common Name			X	X
Cyphastrea agassizi	No Common Name			X	X
Heliopora coerulea	No Common Name			X	X

Corals					
Pavona venosa	No Common Name			X	X
Turbinaria reniformis	No Common Name			X	X
Pocillopora meandrina	Cauliflower Coral	Candidate			X
Mollusks					
Tectus niloticus	Top Shell Snail				X
Hippopus hippopus	Giant clam	Candidate			
Tridacna squamosa	Giant clam	Candidate			X

In the BA, USASMDC/ARSTRAT further determined that the proposed action was likely to adversely affect the 11 marine UES consultation species listed in Table 1, and that the proposed action was not likely to adversely affect (NLAA) 54 consultation species (Table 2). Formal consultation was initiated on June 14, 2019, resulting in this Opinion.

Table 2. Marine consultation species not likely to be adversely affected by the proposed action

Scientific Name	Species	ESA	MMPA	CITES	RMI
Sea Turtles					
Caretta caretta	North Pacific Loggerhead Sea Turtle Distinct Population Segment (DPS)	Endangered		X	X
Chelonia mydas	Central North Pacific Green Sea Turtle DPS	Threatened		X	X
	Central Western Pacific DPS	Endangered		X	X
Dermochelys coriacea	Leatherback Sea Turtle	Endangered		X	X
Eretmochelys imbricata	Hawksbill Sea Turtle	Endangered		X	X
Lepidochelys olivacea	Olive Ridley Sea Turtle	Threatened		X	X
Marine Mammals					
Neomonachus schauinslandi	Hawaiian monk seal	Endangered	X	X	
Balaenoptera acutorostrata	Minke Whale		X		
B. borealis	Sei Whale	Endangered	X	X	
B. edeni	Bryde's Whale		X	X	
B. musculus	Blue Whale	Endangered	X	X	X
B. physalus	Fin Whale	Endangered	X	X	
Delphinus delphis	Common Dolphin		X		X
Feresa attenuata	Pygmy Killer Whale		X		
Globicephala macrorhynchus	Short-finned Pilot Whale		X		
Grampus griseus	Risso's Dolphin		X		
Indopacetus pacificus	Longman's Beaked Whale aka -Tropical Bottlenose Whale		X		
Kogia breviceps	Pygmy Sperm Whale		X		
K. sima	Dwarf Sperm Whale		X		
Lagenodelphis hosei	Fraser's Dolphin		X		
Megaptera novaeangliae	Humpback Whale	Endangered	X	X	
Mesoplodon densirostris	Blainville's Beaked Whale		X		
Orcinus orca	Killer Whale		X		
Peponocephala electra	Melon-Headed Whale		X		
Physeter macrocephalus	Sperm Whale	Endangered	X	X	X

Marine Mammals					
Pseudorca crassidens	False Killer Whale		X		X
Stenella attenuata	Spotted Dolphin		X		X
S. coeruleoalba	Striped Dolphin		X		X
S. longirostris	Spinner Dolphin		X		X
Steno bredanensis	Rough-toothed Dolphin		X		
Tursiops truncatus	Bottlenose Dolphin, Pacific		X		
Ziphius cavirostris	Cuvier's Beaked Whale		X		
Fish					
Alopias superciliosus	Bigeye Thresher Shark				X
Manta alfredi	Reef manta ray				X
Sphyrna lewini	Scalloped Hammerhead Shark	Threatened			X
Thunnus orientalis	Pacific bluefin tuna				X
Carcharhinus longimanus	Oceanic white-tip shark	Threatened			
Corals					
Acanthastrea brevis	No Common Name			X	X
Acropora aculeus	No Common Name			X	X
A. aspera	No Common Name			X	X
A. dendrum	No Common Name			X	X
A. listeria	No Common Name			X	X
A. speciosa	No Common Name				X
A. tenella	No Common Name				X
A. vaughani	No Common Name				X
Alveopora verriliiiana	No Common Name			X	X
Pavona cactus	No Common Name				X
P. decussata	No Common Name				X
P. venosa	No Common Name				X
Leptoseris incrustans	No Common Name			X	X
Montipora caliculata	No Common Name			X	X
Turbinaria meseterina	No Common Name				X
T. stellulata	No Common Name			X	X
Mollusks					
Pinctada margaritifera	Black-Lip Pearl Oyster				X
Tridacna gigas	Giant clam	Candidate			X

3 Description of the Proposed Action and Action Area

The proposed action is described in detail in the USASMDC/ARSTRAT BA. The purpose of the Proposed Action is to collect data on a developmental payload by testing missile range performance and to demonstrate capabilities as a prospective means to strike capabilities. Specifically, the FE-2 experiment would develop, integrate, and flight test the developmental payload concept to demonstrate the maturity of key technologies. These technologies include precision navigation, guidance and control, and enabling capabilities. The developmental payload would be launched from Kauai Test Facility located on the PMRF in Hawaii and would travel across a BOA of the Pacific Ocean towards the RTS at the USAKA, formerly known as US Army Kwajalein Atoll, in the RMI. The terminal end of the missile flight test would be at Illeginni Islet in Kwajalein Atoll.

The Proposed Action consists of pre-flight preparations in the BOA and at USAKA, the FE-2 flight test across the BOA with three motor splash downs (Figure 3), payload impact, and post-flight impact data collection, debris recovery, and clean-up operations at USAKA. The Navy proposes to conduct the proposed action within the first half of fiscal year 2020., if a Finding of No Significant Impact (FONSI) under the National Environmental Policy Act (NEPA), can be reached and approved. The following subsections include descriptions of the launch vehicle, pre-flight operations, flight, terminal phase operations, and post-flight operations.

Launch Vehicle Description

The Navy Strategic Systems Program FE-2 program launch vehicle consists of a 3-stage Strategic Target System (STARS) booster (Figure 2) and the developmental payload. The STARS booster vehicle is composed of three motor stages and control electronics. Figure 2 shows a typical STARS vehicle and Table 3 outlines the launch vehicle characteristics. The first stage motor is 4.62 m (182 inches [in]) long with a diameter of 1.37 m (54 in). The second stage motor is 1.32 m (52 in) long with a diameter of 1.37 m (54 in) and the third stage motor is 1.32 (52 in) long with a diameter of 1.37 m (54 in). The amount of propellant in the three boosters of a STARS vehicle totals approximately 13,608 kilograms (kg; 30,000 pounds [lbs]) and the vehicle generates approximately 34,019 kg (75,000 lbs) of thrust (USASMDC/ARSTRAT 2011). The amount of propellant and the environmental impacts of STARS launches was analyzed in 2008 in the Hawaii Range Complex (HRC) EIS/OEIS (US Navy 2008). Since environmental impacts of STARS launches at PMRF have been analyzed as a part of activities at PMRF, we do not further analyze vehicle launch in this document.

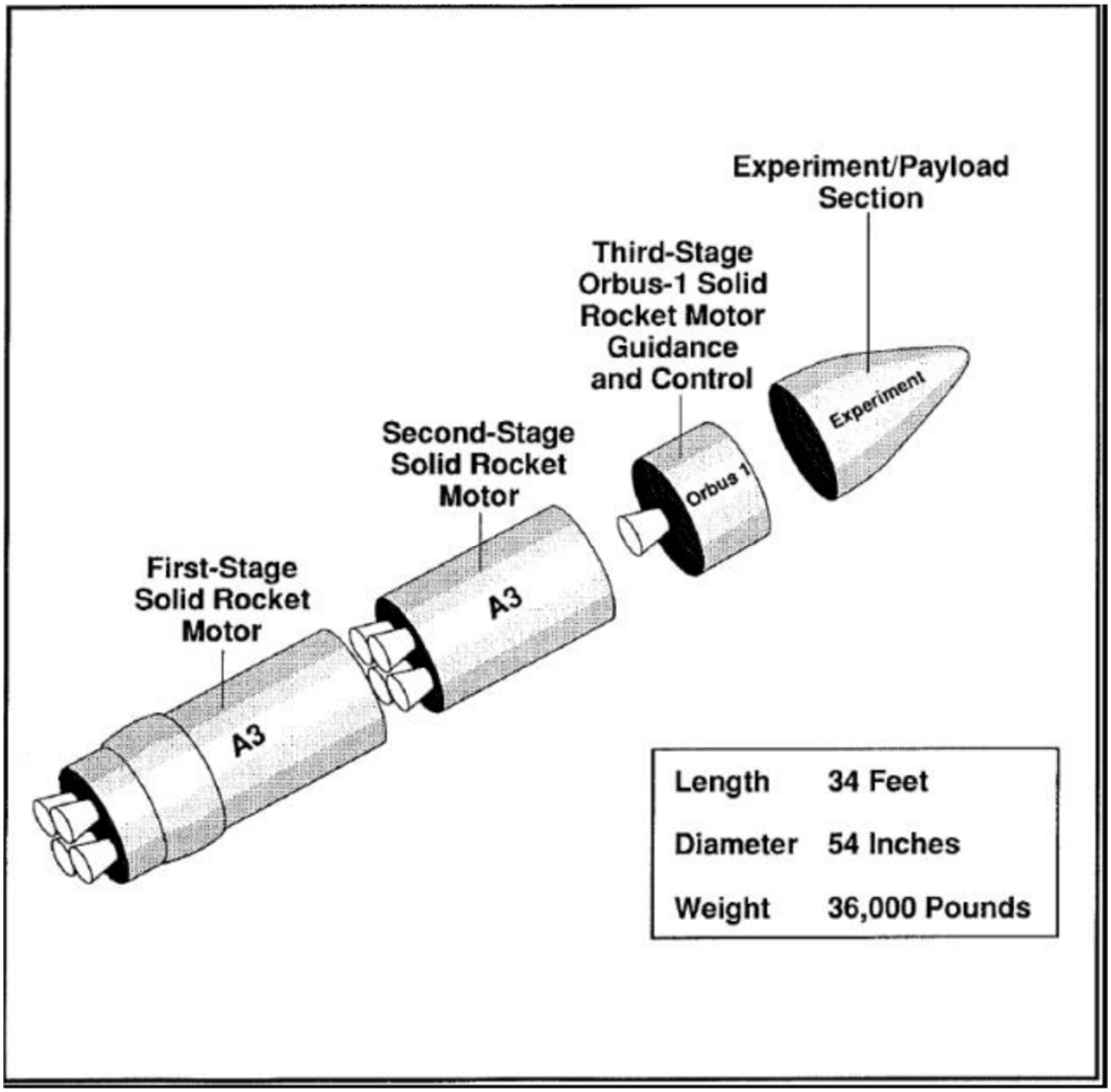

Figure 2. Typical Strategic Target System (STARS) Vehicle

Table 3. Launch Vehicle Characteristics

Major components	Rocket motors, propellant, magnesium thorium (booster interstage)[1], nitrogen gas, halon, asbestos (contained in second stage), battery electrolytes (lithium-ion, silver zinc)
Communications	Various 5- to 20-watt radio frequency transmitters; one maximum 400-watt radio frequency transponder
Power	Up to nine lithium ion polymer and silver zinc batteries, each weighing between 3 and 40 pounds
Propulsion/Propellan	Solid Rocket propellant, 1.3 kg (3 lb) of pressurized nitrogen gas
Other	Small Class C (1.4) electro-explosive devices ,

1 The skin of the STARS first/second interstage structure was manufactured from a magnesium-thorium alloy (HK31A-H24). This is a surplus Polaris A3R asset that has been adapted to STARS and it contains less than 3% (<80 micro curies [µCi]) thorium. The interstage alloys are commercially available products containing magnesium-thorium alloy and are exempted from controls by the Nuclear Regulatory Commission (10 CFR 40.13) and the Radiological Procedures Protection Manual (RPPM) since there is no physical, chemical or metallurgical processing performed on the items.

Table 3 details the launch vehicle characteristics and Table 4 describes the payload system characteristics. Up to 454 kg or (1,000 lbs) of tungsten will be contained in the payload. A nose fairing covers the payload until separation from the third stage motor. This nose fairing is approximately 3.12 m (100 in) long composed with a diameter of 1.37 m (54 in) and then tapering to a 10.16 cm (4 in) diameter at the nose. The nose fairing is a single piece but there are two clamshell extensions on the bottom 61 cm (24 in) in length that separate into two symmetric halves.

Table 4. Payload System Characteristics

Structure	Aluminum, steel, titanium, magnesium and other alloys, copper, fiber glass, chromate coated hardware, tungsten, plastic, Teflon, quartz, RTV silicone
Communications	Two less-than-20-watt radio frequency transmitters
Power	Up to three lithium ion polymer batteries, each weighing between 3 and 50 lbs
Propulsion/Propellant	None
Other	Class C (1.4) electro-explosive devices for safety and payload subsystems operations

Launch: The FE-2 missile will be launched from land at PMRF and enter an over-ocean flight phase within seconds after the launch.

Over-Ocean Flight: During the planned FE-2 flight over the BOA, the first-stage motor will burn out and separate from the second stage. Further into flight, the second-stage and third-stage motors would also burn out and separate. Jettison of the fairing and payload separation from the fairing would occur inside the atmosphere. Splashdown of all three spent motor stages and the fairing would occur at different points in the open ocean between 65 and 2,800 km from the launch pad. Figure 3 depicts the drop zones for the rocket motors. The nose fairing is expected to splashdown in motor drop zone 2. Following separation from the launch vehicle, the payload would use autonomous flight control to fly at high-speeds in the upper atmosphere towards RTS. If the payload's onboard computers determine that there is insufficient energy to reach the target area, the payload will be directed to descend in a controlled termination of the flight into the BOA.

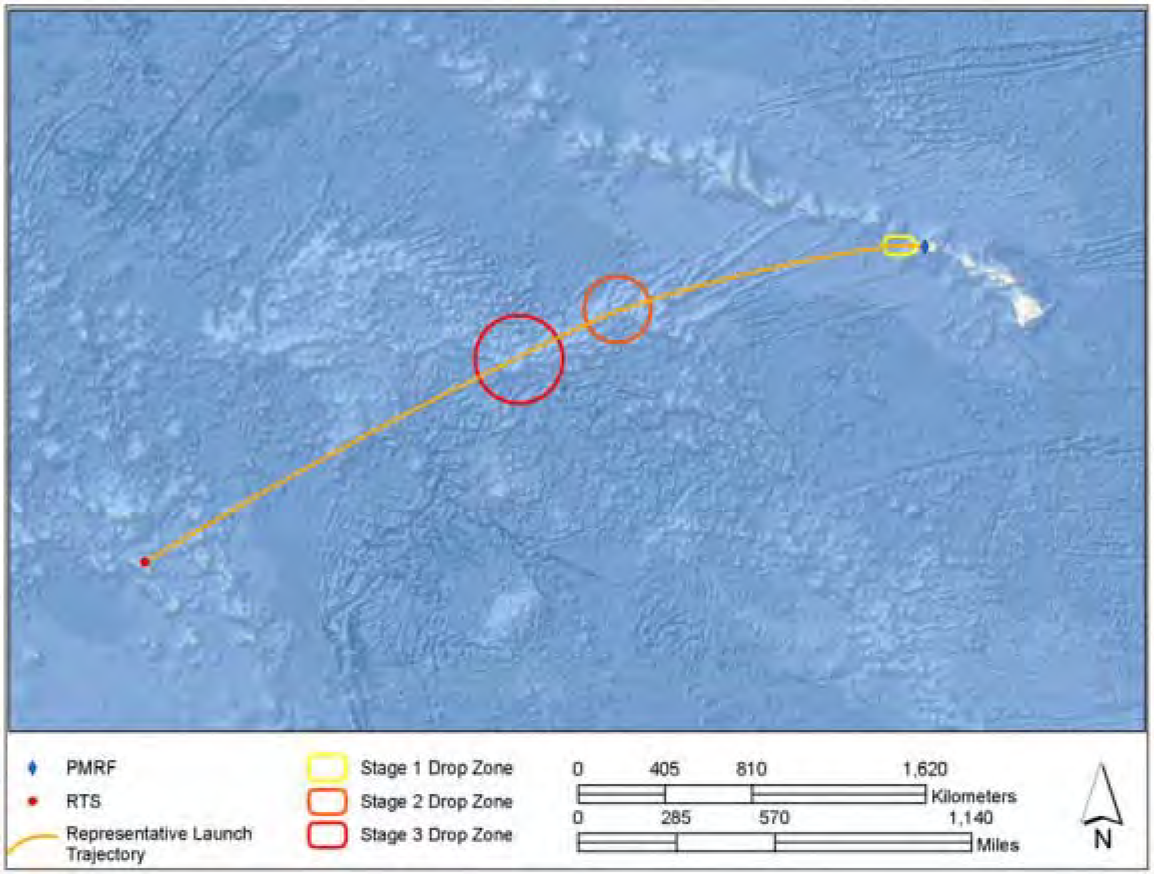

Figure 3. Representative Drop Zones for spent motor stages and nose fairing assembly.

Upon reaching the terminal end of the flight, the payload would impact on the non-forested northwestern end of Illeginni Islet (Figure 4 and Figure 5). A crater would form as a result of this impact and leave debris containing less than 454 kg (1,000 lbs) of tungsten. Targeted areas for the payload will be selected to minimize impacts to reefs and identified wildlife habitats. A coral reef or shallow water impact at Illeginni is not part of the proposed action, would be unintentional, and is unlikely (SSP 2019).

Figure 4. Location of Illeginni Islet, Kwajalein Atoll, Republic of the Marshall Islands.

Figure 5. Potential Land Impact Area on Illeginni Islet, Kwajalein Atoll.

Sensor Coverage in the BOA:

The flight path would initiate from the PMRF, travel across the BOA (avoiding the Northwest Hawaiian Islands) and continue to USAKA in the RMI. The flight path would essentially be the same as that analyzed in the Final Environmental Impact Statement for the Strategic Target System (USASDC 1992), the HRC EIS/OEIS (US Navy 2008), the FE-1 launch (NMFS 2017c) and the THAAD launch operation in 2019 (NMFS 2019). A series of sensors would overlap coverage of the flight from launch at Kauai Testing Facility (KTF) until impact at USAKA. The sensors would include:

- Ground-based optics and radars at PMRF
- Sea-based sensors on the Mobile Aerial Target Support System (MATSS) out of PMRF, the Kwajalein Mobile Range Safety System (KMRSS) on board the US Motor Vessel (USMV) Pacific Collector, and the Pacific Tracker
- Additional airborne and waterborne sensors on military or commercial aircraft are not planned as part of the FE-2 flight test but might be scheduled by other agencies to collect data on FE-2.

Sensor Coverage at USAKA:

Radars would be placed on Illeginni Islet to gather information on the payload. Up to four radar units, which would fit within a 61 cm by 38 cm by 15 cm (24 in by 15 in by 6 in) box, would be placed within the impact area and may be destroyed by payload impact. These radars are powered by on-shore generator power.

In addition to land-based radars and sensor vessel support, up to 12 self-stationing Lawrence Livermore National Laboratory Independent Diagnostic Scoring System (LIDSS) rafts may be placed in the lagoon and ocean waters near Illeginni Islet (Figure 6). These rafts would be equipped with battery-powered electric motors for propulsion to maintain position in the water. Two types of rafts will be used, hydrophone rafts and camera/radar rafts. Hydrophone rafts are equipped with hydrophones that are deployed off the back of the raft and hang in the water at a depth of approximately 3.7 m. Camera rafts are equipped with stabilized cameras and/or radar as well as hydrophones as described above. Before the flight test, one or two range landing craft utility (LCU) vessels would be used to deploy the rafts. Rafts will be deployed in waters at least 4 m deep to avoid contact with the substrate and/or coral colonies. Sensors on the rafts would collect data during the payload descent until impact.

Figure 6. Notional Locations of LIDSS Rafts.

Pre-Flight Preparation at Illeginni Islet:
Pre-flight preparation activities at Illeginni Islet would include several vessel round-trips and helicopter trips for equipment and personnel transport. There would be increased human activity on Illeginni Islet that would involve up to 24 persons over a 3-month period. Heavy equipment placement and use on Illeginni Islet would occur at times and be limited to transport on existing roads from the harbor to the impact area as well as in the impact area itself.

Flight Operations:
After launch from KTF, the vehicle would be monitored during flight over the BOA by land, sea and/or air-based sensors deployed prior to launch. The FE-2 vehicle would avoid flying over the Northwestern Hawaiian Islands (NWHI) and would traverse over the BOA to Illeginni Islet in the RTS at Kwajalein Atoll (Figure 1).

Following motor ignition and liftoff from the launch location, the first-stage motor would burn out downrange and separate from the second stage. Farther into flight, the second-stage would also burn out and separate, with the shroud assembly also being jettisoned prior to third stage ignition. Farther into flight, the third-stage would also burn out and separate from the payload. Splashdown of all three spent motor stages and the shroud assembly would occur at different points in the open ocean between 65 and 2,800 km from the launch pad . Jettison of the fairing and separation of the payload would occur outside the atmosphere. The mission planning process would avoid to the maximum extent possible all potential risks to environmentally significant areas. All actual impact zones would be sized based on range safety requirements and chosen as part of the mission analysis process.

If the launch vehicle were to deviate from its course or should other problems occur during flight that might jeopardize public safety, the onboard flight termination system (FTS) would be activated. The FTS would initiate a predetermined safe mode for the vehicle, causing it to fall towards the ocean and terminate flight. No inhabited land areas would be subject to unacceptable risks of falling debris. Computer-monitored destruct lines, based on no-impact lines, are pre-programmed for the flight safety software to avoid any debris falling on inhabited areas. An FTS on the payload would include a failsafe operation to further ensure the safety of the Marshall Islands. This failsafe requires positive action to be taken by range safety personnel to allow the payload to continue flight to the vicinity of Illeginni Islet. The FTS would also contain logic to detect a premature separation of the booster stages and initiate a thrust termination action on all of the prematurely separated stages. Thrust would be terminated by initiation of an explosive charge to vent the motor chamber, releasing pressure and significantly reducing propellant combustion. This action would stop the booster's forward thrust, causing the launch vehicle to fall along a ballistic trajectory into the ocean. The FTS would be designed to prevent any debris from falling into any protected area.

The payload would fly toward pre-designated target sites at Illeginni Islet. If data from payload onboard sensors indicate that there is insufficient energy to reach the target area, the payload would be terminated causing it to fall along a ballistic trajectory into the over-ocean flight corridor in the BOA.

Upon reaching the terminal end of the flight, the payload would impact on the non-forested northwestern end of Illeginni Islet (Figure 5). A crater would form as a result of this impact and leave debris containing less than 454 kg (1,000 lb) of tungsten[1]. Targeted areas for the payload would be selected to minimize impacts to reefs and identified wildlife habitats. The impact point on Illeginni Islet would be west of the forest tree line to avoid affecting sensitive bird habitat. A coral reef or shallow water impact at Illeginni is not part of the Proposed Action, would be unintentional, and is unlikely.

<u>Post-flight Operations:</u>

Post-flight operations may include manual cleanup of payload debris, use of heavy equipment for cleanup and repairs, retrieval of sensors, and use of remotely operated vehicles (ROVs) for underwater debris retrieval as described below.

Post-flight debris deposited on Illeginni Islet or in the adjacent ocean or lagoon would be recovered. Prior to recovery and cleanup actions at the impact site, unexploded ordinance

[1] The payload debris would include tungsten for ballast, etc., in accordance with Table 3-2 of the BA; exact quantities of tungsten are unknown at this time. In order to provide an appropriate conservative assessment, a quantity of up to 454 kg (1,000 lb) of tungsten alloy is used for the environmental effects analysis.

personnel would first survey the impact site for any residual explosive materials. For a land impact at Illeginni Islet, the impact areas would be washed down if necessary to stabilize the soil. Post-flight recovery operations at Illeginni Islet will involve manual cleanup and removal of all visible experiment debris, including hazardous materials, followed by filling in larger craters with ejecta using a backhoe or grader. Repairs will be made to the impact area if necessary. USAKA and RTS personnel are usually involved in these operations. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be returned to Kwajalein Island for proper disposal in the US. Following cleanup and repairs to the Illeginni site, soil samples would be collected at various locations around the impact area and tested for pertinent contaminants. Recovery and cleanup operations on Illeginni Islet could possibly cause some short-term disturbance to migratory bird habitat, potential sea turtle nesting habitat, and nearshore coral reef habitat.

While a shallow water impact is not planned or expected, any payload impact debris found in the shallow waters near Illeginni Islet would be removed while attempting to not further disturb or damage corals or other marine organisms. Payload recovery/cleanup operations in the lagoon and ocean reef flats, within 500 to 1,000 ft of the shoreline, are conducted similarly to land operations when tide conditions and water depth permit. A backhoe is used to excavate the crater. Excavated material is screened for debris and the crater is usually back-filled with ejecta from around the rim of the crater. While not planned or expected, should the payload impact in the deeper waters of the atoll lagoon, a dive team from U.S. Navy Supervisor of Salvage and Diving, USAKA or RTS would be brought in to conduct underwater searches. If warranted due to other factors, such as significant currents, mass of the debris to be recovered, etc., the recovery team would consider the use of a remotely operated vehicle (ROV) instead of divers.

If an inadvertent impact occurs on the reef, reef flat, or in shallow waters less than 3 m deep, an inspection by project personnel would occur within 24 hours. Representatives from the NMFS and FWS would also be invited to inspect the site as soon as practical after the test. The inspectors would be invited to assess any damage to coral and other natural and biological resources and, in coordination with SSP, USAKA and RTS representatives, decide on any mitigation measures that may be required. In general, payload recovery operations would not be attempted in deeper waters on the ocean side of the Atoll. Searches for debris would be attempted out to depths of up to 55 m. An underwater operation similar to a lagoon recovery would be used if debris were located in this area.

<u>Best Management Practices (BMPs):</u>

- During travel to and from impact zones, including Illeginni Islet, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.
- Any observation of marine mammals or sea turtles during ship travel or overflights would be reported to the USAG-KA Environmental Engineer.
- Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life.

- Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous waste incidents would comply with the emergency procedures set out in the Kwajalein Environmental Emergency Plan (KEEP) and the UES.
- Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport and would not intentionally discharge fuels or waste materials into terrestrial or marine environments.
- All equipment and packages shipped to USAKA will undergo inspection prior to shipment to prevent the introduction of alien species into Kwajalein Atoll.
- Pre-flight monitoring by qualified personnel will be conducted on Illeginni Islet for sea turtles or sea turtle nests. For at least 8 weeks preceding the FE-2 launch, Illeginni Islet would be surveyed by pre-test personnel for sea turtles, sea turtle nesting activity, and sea turtle nests. If possible, personnel will inspect the area within days of the launch. If sea turtles or sea turtle nests are observed near the impact area, observations would be reported to appropriate test and USAG-KA personnel for consideration in approval of the launch and to NMFS.
- Personnel will report any observations of sea turtles or sea turtle nests on Illeginni to appropriate test and USAG-KA personnel to provide to NMFS.
- To avoid impacts on coral heads in waters near Illeginni Islet, sensor rafts would not be located in waters less than 4 m (13 ft) deep.
- When feasible, within one day after the land impact test at Illeginni Islet, USAG-KA environmental staff would survey the islet and the near-shore waters for any injured wildlife, damaged coral, or damage to sensitive habitats. Any impacts to biological resources would be reported to the Appropriate Agencies, with USFWS and NMFS offered the opportunity to inspect the impact area to provide guidance on mitigations.
- Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to the USAG-KA Environmental Office and SMDC, who would then inform NMFS and USFWS. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas would also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.
- For recovery and rehabilitation of any injured migratory birds or sea turtles found at Illeginni Islet, USFWS and NMFS would be notified to advise on best care practices and qualified biologists would be allowed to assist in recovering and rehabilitating any injured sea turtles found.
- If an inadvertent impact occurs on the reef, reef flat, or in shallow waters less than 3 m (10 ft) deep, an inspection by project personnel would occur within 24 hours. Representatives from the NMFS and USFWS would also be invited to inspect the site as soon as practical after the test. The inspectors would assess any damage to coral and other natural and biological resources and, in coordination with SSP, USAG-KA and RTS representatives, decide on any response measures that may be required.
- Debris recovery and site cleanup would be performed for land or shallow water impacts. To minimize long-term risks to marine life, all visible project-related debris would be recovered during post-flight operations, including debris in shallow lagoon or ocean

waters by range divers. In all cases, recovery and cleanup would be conducted in a manner to minimize further impacts on biological resources.

- At Illeginni Islet, should any missile components or debris impact areas of sensitive biological resources (i.e., sea turtle nesting habitat or coral reef), a USFWS or NMFS biologist would be allowed to provide guidance and/or assistance in recovery operations to minimize impacts on such resources. To the greatest extent practicable, when moving or operating heavy equipment on the reef during post-test clean up, protected marine species including invertebrates will be avoided or effects to them will be minimized. This may include movement of these organisms out of the area likely to be affected.
- During post-test recovery and cleanup, should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work would be delayed until such species were out of harm's way or leave the area.

3.1 Interrelated/Interdependent Actions

Military training and testing at Kwajalein Atoll has been ongoing since World War II. Testing of missile programs at Kwajalein began in 1959 for the Nike Zeus missile program. The Minuteman (MM) I program began in 1962, MMII began in 1965, and MMIII began in 1970. In addition to the MM program, anti-ballistic missile (ex. THAAD), and other missile development and testing take place at the RTS, along with other military training and testing activities, and commercial missile launches. If it were not for these numerous activities, it is doubtful that the facilities at USAKA and RTS would be required. Therefore actions to develop and maintain USAKA and RTS facilities and infrastructure, and to support the various missions, are interrelated and/or interdependent with the training and testing activities that occur at the USAKA and RTS. However, much of the infrastructure and facilities are designed to support numerous programs and missions, with few being project-specific. Therefore, support activities that are solely attributable to the FE-2 testing program constitute a small portion of the total that occur at USAKA and RTS in support of the site's numerous missions. Further, per the Document of Environmental Protection (DEP) procedures outlined in the UES, any USAKA and RTS actions that may affect the USAKA environment require structured environmental review, with coordination and/or consultation as appropriate. Based on this, we expect that interrelated or interdependent actions that may be solely attributable to the FE-2 test would be virtually inseparable from the routine activities at USAKA and RTS, and any impacts those actions may have would be considered through the DEP procedures outlined in the UES.

3.2 Action Area

As described above, the action area for this consultation begins after the launch immediately offshore from PMRF, Kauai, where the sonic boom of the accelerating missiles would reach the ocean surface. The action area extends from there, across the Pacific Ocean along a relatively narrow band of ocean area directly under the flight path of the missile, where the sonic boom and spent missile components are expected to impact the surface (Figures 1 and 3). The action area also includes the area of and around Kwajalein Atoll, RMI where the payload would impact the target areas (Figure 5), as well as the areas immediately around support vessels and sensor rafts used to monitor the payload impacts, and the down-current extent of any plumes that may result from discharges of wastes or toxic chemicals such as fuels and/or lubricants associated with the machinery used for this activity.

4 Species and Critical Habitats Not Likely to be Adversely Affected

As explained above in Section 1, USASMDC/ARSTRAT determined that the proposed action was not likely to adversely affect (NLAA) the 54 consultation species listed in Table 2, and would have no effect on critical habitats designated under the ESA and/or the UES. With the exception that we have determined that the proposed action may affect, but is NLAA critical habitat that has been designated under the ESA for Hawaiian monk seals and Main Hawaiian Islands (MHI) insular false killer whales, this section serves as our concurrence under section 7 of the ESA of 1973, as amended (16 U.S.C. §1531 *et seq.*), and under section 3-4.5.3(d) of the UES, 15th Edition, with USASMDC/ARSTRAT's determination.

The UES does not specifically define the procedure to make a NLAA determination. However, the Compact clearly intends that the UES provide substantially similar environmental protections as the ESA. We interpret this to include adoption of the ESA NLAA determination process. In order to determine that a proposed action is not likely to adversely affect listed species, under the ESA, we must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint FWS-NMFS Endangered Species Consultation Handbook. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are positive effects without any adverse effects (FWS and NMFS 1998). As described in Section 2, test flights have 3 distinct phases: Launch; Over-Ocean Flight; and Terminal Flight and Impact in the RMI. Each phase has potential stressors, listed below, that are based on what the missile is doing, and on activities done to support the test.

Over-Ocean Flight: The potential stressors during over-ocean flight are:

a. Exposure to elevated noise levels;
b. Impact by falling missile components; and
c. Exposure to hazardous materials.

Terminal Flight and Reentry Vehicle Impact in the RMI: The potential stressors during terminal flight, payload impact, and preparation and restoration work at Kwajalein Atoll are:

a. Exposure to elevated noise levels;
b. Impact by falling missile components;
c. Exposure to hazardous materials;
d. Disturbance from human activity and equipment operation; and
e. Collision with vessels.

NMFS has determined an additional stressor from this proposed action:

a. Long-term addition of man-made objects to the ocean.

Each of these stressors are addressed below to determine whether or not individuals of any of the ESA-listed and UES-protected marine species considered in this consultation are likely to be adversely affected by that stressor. The species that may be exposed to stressors during each phase, and their likely response to exposure are based on the biological and/or ecological characteristics of each species. Any incidence where a stressor has more than a discountable risk of causing an adverse effect on any individual of the ESA- and/or UES-protected species will result in that stressor and those species being considered in the following biological opinion.

a. Exposure to elevated noise levels: While in flight between PMRF and Kwajalein Atoll, the missile and the payload would travel at velocities that cause sonic booms. High-intensity in-water noise would be created when large missile components, such as spent rocket motors' impact the ocean's surface (splash-down). The impact from the payload hitting the ground will also create a sound to land and water that could transfer to water causing impulsive sound sources. High intensity impulsive noises can adversely affect marine life. The USASMDC/ARSTRAT will also create sounds from vessels and human activity in and near water during placement and retrieval of sensors and other data collecting instruments, and retrieval of debris from the impact. Effects vary with the frequency, intensity, and duration of the sound source, and the body structure and hearing characteristics of the affected animal. Effects may include: non-auditory physical injury; temporary or permanent hearing damage expressed as temporary threshold shift (TTS) and permanent threshold shift (PTS) respectively; and behavioral impacts such as temporarily masked communications or acoustic environmental cues and modified behaviors.

Sound is a mechanical disturbance consisting of minute vibrations that travel through a medium, such as air, ground, or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or cycles per second. Sound level describes the sound's loudness. Loudness can be measured and quantified in several ways, but the logarithmic decibel (dB) is the most commonly used unit of measure, and sound pressure level (SPL) is a common and convenient term used to describe intensity. Sound exposure level (SEL) is a term that is used to describe the amount of sound energy a receiver is exposed to over time. The dB scale is exponential. For example, 10 dB yields a sound level 10 times more intense than 1 dB, while a 20 dB level equates to 100 times more intense, and a 30 dB level is 1,000 times more intense. Sound levels are compared to a reference sound pressure, based on the medium, and the unit of measure is the micro-Pascal (μPa). In water, sound pressure is typically referenced to a baseline of 1 μPa (re 1 μPa), vice the 20 μPa baseline used for in-air measurements. As a rule of thumb, 26 dB must be added to an in-air measurement to convert to an appropriate in-water value for an identical acoustic source (Bradley and Stern 2008). Root mean square (RMS) is the quadratic mean sound pressure over the duration of a single impulse. RMS is used to account for both positive and negative values so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units rather than by peak pressures. For brevity, all further references to sound level assume dB_{rms} re 1 μPa, unless specified differently.

Transmission loss (attenuation of sound intensity over distance) varies according to several factors in water, such as water depth, bottom type, sea surface condition, salinity, and the amount of suspended solids in the water. Sound energy dissipates through mechanisms such as spreading, scattering, and absorption (Bradley and Stern 2008). Spreading refers to the apparent decrease in sound energy at any given point on the wave front because the sound energy is spread across an increasing area as the wave front radiates outward from the source. In unbounded homogenous water, sound spreads out spherically, losing as much as 7 dB with each doubling of range. Toward the other end of the spectrum, sound may expand cylindrically when vertically bounded such as by the surface and substrate, losing only about 3 dB with each doubling of range. Scattering refers to the sound energy that leaves the wave front when it "bounces" off of an irregular surface or particles in the water. Absorption refers to the energy that is lost through conversion to heat due to friction. Irregular substrates, rough surface waters, and particulates and bubbles in the water column increase scattering and absorption loss. Shallow nearshore water around Illeginni where the payload may impact, is vertically bounded by the seafloor and the surface, but is considered a poor environment for acoustic propagation because sound dissipates rapidly due to intense scattering and absorption. The unbounded deep open ocean waters where the motors would impact is considered a good acoustic environment where spherical spreading would predominate in the near field.

In the absence of location-specific transmission loss data, equations such as RL = SL – #Log(R) (RL = received level (dB); SL = source level (dB); # = spreading coefficient; and R = range in meters (m)) are used to estimate RL at a given range (isopleth). Spherical spreading loss is estimated with spreading coefficient of 20, while cylindrical spreading loss is estimated with spreading coefficient of 10. Spreading loss in near shore waters is typically somewhere between the two, with absorption and scattering increasing the loss. $RL = SL - 20_{Log}(R)$ was used here to estimate ranges in deep open ocean water, and $RL = SL - 15_{Log}(R)$ was used to estimate ranges in the lagoon and reef flat areas around Illeginni.

The sound pressures associated with non-auditory injury are very high and are generally associated with a shock wave that is generally not found in sounds that are created by a splashdown. The Navy identified a threshold for non-auditory injury based on gastrointestinal bursting at 237 dB re: 1 µPa (Finneran and Jenkins 2012). The sounds estimated from the splashdowns and sonic booms are clearly below those thresholds and are not likely to cause non-auditory injury to marine mammals, sea turtles, elasmobranchs, and large fishes.

Table 5. Estimated thresholds for TTS and behavioral changes for hearing groups. Source: Finneran and Jenkins 2012; Popper et al. 2014; NMFS 2016.

Hearing Group	**TTS peak pressure threshold (SPL_{peak})**	**Weighted TTS onset threshold (SEL_{CUM})**	**Estimated threshold for behavioral changes**
Low-frequency cetaceans (humpback whale and other baleen whales)	213 dB	179 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
Mid-frequency cetaceans (dolphins, pilot whales and other toothed whales)	224 dB	178 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
High-frequency cetaceans (Kogia, true porpoises)	196 dB	153 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
Phocid pinnipeds (Hawaiian monk seals and other true seals)	212 dB	181 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
Sea turtles	224 dB	200 dB	160 dB
Sharks, rays, and fish	229 dB*	186 dB*	150 dB

* - SPL for lethal and sublethal damage to fish with swim bladders exposed to not specific to hearing.

The threshold for the onset of behavioral disturbance for all marine mammals from a single exposure to impulsive in-water sounds is ≥ 160 dB. Ongoing research suggests that these thresholds are both conservative and simplistic (detailed in Southall et al. 2007 and NOAA 2013). The draft revised thresholds for marine mammals uses two metrics: 1) exposure to peak sound pressure levels (SPL_{peak}); and 2) exposure to accumulated sound exposure levels (SEL_{cum}). The thresholds for single exposures to impulsive in-water sounds are listed in Table 5 for the onset of injury and temporary hearing impacts (NMFS 2016). Corals and mollusks can react to exposure to intense sound and could be affected by concussive forces if exposed to very intense sound sources such as an underwater detonation.

Sonic booms

A sonic boom is a thunder-like noise caused by the shock wave generated by an object moving at supersonic speed. As objects travel through the air, the air molecules are pushed aside with great force and this forms a shock wave much like a boat creates a bow wave (Kahle et al. 2019). Exposure to sonic booms would have insignificant effects on any of the species considered in this consultation. The FE-2 vehicle may generate sonic booms from shortly after launch, along the flight path in the BOA, to impact at or near Illeginni. Sound attenuates with distance from the source due to spreading and other factors. The higher the missile climbs, the quieter the sonic boom would be at the Earth's surface. Similarly, the greater the distance either side of the centerline of the flight path, the quieter the sonic boom. Therefore, the sound intensity would be loudest directly below the missile when the component is closest to the surface. Additionally, Laney and Cavanagh (2000) report that sound waves arriving at the air/water interface at an angle less steep than 13.3º from of the vertical will not normally propagate into water. This means that within the footprint of the sonic boom, only those marine animals within 13.3º of directly below the source could be expected to hear the sonic boom. Sounds originating in air, even intense ones like sonic booms transfer poorly into water, and most of its energy would refract at the surface or absorb in waves or natural surface disturbance at the surface. Once in the water, the sounds of a sonic boom would attenuate with distance. For this project, Kahle et al. (2019) estimated sound transfer from air to water using a model absent all atmospheric variables that would increase refraction, absorption, and dissipation. The loudest sounds were assumed to be near launch (145 dB re: 1 μPa) and at impact site (175 dB). Considering the short (few seconds) duration of the exposure, as noted below, neither are loud or long enough to cause TTS in animals of any of the hearing groups.

Using a model absent most variables that would reduce spreading, (Navy 2017)) predicted the sonic boom footprint of sounds ≥ 160 dB to cover at most a 20.9 square mile radius, and 130.5 square mile radius for sounds ≥ 150 dB. The duration of a sonic boom at any given point within the footprint would be about 0.27 seconds.

In summary, at its loudest (175 dB), an in-water sonic boom exceeds no thresholds for injury to any of the species considered in this consultation, and it is well below the new proposed threshold for the onset of temporary hearing impacts for all hearing groups. Large areas were estimated to be affected by sounds high enough to cause behavioral responses for turtles and fish. However, the models did not account for refraction at the surface, wind or other atmospheric factors like wind and moisture that would dissipate the spreading; it will actually be a much smaller area, as would the corresponding estimate of animals affected by the sonic boom. Those factors would also significantly reduce the intensity of the noise in the water column where most of the UES consultation species spend the majority of their time. Nonetheless, the USASMDC/ARSTRAT estimated that they could affect animals in those respective areas of effect if they were near the surface. All animals in the action area could be exposed to the sonic boom at the impact site for no more than 0.3 seconds. We believe that, at most, an exposed individual may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects.

Exposure to splash-down noise caused by the impact of the falling components in the BOA would be discountable for any of the species considered in this consultation. Three spent rocket motors and a nose fairing will fall into the ocean during the flight. The motors are the only components of sufficient size and velocity to create significant noise levels on splash-down. The noise generated by the splash-down will be heard by every hearing group, some even up to a few miles away. The USASMDC/ARSTRAT predicted the impulsive noises created by the splash based on the size of the components, listed in Table 6.

Table 6. Stage Impact Contact Areas and Peak Sound Pressure Levels for FE-2 Vehicle Components (Kahle et al. 2019).

Stage	Contact Area m^2 (ft^2)	Peak Sound Pressure Level (dB re 1 μPa)
Stage 1 Spent Motor	27.73 (81.12)	218
Stage 2 Spent Motor	10.17 (33.38)	205
Nose Fairing	16.81 (55.14)	196
Stage 3 Spent Motor	5.94 (19.5)	201

Of the three motors, the first stage is the largest and the one expected to make the most noise on impact; a brief (less than one second) impulse of 218 dB @ 1m (Kahle et al. 2019). The vehicle is designed to avoid NWHI. All four objects would fall into deep open ocean waters. The first would splash-down shortly after takeoff near Kaula Rock in the Hawaiian Islands. The remaining objects would splash-down in tropical waters closer to the target site at Illeginni Islet than Hawaii but still in deep ocean waters. Cetaceans, sea turtles, adult scalloped hammerhead sharks, oceanic white tip sharks, bigeye thresher sharks, rays, and pelagic fish may be affected by this stressor. Hawaiian monk seals may be affected by this stressor near the launch.

As sounds dissipate with distance, they get less intense and are less capable of producing injury and behavioral responses. Assuming spherical spreading, the range to the hearing groups' TTS isopleths around each splash-down are listed in Table 7. Since exposure to sounds that could cause TTS would be harmful, we evaluated the probability of an exposure to UES consultation species. The best information available to describe the abundance and distribution of open ocean species considered in this consultation, supports the understanding that these animals are widely scattered, and their densities are very low in the open ocean areas where the motors would splash-down. We know of no information to suggest that the splash-down zones are in areas of any significance that would cause any congregations of these species.

Because the area of influence for TTS is within feet of their impact with the surface, the splash-downs will create an acoustic area of effect little or no greater than that of direct contact. As such, the probability of exposure is the same as a direct contact. The USASMDC/ARSTRAT compared marine mammal density information from Hawaii, and sea turtle density information from Guam, against the expected range of effect around falling missile components to estimate the probability of effect. Their modeling suggests that the probability of exposing marine mammals to a TTS-level exposure for a test flight would be between 1 in 261,327 chance for the most common and sensitive species (Hanser et al. 2013). This is likely an overestimate, since those calculations did not include weighting factors used in our evaluations, which reduce the zone of influence. Based on the low annual number of splash-downs, their wide spacing, their small area of effect (< 100 m), and the expected low densities of the consultation species in the affected areas, we believe that the risk of exposure to splash-down acoustic effects in the open ocean is discountable for all of the species considered in this consultation.

Table 7. Estimated distances from source noise to TTS thresholds

Hearing Group	TTS peak pressure threshold (SPL_{peak})	Isopleths to TTS threshold from:			
		218 dB	205 dB	201 dB	196 dB
Low-frequency cetaceans (humpback whale and other baleen whales)	213 dB	1.8 m (5.9 feet)	0.4 m	0 m	0 m
Mid-frequency cetaceans (dolphins, pilot whales and other toothed whales)	224 dB	0 m	0 m	0 m	0 m
High-frequency cetaceans (Kogia, true porpoises)	196 dB	0.2 m (0.65 feet)	0 m	0 m	0 m
Phocid pinnipeds (Hawaiian monk seals and other true seals)	212 dB	1 m (3.28 feet)	0.2 m	0 m	0 m
Sea turtles	224 dB	0 m	0 m	0 m	0 m
Sharks, rays, and fish	229 dB*	0 m	0 m	0 m	0 m

In each hearing group, the individuals affected would have to be within six feet of the source to experience TTS. The sounds produced by splashdowns will be louder or equal to the 160 dB behavior response thresholds for all hearing groups, up to ½ mile away from the source for some species, and some species should be able to detect sounds (below behavior thresholds) for a few more miles. The sounds will be a short impulse, which will dissipate within seconds of impact. We believe that, at most, an exposed individual may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure.

The USASMDC/ARSTRAT will use vessels of varying size to install and retrieve equipment in water to gather data and remove debris. Large vessels can create sounds ranging from 170-190 dB (re: 1 µPa). Smaller vessels like skiffs with outboards range from 150-170 dB. Vessels are generally moving and the sound sources are considered non-impulsive and mobile. Human activity in water during retrieval of instruments, debris, and ejecta are not louder than those sources. Air bubbles from SCUBA are among the higher noise sources considered, and were reported by Radford et al. (2005) with mean levels of 161 dB and mean peak levels of 177 dB at 1 meter. We consider this source a non-impulsive, mobile, intermittent noise source. Because of the mobile nature of vessels and the intermittent nature of SCUBA bubbles, animals of all hearing groups are not likely to be exposed to the source long enough or continuously enough to experience TTS from vessels and SCUBA air bubbles. Furthermore, behavioral disturbances are likely brief because the mobile and temporary nature of the sources, and the noises will likely have an immeasurable effect on an individual's behavior during and after exposure.

For payload impacts in the ocean south of Illeginni, sea turtles, scalloped hammerhead sharks, oceanic white tip sharks, bigeye thresher sharks, manta rays, and humphead wrasse along the outer edge of the fringing reef may be exposed to a brief pulse of sound from air or underground.

The USASMDC/ARSTRAT recorded similar payload strikes at Illeginni that produced sounds at a level of 140 dB re: 20 µPa 18 m from the source. Using backtracking, the measurements corresponds to a source level of 165 dB, and loosely corresponds to underwater sounds at 191 dB. This is likely an overestimate, because the model did not account for sound refraction, absorption, and other dissipation which happens in natural environments. By the time the sound reaches water, it will likely be less than 191 dB. The sound at payload impact will be too low to cause TTS. At most, we expect that an exposed individual may experience a temporary behavioral disturbance, in the form of slight change in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects. Being much less acoustically sensitive, any exposed corals or mollusks that may be on the outer reef edge are expected to be unaffected by payload impact noise. Based on the best available information, exposure to splash-down noise is expected to have insignificant effects for all species considered in this consultation.

b. Impact by falling missile components: For the reasons discussed below, it is discountable that any of the species considered in this consultation would be hit by falling missile components, or to be close enough to an impact site to be significantly affected by concussive forces. It is also discountable that any of the species identified in Table 2 would be hit by payload or ejecta, or be significantly affected by concussive forces during the single planned payload strike on Illeginni Islet. However, the payload strike on Illeginni Islet may adversely affect the species identified in Table 1. Therefore, the potential effects of this stressor on those species are considered below in the effects of the action section (Section 4).

Direct Contact

The Proposed Action will result in spent rocket motors and the nose fairing splashing down into the BOA as well as impact of the payload on land at Illeginni Islet. These falling components will directly contact aquatic and/or terrestrial habitats and have the potential to directly contact consultation species. Payload component contact with the land may result in cratering and ejecta radiating out from the point of impact.

On January 11, 2005, the FWS issued a no-jeopardy Opinion regarding effects on nesting green sea turtles at Illeginni Islet for the U.S. Air Force's (USAF) Minuteman III testing, another missile test operation which is conducted at the same Islet and target site. The FWS Opinion included an incidental take statement for the annual loss of no more than three green sea turtle nests, or injury or loss of up to 300 hatchlings, per year as a result of reentry vehicles impacts at Illeginni Islet. While direct estimates for cratering and ejecta field size are not available for the FE-2 proposed payload, cratering and ejecta are expected to be less than those of MMIII reentry vehicles (RVs). Therefore, MMII estimates of cratering and shock waves (USAFGSC and USASMDC/ARSTRAT 2015) are used as a maximum bounding case for this proposed action.

Three spent rocket motors, and various smaller/lighter missile components would fall into the ocean during the flight. To be struck by a missile component, an animal would have to be at, or very close to the surface, and directly under the component when it hits. USASMDC/ARSTRAT (2019) reports that the first stage motor is about 4.6 m long, 1.37 m in diameter, and is the largest component. The second stage motor is 2.26 m long with a diameter of 1.37 m and the third stage motor is 1.32 m long with a diameter of 1.37 m. Direct contact areas for these individual components are listed in Table 6 and total approximately 61 m^2.

If a spent rocket motor or other FE-2 component were to strike a cetacean, sea turtle, or fish near the water surface, the animal would most likely be killed or injured. Based on the above discussed affected areas, and the best available species density information, chances of direct contact to cetaceans and sea turtles in the BOA were calculated. Calculations are based on methodology in the Mariana Islands Training and Testing Activities Final EIS (Appendix G in US Navy 2015a) and the Hawaii-Southern California Training and Testing EIS (Appendix G in US Navy 2013).

A probability of direct contact and total number of exposures by falling components in the BOA were calculated for each marine mammal species and for a sea turtle guild for each FE-2 component based on component characteristics and animal density in the Action Area (SSP 2019). The probability analysis is based on probability theory and modified Venn diagrams with rectangular "footprint" areas for the individual animals and the component impact footprints within the Action Area. Sea turtles were combined into a "sea turtle guild" for analyses due to the lack of species specific occurrence data (Hanser et al. 2013). This sea turtle guild is composed of primarily green and hawksbill turtles as they account for nearly all sightings; however, in theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles (Hanser et al. 2013; SSP 2017, 2019). These analyses assume that all animals would be at or near the surface 100 percent of the time and that the animals are stationary. While these assumptions do not account for animals that spend the majority of time underwater or for any animal movement or potential avoidance to proposed activities, these assumptions should lead to a conservative estimate of direct contact effect on listed species.

Their modeling suggests that the probability of exposing marine mammals to direct impact or injurious concussive force for a test flight would be between 1 in 117,000 and 1 in 14,700,000 depending on the species (

Table 8). The probability of exposing sea turtles is 1 in 710,000 (SSP 2017, 2019). No density information is available for scalloped hammerhead sharks, bigeye thresher sharks, oceanic white tip sharks, bluefin tuna, and the reef or giant manta ray but their densities are believed to be relatively low. Based on that and the expectation that they would be well below the surface most of the time, we believe that the probability of their exposure to direct impact or injurious concussive force would be as low or lower than those described above. While larval stages of fish, corals, and mollusks may also be found in the BOA we believe that the densities are also relatively low and will also be at depths greater than where significant impacts are expected to occur and therefore the probability that any will be impacted is extremely low. The corals considered in this consultation are restricted to shallow nearshore waters well away from missile components falling into the ocean. Therefore, that stressor would have no effect on them. Based on the best available information, we believe that it is discountable that any of the species considered in this consultation would be exposed to missile components falling into the BOA.

Table 8. Probability of Direct Contact from FE-2 Vehicle Components and Estimated Number of Marine Mammal and Sea Turtle Exposures in the BOA.[1]

Species / Group	Average Probability of Impacting One Animal Across Scenarios based on Animal and Component Size				Average Number of Exposures Across Scenarios (number of animals)				Estimated Total Number of Exposures
	1st Stage Motor	2nd Stage Motor	Nose Fairing	3rd Stage Motor	1st Stage Motor	2nd Stage Motor	Nose Fairing	3rd Stage Motor	
Marine Mammals									
Balaenoptera acutorostrata	3.18E-08	1.98E-09	3.24E-09	7.09E-10	1.56E-06	6.31E-07	1.03E-06	3.96E-07	3.62E-06
B. borealis	4.90E-08	3.49E-09	5.27E-09	1.37E-09	9.10E-08	4.21E-08	6.37E-08	2.90E-08	2.26E-07
B. edeni	4.56E-08	3.18E-09	4.86E-09	1.24E-09	6.56E-08	3.55E-08	5.43E-08	1.89E-08	1.74E-07
B. musculus	8.72E-08	7.23E-09	1.00E-08	3.15E-09	5.06E-08	2.73E-08	3.77E-08	2.08E-08	1.36E-07
B. physalus	6.84E-08	5.34E-09	7.65E-09	2.23E-09	4.77E-08	2.42E-08	3.46E-08	1.77E-08	1.24E-07
Feresa attenuata	1.78E-08	8.80E-10	1.66E-09	2.66E-10	9.09E-07	2.92E-07	5.50E-07	1.54E-07	1.91E-06
Globicephala macrorhynchus	2.30E-08	1.27E-09	2.24E-09	4.20E-10	2.65E-06	2.88E-07	5.07E-07	1.47E-07	3.59E-06
Grampus griseus	1.85E-08	2.50E-09	3.96E-09	9.36E-10	2.07E-06	8.88E-07	1.40E-06	5.81E-07	4.94E-06
Indopacetus pacificus	2.98E-08	1.81E-09	3.01E-09	6.39E-10	1.07E-06	4.24E-07	7.03E-07	2.62E-07	2.46E-06
Kogia breviceps	1.94E-08	9.98E-10	1.83E-09	3.11E-10	6.55E-07	2.19E-07	4.02E-07	1.19E-07	1.40E-06
K. sima	1.80E-08	8.93E-10	1.67E-09	2.70E-10	1.49E-06	4.81E-07	9.02E-07	2.55E-07	3.13E-06
Lagenodelphis hosei	1.80E-08	8.93E-10	1.67E-09	2.70E-10	4.38E-06	1.42E-06	2.65E-06	7.50E-07	9.20E-06
Megaptera novaeangliae	4.90E-08	3.49E-09	5.27E-09	1.37E-09	5.86E-06	6.58E-07	9.95E-07	4.54E-07	7.97E-06
Mesoplodon densirostris	2.40E-08	1.35E-09	2.35E-09	4.49E-10	2.39E-07	8.75E-08	1.52E-07	5.09E-08	5.30E-07
Orcinus orca	3.18E-08	1.98E-09	3.24E-09	7.09E-10	2.21E-08	8.95E-09	1.47E-08	5.62E-09	5.13E-08
Peponocephala electra	1.80E-08	8.93E-10	1.67E-09	2.70E-10	4.17E-07	1.35E-07	2.53E-07	7.14E-08	8.76E-07
Physeter macrocephalus	4.45E-08	3.08E-09	4.73E-09	1.19E-09	8.00E-07	3.06E-07	4.70E-07	1.72E-07	1.75E-06
Pseudorca crassidens	2.40E-08	1.35E-09	2.35E-09	4.49E-10	1.31E-06	1.17E-07	2.03E-07	7.43E-08	1.71E-06
Stenella attenuata	1.68E-08	8.04E-10	1.54E-09	2.37E-10	1.32E-06	2.58E-07	4.93E-07	1.81E-07	2.25E-06
S. coeruleoalba	1.80E-08	8.93E-10	1.67E-09	2.70E-10	7.49E-07	3.86E-07	7.24E-07	2.65E-07	2.12E-06
S. longirostris	1.68E-08	8.04E-10	1.54E-09	2.37E-10	1.58E-06	3.67E-07	7.02E-07	3.20E-07	2.97E-06
Steno bredanensis	1.78E-08	8.80E-10	1.66E-09	2.66E-10	1.05E-06	7.10E-08	1.33E-07	2.91E-08	1.28E-06
Tursiops truncatus	2.03E-08	1.07E-09	1.93E-09	3.37E-10	1.76E-06	4.61E-08	8.36E-08	2.00E-08	1.90E-06
Ziphius cavirostris	2.59E-08	1.50E-09	2.56E-09	5.09E-10	9.01E-08	3.39E-08	5.80E-08	2.02E-08	2.02E-07
Neomonachus schauinslandi	1.73E-08				6.02E-09				6.02E-09
Total Marine Mammal Exposures					**2.92E-05**	**6.68E-06**	**1.18E-05**	**4.01E-06**	**5.17E-05**
Sea Turtles									
Sea Turtle Guild [2]	1.55E-08	6.70E-10	1.25E-09	2.04E-10	6.70E-07	2.17E-07	4.06E-07	1.16E-07	1.41E-06

1 Animal densities used for analyses are presented in table 5-9. The first stage motor would splashdown in motor drop zone 1, the second stage motor and nose fairings in motor drop zone 2, and the third stage motor in motor drop zone 3.
2 Sea turtles were combined into a "sea turtle guild" in the Marine Species Density Database due to the lack of species specific occurrence data (Hanser et al. 2017). This sea turtle guild is composed of primarily green and hawksbill turtles as they account for nearly all sightings in the study area; however, in theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles (Hanser et al. 2017).

Debris and ejecta from a land impact would be expected to fall within 91 m of the impact point. Of the species identified in Table 2, only green and hawksbill sea turtles may occur close enough to the potential impact site at Illeginni Islet to be affected by these stressors. Therefore we believe that, with the exception of green and hawksbill sea turtles, it is discountable that any of those species would be exposed to debris from the payload impact on Illeginni Islet.

Empirical evidence from previous tests corroborates predictions of the propagation of shock waves associated with impact were approximately 37.5 m through the adjacent reef from the point of impact on the shoreline (USAFGSC and USASMDC/ARSTRAT 2015). Although green and hawksbill sea turtles may occur around Illeginni Islet, they do so infrequently and in low numbers, and typically in waters closer to the reef edge, which is over 500 feet from shore, where they spend the majority of their time under water. Therefore, we consider it unlikely that either turtle species would be close enough to shore to be within the range of shock wave effects, and that any exposure to ejecta would be in the form of relatively slow moving material sinking to the bottom near the animal. In the unlikely event of a turtle being within the ejecta zone during the impact, at most, an exposed animal may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects.

Non-larval Fish, Corals, and Mollusks near Illeginni Islet. Non-larval forms of 23 coral species, three fish species, and five mollusk species have the potential to occur on the reefs and waters in the vicinity of Illeginni Islet. These forms include the relevant coral and mollusk species and adults and juveniles of the relevant fish species. Although coral reefs are not planned or expected to be targeted, a land payload impact on the shoreline of Illeginni could result in ejecta/debris fall, shock waves, and post-test cleanup operations, which may affect and will likely adversely affect at least some of the consultation fish, coral and mollusk species on the adjacent reef. The analysis of these potential effects are analyzed below in Section 6.

<u>c. Exposure to hazardous materials</u>: For all of the species considered in this consultation, exposure to action-related hazardous materials is expected to have insignificant effects. During over-ocean flight, any substances of which the launch vehicle is constructed or that are contained on the launch vehicle and are not consumed during FE-2 flight or spent motor jettison will fall into the BOA when first-, second-, and third-stage launch vehicle motors and nose fairing are released. The launch vehicle includes rocket motors, solid rocket propellant, magnesium thorium in the booster interstage, asbestos in the second stage, battery electrolytes (lithium-ion and silver-zinc), radio frequency transmitters, and small electro-explosive devices. Though the batteries carried onboard the rocket motors would be discharged by the time they splash down in the ocean, they would still contain small quantities of electrolyte material. The amount of other toxic substances, such as battery acid, hydraulic fluids, explosive residues and heavy metals is small (SSP 2017, 2019). The affected areas would be very small locations within the drop zones, and the hazardous materials within the missile component debris would sink quickly to the seafloor at depths of multiple thousands of feet; well away from protected marine species. Materials leaked at the surface and in the water column as the debris sinks would be quickly diluted by the enormous relative volume of sea water, aided by the debris' movement through the water column and by ocean currents, thus never accumulating to levels expected to elicit a detectable response should a protected species be exposed to the material in the upper reaches of the water column. On the seafloor, the materials would leak or leach into the water and be rapidly diluted by ocean currents, or leach into bottom sediments. However, it is discountable that any of the consultation species would encounter the diluted materials near the seafloor, or in the bottom sediments.

Pre-test preparatory and post-test cleanup activities may involve heavy equipment and ocean-going vessels, which have the potential to introduce fuels, hydraulic fluids, and battery acids to terrestrial habitats as well as marine habitats. Any accidental spills from support equipment operations would be contained and quickly cleaned up. All waste materials would be transported to Kwajalein Islet for proper disposal in the U.S.

With the payload impact on Illeginni, debris including hazardous materials would fall on Illeginni and possibly into nearshore habitats. The payload carries up to 1,000 lbs of tungsten alloy which will enter the terrestrial and possible marine environments upon impact. The Navy estimated tungsten concentrations at Illeginni Islet over time by using a model which incorporated the results of the column experiments measuring dissolution and sorption of tungsten in Illeginni Islet soils (US Navy 2017b). The dissolution rate and sorption affinities were used to estimate tungsten concentrations in the freshwater zone just below the zone of tungsten deposition in soil. Shortly after tungsten is deposited in the carbonate soil, aqueous tungsten concentrations would increase. With regular precipitation (assumed at 2.5 m/yr) modeled concentrations reached a steady state in less than one year and remained constant for the following 25 years, the period for which the model was run. The steady state concentration was primarily controlled by the rate of tungsten alloy dissolution and the rate of precipitation. Based on the model parameters, estimated aqueous tungsten concentrations will be between 0.006 mg/L and 0.015 mg/L, which are both below the US EPA Residential screening level of 0.016 mg/L.

The payload structure itself contains heavy metals including aluminum, titanium, steel, magnesium, tungsten, and other alloys. Debris and ejecta from a land impact would be expected to fall within 91 m of the impact point. Only trace amounts of hazardous chemicals are expected to remain in terrestrial areas. If any hazardous chemicals enter the marine environment, they are expected to dilute and disperse quickly by currents and wave action. Post-flight cleanup of the impact area will include recovery/cleanup of all visible debris including during crater backfill. Searches for debris would be attempted out to water depths of up to 55 m if debris enters the marine environment. Considering the quantities of hazardous materials, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, we believe that any effects from chemicals will be insignificant to protected species in the area.

d. Long-term addition of man-made objects to the ocean

This operation will scatter missile components throughout the Pacific Ocean. Man-made objects in the form of vessels, piles, pipelines, vehicles, and purposeful and unintended marine debris has entered all oceans for millennia and most of it is unquantified, especially things that do not float. Whales and sea turtles are most commonly observed entangled in fishing gear that floats on the surface, and recent surveys of sea turtles noted that they ingest plastics that float (high-density polyethylene, low-density polyethylene, and polypropylene) more commonly than plastic that does not float (Jung et al. 2018; White et al. 2018). This may suggest that man-made objects that float may pose more risk than objects that lay at the bottom of the ocean.

Almost all of the products in the missiles sink as soon as they impact the water and will likely remain on the bottom after the project is implemented. Missiles are approximately 10.4 m long and weigh approximately 36,000 lbs fully assembled. The booster contains a solid propellant of hydroxyl terminated polybutadiene (HTPB) composition. The amount of propellant is approximately 30,000 lbs, most of which will burn and release into the atmosphere leaving very little left as it enters the ocean and sinks to the bottom. We expect complete combustion of propellant and liquid fuel therefore the amount of material expected to sit at the bottom of the ocean would be less than the reported maximums here. Therefore assuming the maximum weight including if the experimental payload does not detach and is lost in the BOA, a total of 6,000 lbs of material could land in the ocean.

All components of the missile (stages 1-3) are expected to sink immediately after entry into the water. If the payload does not detach and the missile is lost to the BOA, it would be expected to sink as well. We also understand that there is a paucity of data or observations of animals' interactions with debris at the bottom of the ocean, and that carcasses that do not float on the surface are almost never observed or captured for study. Nonetheless, based on empirical observation, the majority of entanglements are observed in gear that floats. Similarly, material that floats are observed more often in ingested non-organic material. The pelagic species are generally observed in the water column and are not considered bottom-dwelling, and they are less likely to be exposed to objects that are at the bottom than if they were mid-column or at the surface and impacts from projectiles are discussed in section b above. We therefore expect the addition to debris from this proposed action to the bottom of the ocean to be insignificant.

e. Disturbance from human activities and equipment operation: Many of the activities done to complete pre-flight preparations and post-flight restoration work at Kwajalein Atoll, would take place in marine waters inhabited by protected marine species covered by this consultation. Those activities may affect any of the species considered in this consultation should those species encounter or be directly impacted by ongoing activities. However, none of the planned activities would intentionally contact marine substrates or consultation species, except those activities taken to restore in-water areas that may be impacted by the payload at Illeginni Islet. Impact restoration actions that may be taken in marine waters around Illeginni Islet may adversely affect species identified in Table 1, but not any of the species identified in Table 2. The sessile species in Table 2 (4 corals and black-lip pearl oyster) are not likely to occur in the area where they could be affected. Similarly, the motile species in Table 2, either do not occur in the area that may be impacted (marine mammals and three oceanic turtles), or they are expected to temporarily leave the area with no measurable effect on their fitness (green and hawksbill turtles, manta rays, oceanic white tip sharks, bigeye thresher sharks, and scalloped hammerhead sharks). The potential effects of in-water restoration activities on the corals and top shell snails in Table 1 will be considered later in the Effects of the Action Section.

For all other operations (vessel movement, dive operations, deployment and recovery of the LIDSS rafts, etc.) the most likely reaction to exposure to the activities, would be a short-term avoidance behavior, where motile species such as marine mammals, sea turtles, and fish temporarily leave the immediate area with no measurable effect on their fitness, then return to normal behaviors within minutes of cessation of the activity. Sessile organisms such as mollusks may temporarily close their shells or adhere more tightly to the substrate, also returning to normal behaviors within minutes of cessation of the activity. Although top shell snails and giant clams may be moved, because of their protective shells, it is unlikely that these animals would be killed or significantly injured.

Corals are not expected to have any measurable reaction to short-term non-contact activities. While it has properly been assumed for listed vertebrate species that physical contact of equipment or humans with an individual constitutes an adverse effect due to high potential for harm or harassment, the same assumption does not hold for listed corals due to two key biological characteristics: 1) all corals are simple, sessile invertebrate animals that rely on their stinging nematocysts for defense, rather than predator avoidance via flight response. So whereas it is logical to assume that physical contact with a vertebrate individual results in stress that constitutes harm and/or harassment, the same does not apply to corals because they have no flight response; and 2) Most reef-building corals, including all the listed species, are colonial organisms, such that a single larva settles and develops into the primary polyp, which then multiplies into a colony of hundreds to thousands of genetically-identical polyps that are seamlessly connected through tissue and skeleton. Colony growth is achieved mainly through the addition of more polyps, and colony growth is indeterminate. The colony can continue to exist even if numerous polyps die, or if the colony is broken apart or otherwise damaged. The individual of these listed species is defined as the colony, not the polyp, in the final coral listing rule (79 FR 53852). Thus, affecting some polyps of a colony does not necessarily constitute harm to the individual.

Planned protective measures would reduce the potential for this interaction by watching for and avoiding protected species during the execution of pre-flight preparations and post-flight restoration work. Based on the best available information, project-related disturbance may infrequently cause an insignificant level of behavioral disturbance for the species identified in Table **2**, but may adversely affect the species identified in Table 1.

f. Collision with vessels: The Proposed Action has the potential to increase ocean vessel traffic in the action area during both pre-flight preparations and post-flight activities, however it is discountable that any of the species considered in this consultation would experience a collision with a project-related vessel. As part of FE-2 flight test monitoring and data collection, sea based sensors will be deployed along the flight path on vessels in the BOA. These three vessels (Figure 1) will travel from PMRF or USAKA to locations along the flight path. Pre-flight activities at or near USAKA will include vessel traffic to and from Illeginni Islet. Prior to launch, radars will be placed on Illeginni Islet and would be transported aboard ocean going vessels. Sensor rafts will also be deployed near the impact site from a LCU vessel. Approximately four vessel round trips to Illeginni will be conducted for pre-flight and four for post-flight activities.

Post-flight, payload debris recovery and clean-up will take place at Illeginni Islet. These post-test cleanup and recovery efforts will result in increased vessel traffic to and from Illeginni Islet. Vessels will be used to transport heavy equipment (such as backhoe or grader) and personnel for manual cleanup of debris, backfilling or any craters, and instrument recovery. Deployed sensor rafts (Figure 6) will also be recovered by a LCU vessel. In the event of an unintended shallow water impact or debris entering the shallow water environments from a land impact near the shoreline, debris would be recovered. Smaller boats will transport divers, and ROVs if needed, to and from Illeginni to locate and recover this debris in waters up to approximately 30.5 m deep on the ocean side of Illeginni and within 152 to 305 m of the islet's shoreline on the lagoon side.

Sea turtles and cetaceans must surface to breathe air. They also rest or bask at the surface. Therefore, when at or near the surface, turtles and cetaceans are at risk of being struck by vessels or their propellers as the vessels transit. Corals could also be impacted if a vessel runs aground or drops anchors on the reef. Conversely, scalloped hammerhead sharks, bigeye thresher sharks, oceanic white tip sharks, manta rays, and humphead wrasse respire with gills and as such do not need to surface to breathe and are only infrequently near the surface. They are also agile and capable of avoiding oncoming vessels.

The conservation measures that are part of this action include requirements for vessel operators to watch for and avoid marine protected species, including adjusting their speed based on animal density and visibility conditions. Additionally, no action-related anchoring is planned and vessel operators are well trained to avoid running aground. Therefore, based on the best available information we consider the risk of collisions between project-related vessels and any of the consultation species identified in Tables 1 and 2 to be discountable.

Critical habitat: Critical habitat for the Hawaiian Monk Seal has been designated in the main Hawaiian Islands and the Northwestern Hawaiian Islands. Critical habitat was designated for this species in 1986 with revisions in 1988 and 2015 (80 FR 50925). In the revised rule, critical habitat includes terrestrial areas used for pupping, nursing, and haul-out as well as marine habitat within 10 m of the seafloor out to the 200 m depth contour (80 FR 50925). No Hawaiian monk seal critical habitat was designated immediately adjacent to the Pacific Missile Range Facility on Kauai, Hawaii.

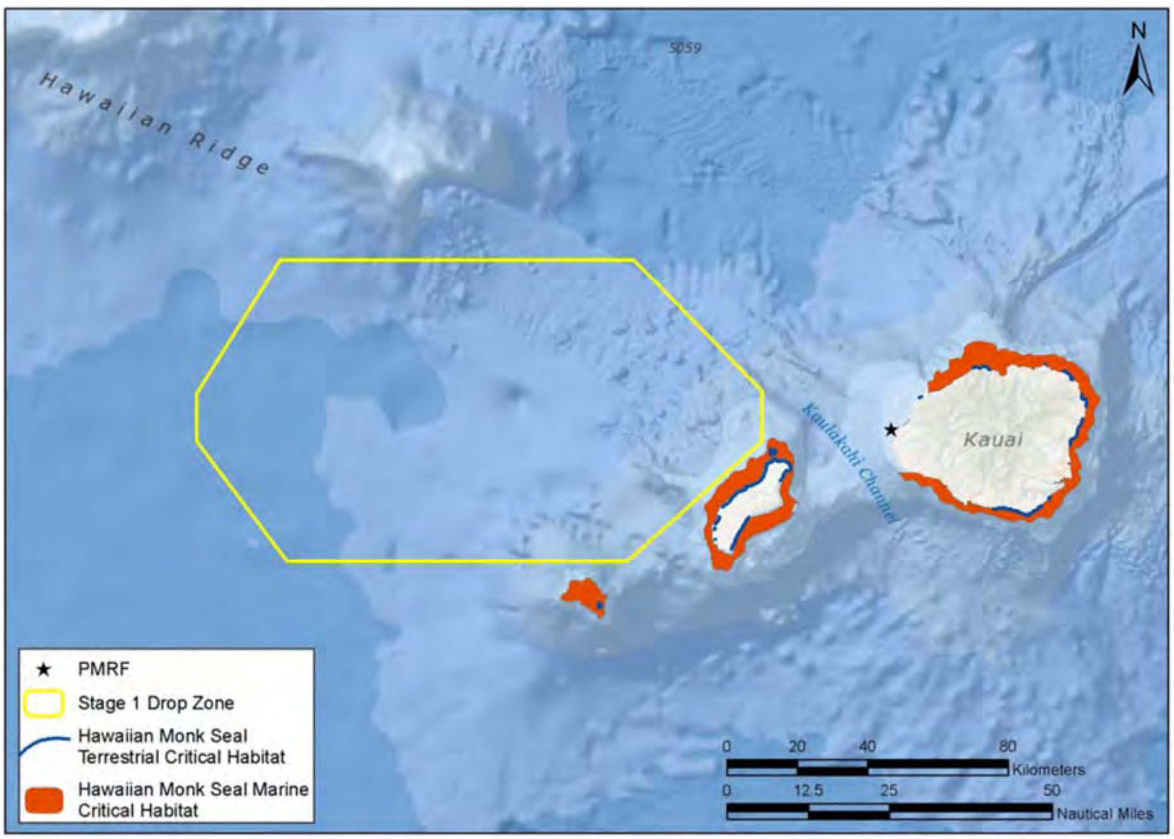

Figure 7. Representative Stage 1 Spent Motor Drop Zone and designated Hawaiian Monk Seal Critical Habitat.

The flight path of the FE-2 flight test is not expected to cross designated critical habitat for Hawaiian monk seals but is expected to cross MHI insular false killer whale critical habitat in the MHI. However, the first stage booster could potentially land in or near monk seal designated critical habitat. Additionally, there is no designated critical habitat within the RMI. The essential features for the conservation of the Hawaiian monk seal are: 1) terrestrial areas and adjacent shallow, sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing; 2) marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging; and 3) significant areas used by monk seals for hauling out, resting or molting.

Designated critical habitat for Hawaiian monk seals is outside the area of effect for the FE-2 flight test. The spent stage one motor drop zone in the BOA is the closest potential action which could affect Hawaiian monk seal critical habitat (Figure 7). The stage one motor drop zone is at least 26 km (16 mi) from critical habitat at Kaula Island, 48 km (30 mi) from critical habitat at Niihau, and 70 km (43 mi) from critical habitat at Nihoa. Therefore any effects to any essential feature of Hawaiian monk seal critical habitat are extremely unlikely to occur. These effects are therefore discountable.

Hazardous materials within the missile, including unburnt propellant, may affect water quality in the immediate area around the splash-down of each stage of the missile. However, as described above, hazardous materials within missile debris would sink quickly to the seafloor, likely to depths of multiple thousands of feet. Any hazardous materials leaked at the surface and in the water column as the debris sinks would be quickly diluted by the enormous relative volume of sea water, aided by the debris' movement through the water column and by ocean currents. The leaching rate of unburned solid propellant in ocean water is very low. That material would sink to the deep seafloor where it would be quickly diluted by ocean currents as it slowly dissolves over years. Therefore, based on the best available information, potential launch failures are expected to have insignificant effects on monk seal designated critical habitat.

NMFS has also identified that critical habitat for the MHI insular false killer whale is within the action area and potentially includes the transit route of the missile's flight path from Kauai and the proposed device's first stage re-entry location (Figure 7) overlaps a portion of the bathymetric profile of the designated critical habitat (45 m to 3,200 m; 83 FR 35062), specifically north of Niihau and Warning Area 187. The expected area of overlap is rather small (shown in orange; Figure 8) and we do not suspect the first stage booster will significantly affect physical and biological features of the designation critical habitat. Specifically, (1) adequate space for movement and use within shelf and slope habitat; or (2) waters free of pollutants of a type and amount harmful to MHI insular false killer whales. The booster is not of sufficient size to exclude the species from accessing preferred habitat. Additionally, if the booster were to actually land in shallower designated critical habitat and sink the bottom, it may act as artificial reef until such time corrosion dissolves the material. Furthermore, we expect all propellant to be used and no liquid chemicals would be introduced into the environment other than the metal material of the first stage. Furthermore, the addition of material to deep ocean depths was already discussed in Section b above. NMFS therefore concludes this proposed action may affect, but is not likely to adversely affect designated MHI insular false killer whale critical habitat, and is therefore considered insignificant.

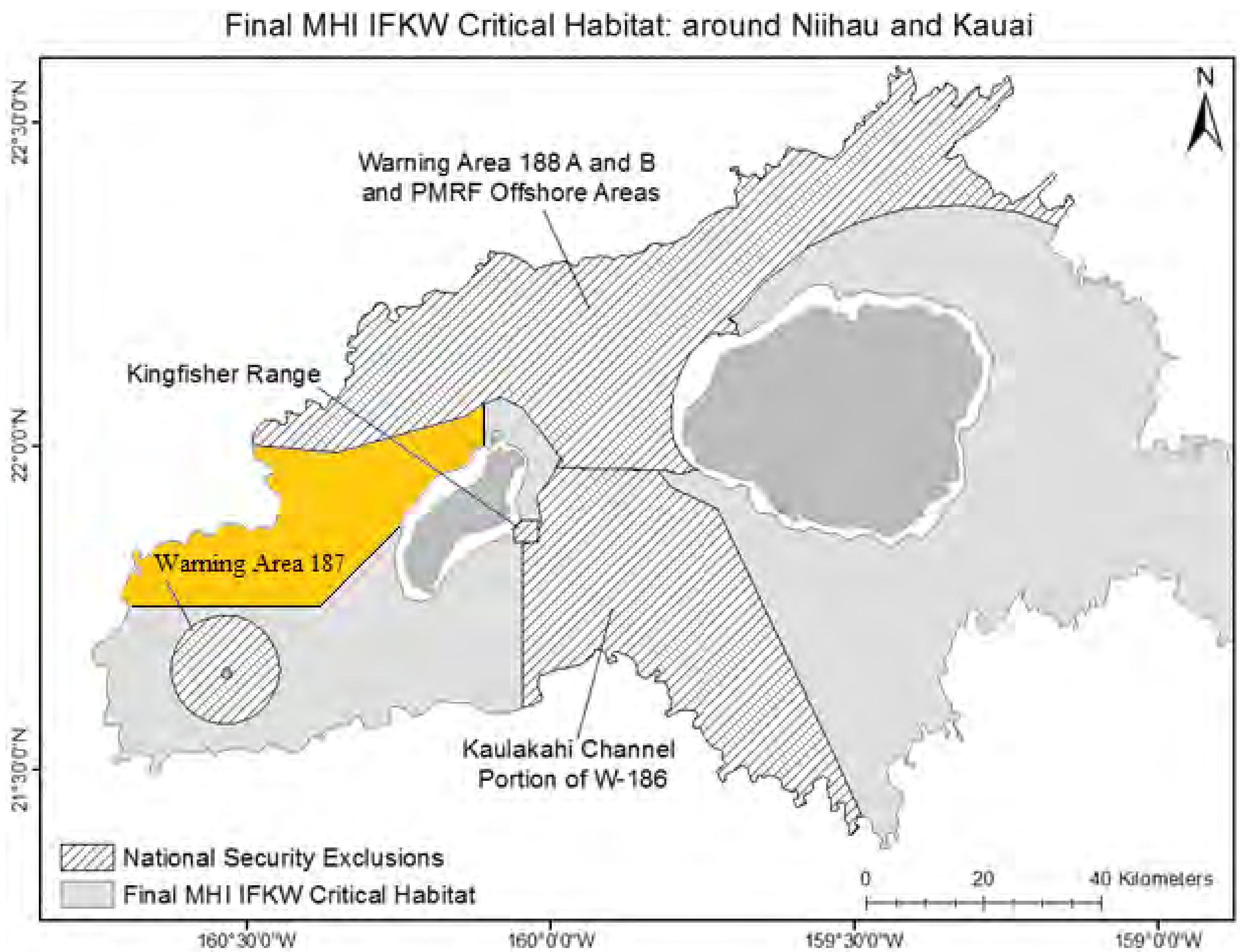

Figure 8. Designated MHI insular false killer whale critical habitat with National Security Exclusion Areas as noted in 83 FR 35062 with approximate projected area of overlap from the proposed action shown in orange[2].

Considering the information presented above, and in the best scientific information available about the biology and expected behaviors of the marine species considered in this consultation, we agree that exposure to the proposed action would have insignificant effects, or the likelihood of exposure would be discountable for the consultation species identified in Table 2. Further, we have determined that the proposed action would have discountable or insignificant effects on designated critical habitat for the Hawaiian monk seal or MHI insular false killer whale.

Therefore, we concur with your determination that conducting the proposed FE-2 flight test is NLAA the consultation species identified in Table 2, and would have no effect on designated critical habitat in the RMI. We have also determined that the proposed FE-2 flight test is NLAA to Hawaiian monk seal and MHI insular false killer whale designated critical habitats. Those species and critical habitats will not be considered further in this consultation.

[2] The orange area shown is designated critical habitat and not Warning Area 187- the circled area around Kaula.

5 Status of the Species

This section presents biological or ecological information for the UES consultation species that the proposed action is likely to adversely affect. As stated above in Section 1, USASMDC/ARSTRAT determined that the proposed action was likely to adversely affect the 11 marine UES consultation species listed in Table 1.

As described above in the introduction, the jeopardy analyses in this Opinion considers the risk of reducing appreciably the likelihood of survival and recovery of UES-protected marine species within USAKA. As such, subsections 5.1 through 5.11.4 provide species-specific descriptions of distribution and abundance, life history characteristics (especially those affecting vulnerability to the proposed action), threats to the species, and other relevant information as they pertain to these animals within USAKA. Factors affecting these species within the action area are described in more detail in the Environmental Baseline (Section 6).

5.1 *Pocillopora meandrina* (Cauliflower coral)

Pocillopora meandrina is listed as a species of "least concern" by the IUCN (IUCN 2015). The Center for Biological Diversity petitioned the NMFS to list the cauliflower coral in Hawaii as endangered or threatened under the ESA in March 2018 (CBD 2018). In September 2018, NMFS found that *P. meandrina* may warrant listing under the ESA (83 FR 47592 [September 20, 2018]). This species is now a candidate for listing under the ESA and is therefore protected under the UES. NMFS is currently conducting a Status Review for the species per the ESA standards.

Pocillopora meandrina is in the family Pocilloporidae. This hard coral species forms small upright bushes up to 30 cm in diameter that are cream, green, or pink in color (CBD 2018). Colonies form flattened branches that uniformly radiate out from the original growth point (CBD 2018). This species has a relatively fast growth rate with high recruitment; however, colonies may also be short lived due to recolonization by other coral species and high sensitivity to disturbance (CBD 2018).

5.1.1 Distribution and Abundance

Pocillopora meandrina is found throughout tropical and subtropical Indian and Pacific oceans in shallow reefs (CBD 2018). This range includes Hawaii, Johnston Atoll, American Samoa, the Marshall Islands, Micronesia, the Northern Mariana Islands, and Palau among other island groups (CBD 2018). *Pocillopora meandrina* occurs in shallow reef environments with high wave energy at depths of 1 to 27 m (CBD 2018). The abundance of this coral is still being determined through the status review process.

5.1.2 Life History Characteristics Affecting Vulnerability to Proposed Action

Pocillopora meandrina has been observed at all 11 of the surveyed Kwajalein Atoll islets since 2010 as well as in the Mid-Atoll Corridor. Overall, *P. meandrina* has been observed at 96% (120 of 125) survey sites in Kwajalein Atoll. This species was observed at 100% (5 of 5) of sites at Illeginni Islet since 2010 including in Illeginni harbor.

5.1.3 Threats to the Species

Major threats to *Pocillopora meandrina* include destruction and/or modification of habitat, harvest for the aquarium trade, disease, predation, and high susceptibility to bleaching due to thermal stress (CBD 2018). During a bleaching event in the coastal waters of West Hawaii in 2015, *P. meandrina* exhibited high post-bleaching mortality with approximately 96% of colonies exhibiting partial post-bleaching tissue loss (greater than 5%) and 78% of colonies exhibiting total post-bleaching mortality (CBD 2018). Other bleaching events in the Hawaiian Islands resulted in 1 to 10% mortality for this species (CBD 2018). NMFS is currently evaluating the threats to the species through its status review process.

5.1.4 Conservation of the Species

Pocillopora meandrina is considered an ESA proposed species and has been retained as a consultation species under the UES.

5.2 *Acropora microclados* (Coral)

A. microclados is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. microclados* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.2.1 Distribution and Abundance

The reported range of *A. microclados* is from the Red Sea and northern Madagascar, the Chagos Archipelago in the central Indian Ocean, through the Indo-Pacific region, and eastward to the central Pacific Ocean out to Pitcairn Island. It ranges as far north as the Ryukyu Islands of Japan, and to the south down along the eastern and western coasts of Australia. *A. microclados* is reported as uncommon to common (Veron 2014). Within the area potentially impacted at Illeginni, *A. microclados* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, all of the other USAKA islands, and at 34 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. microclados* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.2.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. microclados is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. Scleractinian corals act as plants during the day and as animals at night, or in some combination of the two. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard et al. 2011).

A. microclados colonies are typically corymbose plates that are attached to hard substrate, with short, uniform, evenly spaced tapered branchlets. It occurs on upper reef slopes and subtidal reef edges at depths of 5 to 20 m. Like other corals, *A. microclados* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. *A. microclados* is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard et al. 2011).

5.2.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. microclados* to these threats. However, the genus *Acropora* is ranked as one of the more susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard et al. 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Brainard et al. 2011). The susceptibility and impacts of disease on *A. microclados* are not well understood, but subacute dark spots disease has been reported in this species, and its genus is considered moderate to highly susceptible to disease. The crown of thorns seastar (*Acanthaster planci*) and corallivorous snails preferentially prey on *Acropora spp.*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *Acropora spp.* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. microclados* is likely included in this trade (Brainard et al. 2011). As described above, *A. microclados* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects on a global level.

5.2.4 Conservation of the Species

A. microclados is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.3 *Acropora polystoma* (Coral)

A. polystoma is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. polystoma* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.3.1 Distribution and Abundance

The reported range of *A. polystoma* is from the Red Sea to central Africa and Madagascar, and the Chagos Archipelago in the central Indian Ocean, through the Indo-Pacific region, eastward to the Tuamotus in the southeastern Pacific Ocean. It ranges as far north as the south of Taiwan, through the South China Sea and the Philippines, and to the south down along the northern coast of Australia and the Coral Sea. *A. ploystoma* is reported as uncommon to common (Veron 2014).

Within the area potentially impacted at Illeginni, *A. ploystoma* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, all of the other USAKA islands, and at 34 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. polystoma* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.3.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. polystoma is a stony coral. *A. polystoma* colonies are typically clumps or corymbose plates that are attached to hard substrate, with tapered branches of similar length. It occurs in highly active intertidal to shallow subtidal reef tops and edges with strong wave action and/or high currents, at depths down to about 10 m. *A. polystoma* is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard et al. 2011).

5.3.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. polystoma* to these threats. However, the genus *Acropora* is ranked as one of the most severely susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard et al. 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Anthony et al. 2008). The genus *Acropora* is considered moderate to highly susceptible to disease, and *A. polystoma* has been reported to experience severe white-band/white plague disease. The crown of thorns seastar (*Acanthaster planci*) and corallivorous snails preferentially prey on *Acropora spp.*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *Acropora spp.* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. polystoma* is likely included in this trade (Brainard et al. 2011). As described above, *A. polystoma* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.3.4 Conservation of the Species

A. polystoma is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.4 *Cyphastrea agassizi* (Coral)

C. agassizi is found primarily in the Indo-Pacific. As a candidate species for listing under the ESA, *C. agassizi* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.4.1 Distribution and Abundance

The reported range of *C. agassizi* is from Indonesia to the Hawaiian Islands in the central Pacific Ocean, and from southern Japan and the Northern Mariana Islands, south to Northeastern Australia. *C. agassizi* is reported as uncommon (Veron 2014). Within the area potentially impacted at Illeginni, *C. agassizi* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, at six more of the 11 USAKA islands, and at 14 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *C. agassizi* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.4.2 Life History Characteristics Affecting Vulnerability to Proposed Action

C. agassizi is stony coral. *C. agassizi* typically forms deeply grooved massive colonies attached to hard substrate. It occurs in shallow reef environments of back- and fore-slopes, lagoons and outer reef channels at depths of about 2 to 20 m. Like other corals, *C. agassizi* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. The reproductive characteristics of *C. agassizi* are undetermined, but its congeners include a mix of hermaphroditic spawners and brooders (Brainard et al. 2011).

5.4.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. *Cyphastrea* are considered generally resistant to bleaching, but elevated temperatures may still cause mortality within this genus (Brainard et al. 2011). The effects of increased ocean acidity are unknown for this genus, but in general, increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals. It also can induce bleaching more so than thermal stress, and tends to decrease growth and calcification rates. The specific susceptibility and impacts of disease on *C. agassizi* are not known, but some of its congeners have been infected with various "band" diseases. As such, it appears that *C. agassizi* is susceptible (Brainard et al. 2011). The susceptibility of *C. agassizi* to predation is unknown. The effects of land-based pollution on *C. agassizi* are largely unknown, but it may pose significant threats at local scales. This coral light to moderately exploited in trade at the genus level (Brainard et al. 2011). As described above, the genus *Cyphastrea* is considered generally resistant to bleaching, but mortality due to elevated temperatures, which may be attributable to anthropogenic climate change, may still occur. As such, this species may be currently adversely affected by those effects on a global level.

5.4.4 Conservation of the Species

C. agassizi is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.5 *Heliopora coerulea* (Coral)

H. coerulea is a very broadly distributed Indo-Pacific coral. It is considered the oldest living coral species. *H. coerulea* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.5.1 Distribution and Abundance

The reported range of *H. coerulea* is from southern east Africa to the Red Sea, across the Indian Ocean to American Samoa in central Pacific Ocean, and from Japan, south to Australia (Brainard et al. 2011). Colonies of *H. coerulea* are often patchy in their distribution, but can dominate large areas. Within the area potentially impacted at Illeginni, *H. coerulea* is estimated to be scattered across submerged hard pavement reef areas, including intertidal and/or inshore rocky areas, at a density of up to 0.53 colonies/m^2. It has been observed at Illeginni, at all of the other USAKA islands, and at 32 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *H. coerulea* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.5.2 Life History Characteristics Affecting Vulnerability to Proposed Action

H. coerulea is a non-scleractinian stony coral. Stony corals are sessile, colonial, marine invertebrates. Unlike the calcium carbonate skeleton of scleractinian corals, the skeleton of *H. coerulea* consists of aragonite, and it is blue instead of white. As with scleractinian corals, the individual unit of a coral colony is called a polyp, which is typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense, but instead of living in "cups on the surface of the coral, *H. coerulea* polyps live in tubes within the skeleton. Each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue called the coenenchyme. As with other corals, *H. coerulea* acts as a plant during the day and as an animal at night, or in some combination of the two. The soft tissue harbors mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard et al. 2011).

H. coerulea is a massive coral that typically forms castellate blades. It occurs in water depths from the intertidal zone down to about 60 m. It is most abundant from the shallow reef crest down to forereef slopes at 10 m, but is still common down to 20 m. Like other corals, *H. coerulea* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. *H. coerulea* colonies have separate sexes. Fertilization and early development of eggs begins internally, but the planula larvae are brooded externally under the polyp tentacles. Larvae are considered benthic, as they normally distribute themselves by crawling away vice drifting in the plankton (Brainard et al. 2011).

5.5.3 Threats to the Species

Brainard et al. (2011) suggest that *H. coerulea* is a hardy species. They report that it is one of the most resistant corals to the effects of thermal stress and bleaching, and although there is no specific research to address the effects of acidification on this species, it seems to have survived the rapid acidification of the oceans during the Paleocene-Eocene Thermal Maximum acidification. They also report that disease does not appear to pose a substantial threat, and that adult colonies are avoided by most predators of coral. However, the externally brooded larvae are heavily preyed upon by several species of butterflyfish. Although *H. coerulea* tends to prefer clear water with low rates of sedimentation, Brainard et al. (2011) report that sediment appears to pose no significant threat to the species. Land-based sources of pollution may pose significant threats at local scales. Collection and trade appear to be the biggest threat to this species. *H. coerulea* has been reported as one of the top 10 species involved in international trade. Its morphology and natural color make it highly desirable (Brainard et al. 2011). As described above, *H. coerulea* does not appear to be particularly susceptible to effects attributed to anthropogenic climate change, but it is likely being adversely affected by international trade.

5.5.4 Conservation of the Species

H. coerulea is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.6 *Pavona venosa* (Coral)

P. venosa is a broadly distributed Indo-Pacific. It became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.6.1 Distribution and Abundance

The reported range of *P. venosa* extends down the eastern shore of the Saudi Arabian, into the Red Sea, down to central Africa and Madagascar, across the Indian Ocean to include the Chagos Archipelago and Sri Lanka, through the Indo-Pacific region, eastward to the Tuamotus in the southeastern Pacific Ocean. It ranges as far north as the Ryukyu Islands, through the South China Sea and the Philippines, and to the south down along the east and west coasts of Australia and the Coral Sea. *P. venosa* has been reported as common. Within the area potentially impacted at Illeginni, *P. venosa* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, all of the other USAKA islands, and at 16 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *P. venosa* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.6.2 Life History Characteristics Affecting Vulnerability to Proposed Action

P. venosa is a stony coral. *P. venosa* typically forms massive to encrusting colonies attached to hard substrate. It occurs in shallow reef environments at depths of about 2 to 20 m. The reproductive characteristics of *P. venosa* are unknown, but six of its congeners are gonochoric (separate sexes) spawners; releasing gametes of both sexes that become fertilized in the water (Brainard et al. 2011).

5.6.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. *P. venosa* has moderate to high susceptibility to thermal stress induced "bleaching" where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard et al. 2011). In general, increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals. It can increase the susceptibility to thermal stress, and tends to decrease growth and calcification rates (Anthony et al. 2008). No studies have examined the direct impacts of ocean acidification on *P. venosa*, but some evidence suggests that the genus *Pavona* has some degree of tolerance to acidification (Brainard et al. 2011). The specific susceptibility and impacts of disease on *P. venosa* are not known, but susceptibility is considered to be low (Brainard et al. 2011). There are a medium number of reports of acuter white disease for the genus *Pavona*. The susceptibility of *P. venosa* to predation is considered to be low, but there is no specific information. Members of the genus *Pavona* have varied susceptibility to predation by the crown of thorns seastar (*Acanthaster planci*). There is no specific information about the effects of land-based pollution on *P. venosa*, but it may pose significant threats at local scales. International trade includes the genus *Pavona*, but at relatively low levels (Brainard et al. 2011). As described above, *P. venosa* is susceptible to effects of thermal stress, which may be attributable to anthropogenic climate change. As such, this species is likely being adversely affected by those effects across its range.

5.6.4 Conservation of the Species

P. venosa is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.7 *Turbinaria reniformis* (Coral)

T. reniformis is very broadly distributed across the Indo-Pacific region. *T. reniformis* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.7.1 Distribution and Abundance

The reported range of *T. reniformis* includes the Persian Gulf, the Red Sea, and most of the Indian Ocean basin, through the Indo-Pacific region, and eastward to the central Pacific Ocean out to Samoa and the Cook Islands. It ranges as far north as central Japan, down through the Philippines, around New Guinea, and down along the east and west coasts of Australia, and also down the Marianas, the Marshalls, and east to the Line Islands. It has been reported as common (Veron 2014). Within the area potentially impacted at Illeginni, *T. reniformis* is estimated to occur in small aggregations on submerged hard pavement reef areas, at a density of up to 0.16 colonies/m^2. It has been observed at Illeginni, at five more of the 11 USAKA islands, and at nine of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *T. reniformis* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.7.2 Life History Characteristics Affecting Vulnerability to Proposed Action

T. reniformis is a stony coral. *T. reniformis* colonies are attached to hard substrate and typically form large lettuce-like assemblages of plates. The plates tend to be very convoluted in shallow active water, whereas they are broad and flat in deeper calmer waters. It has been reported from the surface down to over 0 to 40 m, commonly on forereef slopes at 10 m and deeper, but it prefers turbid shallow protected waters where it forms massive and extensive stands. Like other corals, *T. reniformis* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. *T. reniformis* is a gonochoric (separate sexes) spawner; releasing gametes of one sex or the other that become fertilized in the water (Brainard et al. 2011).

5.7.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. Susceptibility of *Turbinaria spp*. to thermal stress induced bleaching (where the coral expels its zooxanthellae) varies regionally, and among species, but ranges between low to moderate. The physiological stress and reduced nutrition from bleaching may have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony. However, *T. reniformis* has shown the potential to reduce bleaching impacts through increased heterotrophic feeding rates (Brainard et al. 2011). The susceptibility of *T. reniformis* to acidification appears to be lower than that of other genera of scleractinian corals tested. However, in most corals studied, acidification impaired growth, as well as impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles for some species (Brainard et al. 2011). Susceptibility and impacts of disease on *T. reniformis* are not known, but both white syndrome disease and black lesions have affected members of this genus. Adult colonies of *Turbinaria spp.* are rarely eaten by the crown of thorns seastar (*Acanthaster planci*), but the gastropod nudibranch (*Phestilla sibogae*) both feeds upon, and infects *Turbinaria spp.* with disease. *T. reniformis* appears to tolerate high turbidity and sedimentation, as well as low-salinity events, but land-based toxins and nutrients may have deleterious effects on a regional scale, depending on the substance, concentration, and duration of exposure. The genus *Turbinaria* has been heavily exploited in international trade, and *T. reniformis* is likely included in this trade (Brainard et al. 2011). As described above, *T. reniformis* may be susceptible to some effects attributed to anthropogenic climate change, and as such could be currently adversely affected by those effects on a global level.

5.7.4 Conservation of the Species

T. reniformis is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.8 *Tectus niloticus* (Top Shell Snail)

The top shell snail is also sometime referred to as *Trochus niloticus*. It is a broadly distributed marine gastropod, and is a consultation species under UES section 3-4.5.1 (a).

5.8.1 Distribution and Abundance

The top shell snail is distributed in sub-tropical to tropical waters of the Indo-Pacific region. They are indigenous to Yap, Palau, and Helen Reef in Micronesia, but have been introduced to nearly every island group across the Indo-Pacific region (Smith 1987). Larvae recruit to shallow intertidal zones, typically along exposed (seaward) shores. Individuals migrate into deeper water as they grow (Heslinga et al. 1984) with maximum reported depth being 24 m (Smith 1987). Data are insufficient to determine current population levels and trends across its range, including in the RMI. Within the area potentially impacted at Illeginni, the top shell snail is estimated to be scattered across submerged hard pavement reef areas, including intertidal and/or inshore rocky areas, at a density of up to 0.09 individuals/m^2. It has been observed at Illeginni, at all of the other USAKA islands, and at 12 of 35 sites within the mid-atoll corridor (NMFS 2014a).

5.8.2 Life History Characteristics Affecting Vulnerability to Proposed Action

The top shell is a nocturnal, herbivorous, marine gastropod mollusk. It is normally found on the reef surface in the intertidal and subtidal zones. The life span is between 15 and 20 years, with sexual maturity occurring at about 2 years. It is a hardy species that is commonly relocated between island groups with high success. Dobson (2001), reports that top shell snails can survive out of the water for up to 36 hours when kept cool and damp. After being relocated on a new reef area and left undisturbed for a brief period, top shell snails typically resume normal behaviors with no measurable effects assuming the relocation site supports adequate forage and shelter.

5.8.3 Threats to the Species

The top shell is highly susceptible to over-exploitation. It is an edible species whose shells are also commercially important in the mother of pearl button industry (Heslinga et al. 1984). They are slow moving and are easily spotted by reef-walkers and snorkelers. Unregulated or poorly regulated harvesting has led to their depletion across their range. Although top shell snails are probably beginning to be affected by impacts associated with anthropogenic climate change (described in more detail in the Environmental Baseline section below), no significant climate change-related impacts to its populations have been observed to date.

5.8.4 Conservation of the Species

The top shell is afforded protection at USAKA as a consultation species under the UES (USAKA 2014).

5.9 *Hippopus hippopus* (giant clam)

H. hippopus is broadly distributed across the Indo-Pacific region. It is a candidate species for listing under the ESA, *H. hippopus* became a consultation species under UES section 3-4.5.1 (a).

5.9.1 Distribution and Abundance

H. hippopus are reported to be found in the eastern Indian Ocean at Myanmar and east to the Fiji and Tonga Islands, in the north as far as southern Japan and then south to the Great Barrier Reef, New Caledonia and Western Australia. Within the area potentially impacted at Illeginni, *H. hippopus* was found throughout the lagoon area but was rare on the ocean side in a recent survey conducted at the impact area. It has been observed at Illeginni, and at eight more of the 11 USAKA islands, and at nine of 35 sites within the mid-atoll corridor (NMFS 2017b).

5.9.2 Life History Characteristics Affecting Vulnerability to Proposed Action

H. hippopus is a giant clam which is markedly stenothermal (i.e., they are able to tolerate only a small range of temperature) and thus restricted to warm waters. Giant clams are typically found living on sand or attached to coral rock and rubble by byssal threads (Soo and Todd 2014), but they can be found in a wide variety of habitats, including live coral, dead coral rubble, boulders, sandy substrates, seagrass beds, macroalgae zones, etc. (Gilbert et al. 2006; Hernawan 2010).

The exact lifespan of tridacnines has not been determined; although it is estimated to vary widely between 8 to several hundred years (Soo and Todd 2014). Little information exists on the size at maturity for giant clams, but size and age at maturity vary by species and geographical location (Ellis 1997). In general, giant clams appear to have relatively late sexual maturity, a sessile, exposed adult phase and broadcast spawning reproductive strategy, all of which can make giant clams vulnerable to depletion and exploitation (Neo *et al.* 2015). All giant clam species are classified as protandrous functional hermaphrodites, meaning they mature first as males and develop later to function as both male and female (Chambers 2007); but otherwise, giant clams follow the typical bivalve mollusk life cycle. At around 5 to 7 years of age (Kinch and Teitelbaum 2010), giant clams reproduce via broadcast spawning, in which several million sperm and eggs are released into the water column where fertilization takes place. Giant clam spawning can be seasonal; for example, in the Central Pacific, giant clams can spawn year round but are likely to have better gonad maturation around the new or full moon (Kinch and Teitelbaum 2010). In the Southern Pacific, giant clam spawning patterns are seasonal and clams are likely to spawn in spring and throughout the austral summer months (Kinch and Teitelbaum 2010). Once fertilized, the eggs hatch into free-swimming trochophore larvae for around 8 to 15 days (according to the species and location) before settling on the substrate (Soo and Todd 2014; Kinch and Teitelbaum 2010). During the pediveliger larvae stage (the stage when the larvae is able to crawl using its foot), the larvae crawl on the substrate in search of suitable sites for settlement and metamorphose into early juveniles (or spats) within 2 weeks of spawning (Soo and Todd 2014).

According to Munro (1993), giant clams are facultative planktotrophs, in that they are essentially planktotrophic (i.e., they feed on plankton) but they can acquire all of the nutrition required for maintenance from their symbiotic algae, *Symbodinium*.

5.9.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, pollution, and exploitation. The harvest of giant clams is for both subsistence purposes (e.g., giant clam adductor, gonad, muscle, and mantle tissues are all used for food products and local consumption), as well as commercial purposes for global international trade (e.g., giant clam shells are used for a number of items, including jewelry, ornaments, soap dishes). The extent of each of these threats is largely unknown. Blidberg et al. (2000) studied the effect of increasing water temperature on *T. gigas, T. derasa,* and *H. hippopus* at a laboratory in the Philippines. *H. hippopus* experienced increased respiration and production of oxygen in elevated temperatures and was therefore more sensitive to higher temperature than the two other species tested. After 24 hours at ambient temperature plus 3°C, however, no bleaching was observed for any of the species. The susceptibility and impacts of disease on *H hippopus* are not known, but incidences of mortality from rickettsiales-like organisms in cultured clams in the western Pacific, one in the Philippines and one in Kosrae have been documented (Norton et al. 1993).

5.9.4 Conservation of the Species

H hippopus is listed in CITES Appendix II, is an ESA candidate species and is therefore a consultation species under the UES.

5.10 *Tridacna squamosa (giant clam)*

T. squamosa is broadly distributed across the Indo-Pacific region. It is a candidate species for listing under the ESA, therefore *T. squamosa* is a consultation species under UES section 3-4.5.1 (a).

5.10.1 Distribution and Abundance

T. squamosa has a widespread distribution across the Indo-Pacific. Its range extends from the Red Sea and East African coast across the Indo-Pacific to the Pitcairn Islands. It has also been introduced in Hawaii (CITES 2004). The species' range also extends north to southern Japan, and south to Australia and the Great Barrier Reef (bin Othman *et al*. 2010). This range description reflects the recent range extension of *T. squamosa* to French Polynesia as a result of observations by Gilbert et al. (2007). Within the area potentially impacted at Illeginni, *T. squamosa* was observed in the lagoon area but not on the ocean side in a recent survey conducted at the impact area. It has been observed at Illeginni, at five more of the 11 USAKA islands, and at 24 of 35 sites within the mid-atoll corridor (NMFS 2017b).

5.10.2 Life History Characteristics Affecting Vulnerability to Proposed Action

T. squamosa is a giant clam which are markedly stenothermal (i.e., they are able to tolerate only a small range of temperature) and thus restricted to warm waters. *T. squamosa* is usually recorded on reefs or sand; it is found attached by its byssus to the surface of coral reefs, usually in moderately protected localities such as reef moats in littoral and shallow water to a depth of 20 m (Kinch and Teitelbaum 2010). This species tends to prefer fairly sheltered lagoon environments next to high islands; however, *T. squamosa* appears to be excluded by *T. maxima* in the closed atoll lagoons of Polynesia (Munro 1992). Neo et al. (2009) found that *T. squamosa* larvae, like many reef invertebrates, prefer substrate with crustose coralline algae. *Tridacna squamosa* is also commonly found amongst branching corals (staghorn, *Acropora* spp.; CITES 2004)

The exact lifespan of tridacnines has not been determined; although it is estimated to vary widely between 8 to several hundred years (Soo and Todd 2014). Little information exists on the size at maturity for giant clams, but size and age at maturity vary by species and geographical location (Ellis 1997). In general, giant clams appear to have relatively late sexual maturity, a sessile, exposed adult phase and broadcast spawning reproductive strategy, all of which can make giant clams vulnerable to depletion and exploitation (Neo *et al.* 2015). All giant clam species are classified as protandrous functional hermaphrodites, meaning they mature first as males and develop later to function as both male and female (Chambers 2007); but otherwise, giant clams follow the typical bivalve mollusk life cycle. *T. squamosa* reaches sexual maturity at sizes of 6 to 16 cm, which equates to a first year of maturity at approximately four years old (CITES 2004). Giant clam spawning can be seasonal; for example, in the Central Pacific, giant clams can spawn year round but are likely to have better gonad maturation around the new or full moon (Kinch and Teitelbaum 2010). In the Southern Pacific, giant clam spawning patterns are seasonal and clams are likely to spawn in spring and throughout the austral summer months (Kinch and Teitelbaum 2010). Once fertilized, the eggs hatch into free-swimming trochophore larvae for around 8 to 15 days (according to the species and location) before settling on the substrate (Soo and Todd 2014; Kinch and Teitelbaum 2010). During the pediveliger larvae stage (the stage when the larvae is able to crawl using its foot), the larvae crawl on the substrate in search of suitable sites for settlement and metamorphose into early juveniles (or spats) within two weeks of spawning (Soo and Todd 2014).

According to Munro (1993), giant clams are facultative planktotrophs, in that they are essentially planktotrophic (i.e., they feed on plankton) but they can acquire all of the nutrition required for maintenance from their symbiotic algae, *Symbodinium*.

5.10.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, pollution, and exploitation. The harvest of giant clams is for both subsistence purposes (e.g., giant clam adductor, gonad, muscle, and mantle tissues are all used for food products and local consumption), as well as commercial purposes for global international trade (e.g., giant clam shells are used for a number of items, including jewelry, ornaments, soap dishes). The extent of each of these threats is largely unknown. Blidberg et al. (2000) studied the effect of increasing water temperature on *T. gigas, T. derasa,* and *H. hippopus* at a laboratory in the Philippines. *H. hippopus* experienced increased respiration and production of oxygen in elevated temperatures and was therefore more sensitive to higher temperature than the two other species tested. After 24 hours at ambient temperature plus 3°C, however, no bleaching was observed for any of the species. In a lab experiment, short-term temperature increases of 3 °C resulted in *T. squamosa* maintaining a high photosynthetic rate but displaying increased respiratory demands (Elfwing et al. 2001). Watson et al. (2012) showed that a combination of increased ocean CO_2 and temperature are likely to reduce the survival of *T. squamosa*. Specifically, in a lab experiment, *T. squamosa* juvenile survival rates decreased by up to 80 percent with increasing pCO_2 and decreased with increasing seawater temperature for a range of temperatures and pCO_2 combinations that mimic those expected in the next 50 to 100 years. The susceptibility and impacts of disease on *T. squamosa* are not known, but incidences of mortality from rickettsiales-like organisms in cultured clams in the western Pacific, one in the Philippines and one in Kosrae have been documented (Norton et al. 1993).

5.10.4 Conservation of the Species

T. squamosa is listed in CITES Appendix II, is an ESA candidate species and is therefore a consultation species under the UES.

5.11 Humphead wrasse

In October 2012, NMFS was petitioned to list the humphead wrasse as threatened or endangered under the ESA and to designate critical habitat for the species. In February 2013, in its 90-day finding, NMFS determined that this action may be warranted and initiated a status review to determine whether the species would be officially listed (78 FR 13614 [February 28, 2013]). In September 2014, NMFS determined that ESA listing of the humphead wrasse was not warranted (79 FR 57875 [September 26, 2014]). However, this species remains protected under the UES and is therefore a consultation species.

5.11.1 Distribution and Abundance

The humphead wrasse is widely distributed on coral reefs and nearshore habitats throughout much of the tropical Indo-Pacific Ocean. The biogeographic range of the humphead wrasse spans from 30° N to 23° S latitude and includes the Red Sea south to Mozambique in the Indian Ocean, from southern Japan in the northwest Pacific south to New Caledonia in the south Pacific and into the central Pacific Ocean including French Polynesia. The humphead wrasse has been recorded from many islands of Oceania including Kwajalein Atoll, but appears to be absent from the Hawaiian Islands, Johnston Island, Easter Island, Pitcairn, Rapa, and Lord Howe Island with the exception of occasional waifs (Randall et al. 1978).

Although humphead wrasses are widely distributed, natural densities are typically low, even in locations where habitats are presumably intact. Unfished or lightly fished areas have densities ranging from 2–27 individuals per 10,000 square meters of reef. At sites near human population centers or at fished areas, densities are typically lower by tenfold or more and in some locations humphead wrasse are rarely observed (Sadovy et al. 2003). Total abundance throughout its range is difficult to estimate because survey methods may not cover all habitable areas. Existing information suggests that humphead wrasse populations are most abundant and stable in the Indian Ocean.

The humphead wrasse is known to occur in the vicinity of Illeginni Islet. As was found in other studies (Donaldson and Sadovy 2001), the humphead wrasse appears to occur in low densities throughout the Kwajalein Atoll area in NMFS and USFWS biennial surveys. Occurrence records of humphead wrasse suggest a broad, but scattered distribution at USAKA with observations of the species at 26% (32 of 125) of sites at 10 of the 11 surveyed islets since 2010. Adult humphead wrasses have been recorded in seaward reef habitats at Illeginni Islet (shallowest depths approximately 5 m deep (USFWS and NMFS 2012; NMFS and USFWS 2018). Although encountered on numerous occasions at USAKA, direct density measures of humphead wrasse have not been obtained. The adults of this species may range very widely, with typically four or fewer individuals observed within a broad spatial reef area (Dr. R. Schroeder pers, comm.). Two neighboring seaward reef flat sites in 2008 were noted to have adult humphead wrasse present (USFWS 2011); thus, a total of eight adult individuals might be exposed to potential MMIII impacts in this region. Absent a direct physical or sound related impact, the adults might be expected to show temporary curiosity, altered feeding patterns, and/or displacement.

Shallow inshore branching coral areas with bushy macro-algae, such as those which may exist along the shallow lagoon reef flat at Illeginni Islet, have been noted as potential essential nursery habitat for juvenile humphead wrasse (Tupper 2007). Recent settler and juvenile numbers are presumed to greatly exceed 20 in such habitat (Tupper 2007) and might be grossly approximated to range from 0 to 100 within the lagoon-side waters of Illeginni (NMFS 2014a). A direct physical strike from a payload fragment, toppling or scattering of coral habitat and/or reef substrate, increased exposure to predation through displacement, and/or sound impacts may result in mortalities of juvenile humphead wrasse, assuming they are present within the impact area. Otherwise, loss of habitat may lead to simple displacement, but with a longer-term functional loss of nursery potential contingent both spatially and temporarily on habitat recovery potential (NMFS 2014b).

Humphead wrasse have been observed to aggregate at discrete seaward edges of deep slope drop-offs to broadcast spawn in the water column; they do not deposit their eggs on the substrate (Colin 2010). This type of behavior is not known at Illeginni Islet, but it may exist; however, similar habitat would occur in nearby waters. The flow dynamics of developing fish eggs and larvae around Illeginni Islet are not understood. Initial flow may be away from the islet, with future return or larval/adult source dynamics from another area. No information exists to support any reasonable estimation of potential ARRW impacts to humphead wrasse eggs and developing larvae (NMFS 2014a).

5.11.2 Life History Characteristics Affecting Vulnerability to Proposed Action

The humphead wrasse is the largest member of the family Labridae. The humphead wrasse is distinguished from other coral reef fishes, including other wrasses, due primarily to its large size along with its fleshy lips in adults (Myers 1999), prominent bulbous hump that appears on the forehead in larger adults of both sexes, and intricate markings around the eyes (Marshall 1964; Bagnis et al. 1972; Sadovy et al. 2003).

Similar to other wrasses, humphead wrasses forage by turning over or crushing rocks and rubble to reach cryptic organisms (Pogonoski et al. 2002; Sadovy et al. 2003 citing P.S. Lobel, pers. comm.). The thick fleshy lips of the species appear to absorb sea urchin spines, and the pharyngeal teeth easily crush heavy-shelled sea snails in the genera *Trochus* spp. and *Turbo* spp. The humphead wrasse is also one of the few predators of toxic animals such as boxfishes (*Ostraciidae*), sea hares (*Aplysiidae*), and crown-of-thorns starfish (*Acanthaster planci*) (Randall 1978; Myers 1989; Thaman 1998; Sadovy et al. 2003).

Both juveniles and adults utilize reef habitats. Juveniles inhabit denser coral reefs closer to shore and adults live in deeper, more open water at the edges of reefs in channels, channel slopes, and lagoon reef slopes (Donaldson and Sadovy 2001). While there is limited knowledge of their movements, it is believed that adults are largely sedentary over a patch of reef and during certain times of the year they move short distances to congregate at spawning sites (NMFS 2009). Humphead wrasse density increases with hard coral cover, where smaller fish are found in areas with greater hard coral cover (Sadovy et al. 2003).

Field reports reveal variable humphead wrasse spawning behavior, depending on location (Sadovy et al. 2003; Colin 2010). Spawning can occur between several and all months of the year, coinciding with certain phases of the tidal cycle (usually after high tide) and possibly lunar cycle (Sadovy et al. 2003; Colin 2010). Spawning can reportedly occur in small (< 10 individuals) or large (≤ 100 individuals) groupings, which can take place daily in a variety of reef types (Sadovy et al. 2003; Sadovy de Mitcheson et al. 2008; Colin 2010). Based on available information, it is suggested that the typical size of female sexual maturation for the humphead wrasse occurs at 40–50 cm TL (Sadovy de Mitcheson et al. 2010). Choat et al. (2006) estimated length at first maturity as 45–50 cm FL for females (6–7 years) and 70 cm FL (9 years) for males.

5.11.3 Threats to the Species

The ERA team identified four major threats to humphead wrasse: 1) habitat destruction, modification, or curtailment; 2) overutilization for commercial, recreational, scientific or educational purposes; 3) disease or predation; 4) the inadequacy of existing regulatory mechanisms; and 5) natural and other man-made factors. Habitat destruction, overfishing, and inadequacy of existing regulatory mechanisms, and some man-made factors such as pollution are threats locally throughout portions of its range. However, the ERA team concluded that four of the five threats evaluated are not significant risks to extinction. Natural and man-made factors, namely climate change, were noted as a small to moderate effect on species risk of extinction.

5.11.4 Conservation of the Species

Humphead wrasse is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

6 Environmental Baseline

The UES does not specifically describe the environmental baseline for a biological opinion. However, under the ESA, the environmental baseline includes: past and present impacts of all State, Federal, or private actions and activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone Section 7 consultation; and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The Consultation Handbook further clarifies that the environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area (FWS and NMFS 1998). The purpose of describing the environmental baseline in this manner within a biological opinion is to provide the context for the effects of the proposed action on the listed species. We apply the ESA standards consistent with the intent of the UES agreement in our effects analysis. As described in Sections 2 and 3 above, the action area where the proposed action may adversely affect consultation species consists of the marine waters adjacent to Illeginni Islet at Kwajalein Atoll, RMI (Figure 9).

Figure 9. Illeginni Islet, RMI

The Marshall Islands consist of 29 atolls and 5 islands aligned in two roughly parallel northwest-southeast chains: the northeastern Ratak Chain and the southwestern Ralik Chain. The total land area is about 70 square miles, and the total lagoon area is about 4,500 square miles. Kwajalein Atoll is located near the center of the island group, about 8 degrees above the equator, and is one of the largest coral reef atolls in the world. The past and present impacts of human and natural factors leading to the status of UES-protected species within the action area include coastal development, armed conflict, direct take, fishing interactions, vessel strikes and groundings, marine debris, and climate change.

Kwajalein Atoll was the site of heavy fighting during World War II (1940s), when the U.S. took it from the Japanese. Many of the islets have been heavily modified by dredge and fill construction operations by both the Japanese and U.S. forces. More recently, the RMI has provided eleven islets around the rim of Kwajalein Atoll for the use by the U.S. Government as part of the RTS. Hundreds of U.S. personnel live on some of the islets, and Marshallese workers commute daily between the U.S. occupied islets and the ones on which they reside. Vessel traffic occurs regularly between the islets, and to and from the atoll. This includes fishing boats, personnel ferries, military service craft, visiting military ships, and cargo vessels that supply the peoples of Kwajalein Atoll. For more than 18 years, the USAKA has participated in testing hypersonic vehicles from ICBM and other flight tests launched from Vandenberg AFB and other locations. Vehicle impacts from such tests have occurred and continue to occur on and in the vicinity of Illeginni Islet and in adjacent ocean waters. In the Opinion on the Minuteman III operations through the year 2030 it was estimated that 49,645 colonies of the 15 species of UES corals and 117 top shell snails may be killed (NMFS 2015).

On May 16, 2005, we issued a letter of concurrence (LOC) with the USAF's "not likely to adversely affect" determination for sea turtles and marine mammals under our jurisdiction. It is important to note that sea turtles are under the jurisdiction of the FWS while in terrestrial habitats, whereas they are under our jurisdiction when in marine habitats. Therefore, any impacts on hauled-out or nesting adult turtles, eggs in nests, or hatchlings before they reach the water, were considered in the 2005 FWS Opinion, not in our LOC.

On March 2, 2017, the US Navy SSP consulted with NMFS on the effects of a near identical action, the Flight Experiment 1 (FE-1). NMFS concluded in a biological opinion dated May 12, 2017 that the FE-1 would not jeopardize 59 marine ESA/UES consultation species." (PIR-2017-10125; I-PI-17-1504-AG). In that opinion, NMFS estimated that the action would result in up to up to 10,417 colonies of UES consultation corals (as quantified in table 7) could experience complete mortality, up to four top shell snails may be killed by the proposed action, and up to 90 clams, and 108 humphead wrasses could be injured or killed by the proposed action. The target site was the exact same as this proposed action and made an impact on land and not in water. No take was quantified for this action.

On February 12, 2019, USASMDC/ARSTRAT, consulted on the Air-launched Rapid Response Weapon (ARRW) Flight Tests NMFS' Biological Opinion was dated July 30, 2019 (PIRO-2019-00639; I-PI-19-1751-AG). This missile test is expected to impact the same islet targeted in this proposed action. As with the FE-1 and FE-2, impact is expected to occur on land, but could occur in water. In that opinion, NMFS estimated that the action would result in up to 10,417 colonies of UES consultation corals could experience complete mortality, up to four top shell snails may be killed by the proposed action, and up to 90 clams, and 108 humphead wrasses could be injured or killed by the proposed action.

On July 4, 2019, we completed informal consultation on the effects of launching a Terminal High Altitude Area Defense (THAAD) missile and subsequent intercept of a medium-range ballistic missile over the Pacific Ocean concluding the operation was not likely to adversely affect 44 species protected under the standards and procedures described in the Environmental Standards and Procedures for U.S. Army Kwajalein Atoll (PIRO-2019-01962; I-PI-19-1769-AG). This test is expected to launch from a neighboring islet within USAKA.

These estimates are likely higher than what the total impacts will be due to the unlikely event of a shoreline impact and the data the estimates were based on. The estimates were based on surveys that have been conducted throughout the area but not in the impact zone. A survey was completed after these estimates were made and some of the corals that were predicted to be in the area were not observed and others were observed at densities lower than what had been estimated (NMFS 2017a). Additional surveys could show that they are indeed in the area but not at higher levels than estimated.

Direct take through harvest continues in the RMI for several of the UES consultation species. For example, sea turtles, black lip pearl oysters, and top shell snails (all of which are UES consultation species) are considered a food source or of economic value by many RMI nationals. The harvest of these and other UES-protected marine species is believed to continue on most of the inhabited islands and islets of the RMI, with the possible exception of the USAKA-controlled islets, where access is limited and the UES prohibits those activities. However, the level of exploitation is unknown, and no concerted research or management effort has been made to conserve these species in the RMI. No information is currently available to quantify the level of impact direct take is having on consultation species in the Marshall Islands.

Despite the development, wartime impacts, and human utilization of marine resources mentioned above, the atoll's position at the center of the Pacific Ocean is far from highly industrialized areas, and its human population remains relatively low. Consequently, the water quality level of the lagoon and the surrounding ocean is very high, and the health of the reef communities, along with the overall marine environment of Kwajalein Atoll, borders on pristine.

Climate change may be affecting marine ecosystems at Kwajalein Atoll. Climate refers to average weather conditions within a certain range of variability. The term climate change refers to distinct long-term changes in measures of climate, such as temperature, rainfall, snow, or wind patterns lasting for decades or longer. Climate change may result from: natural factors, such as changes in the Sun’s energy or slow changes in the Earth’s orbit around the sun; natural processes within the climate system (e.g., changes in ocean circulation); and human activities that change the atmosphere’s makeup (e.g., burning fossil fuels) and the land surface (e.g., cutting down forests, planting trees, building developments in cities and suburbs, etc.), also known as anthropogenic climate change (U.S. Environmental Protection Agency). The global mean temperature has risen 0.76°C over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (Solomon et al. 2007). Sea level rose approximately 17 cm during the 20^{th} century (Solomon et al. 2007) and further increases are expected. Climate change is a global phenomenon so resultant impacts have likely been occurring in the action area. However, scientific data describing impacts in the action area are lacking, and no climate change-related impacts on UES-protected species within the action area have been reported to date.

Climate change-induced elevated water temperatures, altered oceanic chemistry, and rising sea level may be contributing to changes to coral reef ecosystems, and is likely beginning to affect corals and mollusks found in the action area. Globally, climate change is adversely affecting many species of corals. Increasing thermal stress due to rising water temperatures has already had significant effects on most coral reefs around the world. It has been linked to widespread and accelerated bleaching and mass mortalities of corals around the world over the past 25 years (Brainard et al. 2011). As the atmospheric concentration of CO_2 has increased, there has been a corresponding reduction in the pH of ocean waters (acidification). As ocean acidity increases, the calcium carbonate saturation state of the water decreases. Increased ocean acidity has the potential to lower the calcium carbonate saturation state enough to slow calcification in most corals and may increase bioerosion of coral reefs. It is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for corals, and can induce bleaching more so than thermal stress, and tends to decrease growth and calcification rates (Brainard et al. 2011).

By the middle of this century, ocean acidity could lower calcium carbonate saturation to the point where the reefs may begin to dissolve (Brainard et al. 2011).

Attempting to determine whether recent biological trends are causally related to anthropogenic climate change is complicated because non-climatic influences dominate local, short-term biological changes. However, the meta-analyses of 334 species and the global analyses of 1,570 species show highly significant, nonrandom patterns of change in accord with observed climate warming in the twentieth century. In other words, it appears that these trends are being influenced by climate change-related phenomena, rather than being explained by natural variability or other factors (Parmesan and Yohe 2003). However, the implications of these changes are not clear in terms of population level impacts, and data specific to the action area are lacking. Over the long-term, climate change-related impacts could influence the biological trajectories of UES-protected species on a century scale (Parmesan and Yohe 2003). However, due to a lack of scientific data, the specific effects climate change could have on these species in the future are not predictable or quantifiable to any degree that would allow for more detailed analysis in this consultation (Hawkes et al. 2009).

7 Effects of the Action

In this section of a biological opinion, we assess the probable effects of the proposed action on UES-protected species. Effects of the Action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that would be added to the environmental baseline. Direct effects are caused by exposure to the action related stressors that occur at the time of the action. Indirect effects are those that are likely to occur later in time, but are still reasonably certain to occur (50 CFR 402.02). The effects of the action are considered within the context of the Status of the Species, together with the Environmental Baseline and Cumulative Effects sections of this Opinion to determine if the proposed action can be expected to have direct or indirect effects on UES-protected species that appreciably reduce their likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination. The actions are not expected to adversely affect any essential features of critical habitat has been designated in the action area.

Approach. We determine the effects of the action using a sequence of steps. The first step identifies potential stressors associated with the proposed action with regard to listed species. We may determine that some potential stressors result in insignificant, discountable, or beneficial effects to listed species, in which case these potential stressors are considered not likely to adversely affect protected species, and subsequently are considered no further in this Opinion. Those stressors that are expected to result in significant negative (i.e., adverse) effects to listed species are analyzed via the second, third, and fourth steps described below.

The second step identifies the magnitude of the stressors (e.g., how many individuals of a particular species would be exposed to the stressors; *exposure analysis*). In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to a proposed action's effects, and the populations or subpopulations those individuals represent.

The third step describes how the exposed individuals are likely to respond to the stressors (*response analysis*). In this step, we determine if the stressors are likely to result in any adverse effects on exposed individuals.

The final step in determining the effects of the action is to establish the risks those responses pose to listed resources (*risk analysis*). The risk analysis is different for listed species and designated critical habitat. However, as mentioned above, the action area includes no designated critical habitat, thus it is not considered in this Opinion. Our jeopardy determinations must be based on an action's effects on the continued existence of UES-protected species within USAKA. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (probability of extinction or probability of persistence) of listed species depends on the viability of their populations.

7.1 Stressors

As described above in Section 3, we believe that the proposed action would cause five stressors that may affect the consultation species considered in this consultation: exposure to elevated noise levels; impact by falling missile components; exposure to hazardous materials; disturbance from human activity and equipment operation; and collision with vessels. Of those stressors, impact by falling missile components, specifically for the payload that would target Illeginni Islet, is the only stressor that is likely to adversely affect consultation species. The remaining stressors are expected to have insignificant effects (i.e. effects would not result in take) and/or exposure is discountable (extremely unlikely to occur), and those stressors are discussed no further in this Opinion. Similarly, Section 3 described why all of the species identified in Table 2 are unlikely to be adversely affected, and therefore considered no further in this Opinion. In summary, the 7 coral species, top shell snail, and two giant clams, and the humphead wrasse identified in Table 1 may be hit by the falling payload or by ejecta, or be significantly affected by concussive forces during the single planned payload on Illeginni Islet.

Note: Within the seven coral species that may be adversely affected by the proposed action, the effects are expected to be practically identical. Addressing the species individually would significantly increase the length of this Opinion with no discernible improvement in the evaluation. Therefore, all seven coral species are referred to together as "corals", unless an individual species needs to be identified due to some unique sensitivity or response. The same is true for the two clam species.

7.2 Exposure to Impact by Falling Missile Components

This section analyzes the proposed action's potential for exposing UES-consultation corals and top shell snails to being hit by the FE-2 flight test payload or ejecta thereof planned to strike on Illeginni Islet. This analysis is based on the distribution and density report completed for the MM III proposed action, the follow-up survey post action, and on personal communication with the survey team (NMFS 2014b, NMFS 2017a, Kolinski pers. comm. 2015), and on the description of the effects of the FE-1 flight test (SSP 2017), a biological survey conducted at USAKA launch sites by NMFS in preparation for the THAAD operation (NMFS 2018), the recent THAAD test (MDA/USASMDC/ARSTRAT 2019), and the FE-2 flight test (SSP 2019). We believe that the distribution and density report likely over-estimates the number of coral and mollusk species that may be within the action area at Illeginni, but that it represents the best available information to make those estimates.

The quantitative estimates of species distribution and abundance within the potentially affected areas at Illeginni are based on surveys of 136 sites around the 11 USAKA islets, including four sites around Illeginni (NMFS 2014b). Species observed to occur on reef flat, crest, and gently sloping substrates around USAKA islets at depths less than or equal to 35 feet water depth were considered as potentially being present within the MMIII, FE-1, and THAAD impact area and hence the FE-2 impact area. Because the available survey information also includes the observed distribution and abundance of the affected consultation species in numerous habitat types around the 11 USAKA islets and at 35 survey sites throughout the mid-atoll corridor (MAC), we believe that the existing information also serves as a reasonable foundation to estimate the distribution and abundance of these organisms throughout USAKA. Analyses of effect of MMIII reentry vehicles (USAFGSC and USASMDC/ARSTRAT 2015) and FE-1 payload impact (US Navy 2017) at Illeginni Islet were conducted based on coral, mollusk, and fish densities extrapolated from coral presence and abundance from similar reef habitats throughout USAKA. In 2017, NMFS-PIRO completed a report with revised density estimates for many consultation species based on 2014 assessments of the reefs adjacent to the impact area at Illeginni Islet (NMFS-PIRO 2017a and 2017b). The areas surveyed for this assessment encompassed all of the Affect Area reef habitat on the lagoon side and 99% of the reef area on the ocean side (NMFS 2017a and 2017b). Additionally, NMFS-PIRO conducted a survey within USAKA at two launch sites in 2018 to provide data for the THAAD operation (NMFS 2018). Based on coverage area of this assessment, these data are considered the best available information for coral and mollusk species presence and density in the affect area.

The humphead wrasse (*Cheilinus undulatus*) was not observed during the 2014 surveys for the most recent assessment of consultation organisms at Illeginni Islet (NMFS 2017a); however, this species has been recorded in both ocean-side and lagoon-side habitats adjacent to the impact area in other surveys. Since the humphead wrasse is a highly mobile species, the extrapolation methods for estimating density which were previously used for impact analysis are still considered the best available data for a conservative approach. Therefore, humphead wrasse densities were estimated by NMFS Pacific Islands Regional Office (NMFS-PIRO) based on quantitative data collected during the 2008 species inventory, recent impact assessments on natural substrates at USAKA and, for egg and fish recruit derivations, from the literature (NMFS 2014b). *Cheilinus undulatus* typically occurs in broadly distributed low numbers and has been seen near Illeginni islet. It is possible that and estimated 8 adults may occur within the entire potential ocean-side affected area, and 0 to 100 juveniles may occur within the entire potential lagoon-side affected area.

As described above in Sections 2 and 3, there is a chance that the FE-2 flight test payload could strike the water's edge along the lagoon or ocean shore at Illeginni. Empirical observations of historical reentry vehicle impacts from MMIII tests in very shallow waters found that most debris was contained within the crater and ejecta were concentrated within 1.5 to 3 m of the crater rim (USAFGSC and USASMDC/ARSTRAT 2015). As with MMIII reentry vehicles, FE-1, or THAAD test, we estimate that the payload land impact may produce ejecta and debris concentrated near the impact site and extending outward to 91 m. Empirical evidence from MMIII tests corroborates predictions of the propagation of shock waves associated with impact were approximately 37.5 m through the adjacent reef from the point of impact on the shoreline (USAFGSC and USASMDC/ARSTRAT 2015). The USASMDC/ARSTRAT estimates that an area equal to 15,557 yd^2 (13,008 m^2) could be affected by ejecta impact along either shore (Figure 10). Coral, and mollusk mortality or injury could occur from impact by shock/vibration. These reef impacts were based on observations of damaged corals, which can be affected by ground borne vibration.

Habitat suitability for consultation species is lowest along the water's edge and with the exception of sandy patches, typically increases with distance from shore. Based on the professional judgement of the NMFS survey divers, up to 80% of the area potentially affected by ejecta, 12,445 yd^2 (10,406 m^2), is suitable habitat for the consultation species (Kolinski 2014 in USASMDC/ARSTRAT 2015). Similarly, approximately 9,756 m^2 (0.004 mi^2; 75%) of the ocean-side affected area is considered to be potentially viable habitat for consultation fish, coral and mollusk species (S. Kolinski, NMFS-PIRO, pers. comm. 2014). Since the debris fall affect area is larger than the shock wave affect area, we calculated the effects of the action based on the debris fall/ejecta area. Although the exact shape of the affected area is impossible to pre-determine, the seaward portion of such an area is conceptually illustrated as a rough semi-circle on the lagoon and ocean sides of Illeginni with a radius of 300ft (Figure 10).

Figure 10. Representative Maximum Direct Contact Affect Areas for a Shoreline Payload Impact at Illeginni Islet, Kwajalein Atoll.

It is reasonable to assume that the effects of debris fall and shock waves would not occur evenly across an entire area of potentially viable habitat. Thus, the actual habitat area that would be affected is considered to be a proportion of the total estimated viable habitat. Since there are no data available to identify this unknown proportion or the actual amount of viable habitat that would be affected by debris fall or shock waves, these analyses should be regarded as an overestimate and those of maximum effect.

The effects of ejecta impact would not occur evenly across the affected area. Chunks of ejecta would be scattered across the area; impacting a small proportion of the suitable habitat. Also, the area within the shockwave range of effect would be completely contained within the area at risk for ejecta impacts. The anticipated worst-case scenario of a payload land impact at Illeginni islet is a shoreline strike, which would result effects that would extend outward from the point of strike. On both sides of Illeginni Islet, the area may potentially be affected debris fall. Since these areas overlap and since harmed individuals should be counted only once in the effects of the Action, the affected habitat area with the largest estimated take was selected as the worst-case scenario. Although the exact shape of the affect area is impossible to estimate, the seaward portion of such an area is conceptually illustrated as a rough semi-circle on the lagoon and ocean sides of Illeginni Islet with a radius of 91 m.

The aerial extent of potential debris fall effects on the lagoon and ocean sides of Illeginni were calculated to be 13,008 m2. Each of these areas would be subject to potential debris fall based on debris fall distance analyses for similar impacts of the MMIII (USAFGSC and USASMDC/ARSTRAT 2015) and the FE-1 payload (US Navy 2017a). Based on the best professional judgment of NMFS survey divers, approximately 80% or 10,406 m2 of the lagoon-affected area is considered potentially viable habitat for consultation fish, corals, and mollusks (NMFS-PIRO 2017). Similarly, approximately 75% or 9,756 m2 (11,668 yd2) of the ocean-side affected area is considered potentially viable habitat for consultation fish, coral, and mollusk species (NMFS-PIRO 2017).

It is reasonable to assume that the effects of debris fall and shock waves would not occur evenly across an entire area of potentially viable habitat. Thus, the actual habitat area that would be affected is considered to be a proportion of the total estimated viable habitat. Since there are no data available to identify this unknown proportion or the actual amount of viable habitat that would be affected by debris fall or shock waves, these analyses assume that the entire area will be affected and should be regarded as an overestimate and those of maximum effect.

The 99% upper confidence level of the bootstrap mean densities for the potentially affected consultation species in the area was multiplied by the areal extent of potentially affected suitable habitat to estimate the number of coral colonies and top shell snails that may be adversely affected by ejecta and/or shockwave effects by a payload land impact at Illeginni Islet (Table 9).

Table 9. Estimated numbers of consultation coral colonies, and individual mollusks and fish in affected habitat.

Scientific Name	Species	Colonies or Individuals Affected
	Corals	
Acropora microclados	No Common Name	17
A. polystoma	No Common Name	17
Cyphastrea agassizi	No Common Name	14
Heliopora coerulea	No Common Name	4,683
Pavona venosa	No Common Name	14
Turbinaria reniformis	No Common Name	14
Pocillipora meandrina	Cauliflower coral	5,658
	Mollusks	
Tectus niloticus	Top Shell Snail	4
Hippopus hippopus	Giant clam	63
Tridacna squamosa	Giant clam	12
	Fish	
Cheilinus undulates	Humphead wrasse	108 (8 adults/100 juveniles)

7.3 Response to Falling Missile Components

This section analyzes the responses of UES-consultation corals, top shell snails, giant clams, and humphead wrasse that may be exposed to being hit by the FE-2 payload and/or ejecta.

Redacted for Operational Security Concerns

[redacted]

The intensity of the payload impact, and the uniformity of exposure to ejecta and the shockwave would decrease with distance from the point of impact. Any corals and top shell snails directly beneath the payload, or within the crater radius are expected to be instantly killed, with very little left of the organisms that would be recognizable. Beyond the crater, corals and top shell snails would be exposed to ejecta and the ground borne shockwave. Corals and top shell snails immediately beyond the crater would likely experience mortality from impact by high-velocity ejecta, from burial under mobilized crater material, or from exposure to the ground borne shockwave.

The response of corals to ejecta and the ground borne shockwave would depend largely on the scale and intensity of the exposure. Impact by high-velocity dense ejecta (rock or metal), could fracture the hard structure of corals and would likely injure or destroy soft tissues. Fracturing would depend largely on the size and intensity of the impact and on morphology of the impacted coral. Plate-forming and branching corals are more easily broken than large massive or encrusting forms. Fractures due to payload impact are expected to range from pulverization of colonies in and close to the crater, to cracks and/or loss of branches in colonies toward the outer edge of effect. Additionally, exposure to the ground based shockwave could also fracture or dislodge coral colonies out to about 37.5 m from the payload impact. Because the coral skeletons are hard rock-like structures that are rigidly fixed to the hard substrate through which the shock wave would travel, much of the available energy in the substrate can be transferred directly into the coral's skeletal structure. If the shockwave is intense enough, the coral's structure may crack or fracture and/or it may become unattached from the substrate. At close ranges, impact by lower velocity and/or lower density ejecta could affect the soft tissues of corals, ranging from burial to scouring away all or most of the living polyps and interconnecting soft tissues from a colony. At greater ranges, localized damage of a small part of a colony is possible.

Pulverization of a colony's structure, deep burial, or loss of a large proportion of a colony's soft tissue would likely result in the mortality of the colony. Partial fracturing of a coral skeleton and/or dislodgement of a coral from the substrate due to ejecta impact or from exposure to the ground based shock wave would injure the soft tissues at and around the break. Re-growth of soft tissues has energetic costs that could slow other growth and reproduction. Exposed areas of coral skeleton are prone to bioerosion and overgrowth by algae and certain sponges. Large areas of damaged or dead tissue could result in the introduction of algae that may prevent the regeneration of healthy coral tissue, or that may overcome the whole colony. Damaged and stressed tissues may also be more susceptible to infection by coral diseases that may hinder or prevent healing to the point that the colony dies.

Fragmentation is a form of asexual reproduction in some branching corals, resulting in the development of new, but genetically identical colonies. Bothwell (1981) reports that several *Acropora* species successfully colonize through fragmentation and translocation of fragments by storm-driven waves. However, not all coral fragments, or dislodged colonies would be expected to survive. Survival would depend largely on where a fragment falls and how it is oriented after it settles to substrate. A fragment or colony is likely to die if the living tissue is on the underside of the fragment or if the fragment settles into fine sediments. Additionally, in areas that experience regular high surf, such as the ocean side reef at Illeginni, loose coral fragments and colonies could repeatedly become mobilized by the waves. This reduces the likelihood of their survival, and potentially injures additional coral colonies should the fragments be cast against them.

Based on the available information, we believe that the numbers of coral colonies, identified above in Table 9, represent a conservative yet reasonable estimate of the corals that may be adversely affected by the proposed action. Further, this Opinion conservatively assumes that mortality would result for all exposed coral colonies. This approach is being taken to ensure a precautionary assessment is made of the jeopardy risk for the affected species.

In the case of the top shell snail, the effects of exposure to ejecta and shockwave is expected to quickly diminish to insignificance with distance from the payload impact site. Impact by high-velocity dense ejecta (rock or metal) immediately around the crater could penetrate or fracture an exposed snail's shell, either killing the animal directly, or leaving it vulnerable to predation. Conversely, with movement away from the payload impact site, ejecta would become slower, and the ejecta would have to penetrate increasing water depth to impact the snails. Considering the conical shape and thickness of a top shell snail's shell, most ejecta that may strike one that is under water and at any distance from the payload impact site is likely to be deflected without imparting a significant proportion of its kinetic energy to the shell or the animal within.

Top shell snails immediately around the payload crater may also be buried by ejecta. The potential for burial, and the depth of the material under which a snail may be buried would likely decrease quickly with distance from the payload impact site. Mortality could result if the snail is crushed, smothered, or permanently pinned beneath rubble. Non-lethal effects could include energetic costs and/or foraging impacts.

Exposure to intense ground borne shockwaves could injure the soft tissues of top shell snails. Mortality of the snail is possible if the injury is significant enough. The range to the onset of significant injuries for top shell snails exposed to a ground based payload impact shockwave is unknown, but it is likely much less than that estimated for corals (37.5 m). Top shell snails are not rigidly attached to the substrate as are corals. Instead, they adhere to the reef using a muscular foot. Whereas rigidly attached corals would be directly linked to the substrate such that the energy could readily travel into and along its skeletal structure, the muscular foot of the snail would act to isolate the snail's shell from the vibration, and to reduce the transfer of the energy to other soft tissues and organs. Non-lethal effects could include bruising of the foot and other tissues, which may have energetic costs and/or may have reproductive impacts.

As stated above at 7.2, habitat suitability for the consultation species is lowest along the water's edge and typically increases with distance from shore. Therefore, top shell snail density would be lowest in the area immediately adjacent to the payload impact site, where ejecta effects and shockwave would be greatest. Conversely, in the areas where top shell snail density would be highest, ejecta would be slower, and it would have to penetrate several feet of water to impact the snails. Based on this, on the robust nature of snails (see Section 5), and the characteristics of its shell, most ejecta that may strike top shell snails is likely to be deflected without imparting any significant proportion of its kinetic energy to the shell or the animal within. In this situation, ejecta impact would result in little more than inducing the affected snail to briefly adhere more tightly to the substrate before resuming normal behaviors. The range to adverse effects from burial and shockwaves would likely be similarly restricted to the area along the water's edge. Therefore, we expect that 4 top shell snails that may be exposed to the combined effects of a payload land strike (Table 9, above), would be adversely affected by the exposure.

In the case of the clams, the effects of exposure to ejecta and shockwave is expected to quickly diminish to insignificance with distance from the payload impact site. Impact by high-velocity dense ejecta (rock or metal) immediately around the crater could penetrate or fracture an exposed clam shell, or damage soft tissue that is exposed possibly killing the animal. Conversely, with movement away from the payload impact site, ejecta would become slower, and the ejecta would have to penetrate increasing water depth to impact the clams. Considering the thickness of a clam shell, most ejecta that may strike one that is under water and at any distance from the payload impact site is likely to be deflected without imparting a significant proportion of its kinetic energy to the shell or the animal within unless it is able to lodge itself in the shell opening.

Clams immediately around the payload crater may also be buried by ejecta. The potential for burial, and the depth of the material under which a clam may be buried would likely decrease quickly with distance from the payload impact site. Mortality could result if the clam is crushed, smothered, or permanently pinned beneath rubble. Non-lethal effects could include foraging impacts if the clam is unable to filter feed due to debris.

Exposure to intense ground borne shockwaves could injure the soft tissues of clams. Mortality is possible if the injury is significant enough. The range to the onset of significant injuries for clams exposed to a ground based payload impact shockwave is unknown. Clams can be buried in substrate or attached to corals which means they would be directly linked to the substrate such that the energy could readily travel into the shell and affect the soft tissue and organs. Non-lethal effects could include bruising of the tissues, which may have energetic costs and/or may have reproductive impacts.

As stated above at 7.2, habitat suitability for the consultation species is lowest along the water's edge and typically increases with distance from shore. Therefore, clam density would be lowest in the area immediately adjacent to the payload impact site, where ejecta effects and shockwave would be greatest. Conversely, in the areas where clam density would be highest, ejecta would be slower, and it would have to penetrate several feet of water to impact the clams. Based on this, on the robust nature of clams (see Section 5), and the characteristics of its shell, most ejecta that may strike clams is likely to be deflected without imparting any significant proportion of its kinetic energy to the shell or the animal within. In this situation, ejecta impact would result in little more than inducing the affected clam to close before resuming normal behaviors. The range to adverse effects from burial and shockwaves would likely be similarly restricted to the area along the water's edge. Therefore, we expect that 75 clams that may be exposed to the combined effects of a payload land strike (Table 9, above), would be adversely affected by the exposure.

In the case of the humphead wrasse, the USASMDC/ARSTRAT estimated that there will be up to 100 juvenile, and eight adult humphead wrasses in the area of impact pictured in Figure 10 (MDA/USASMDC/ARSTRAT 2019; SSP 2019). An individual animal could be exposed to ejecta hitting and traveling through the water and from the shock wave produced from the main projectile's impact. An animal subjected to a direct impact, concussive shock waves from the impact, ejecta, or a near miss of ejecta would result in wounding or death. Potential injuries may include cuts, gashes, bruises, broken bones, rupture or hemorrhage of internal organs, amputation, or other broken body parts; any of which could result in an animal's death. Since the arcs (the affected area on the lagoon and the affected area on the ocean) were drawn and estimated based on shoreline strikes on each side, the model assumes mishits on every test, which is highly unlikely to occur. Furthermore, it assumes that ejecta will uniformly spread, especially to the outer extents of those circles (~100 m away). Humphead wrasses were observed beyond the reef crest near the edges of those arcs. As mentioned in previous sections, the USASMDC/ARSTRAT observed the majority of ejecta stayed within a few meters of the impact area. The density of ejecta is expected to decrease with distance from the point of impact (USAFGSC and USASMDC/ARSTRAT 2015). Ejecta is also likely to lose velocity the further it travels from the source. The depth of the water in the 91 m radius is expected to be less than 3 m. Humphead wrasses are generally not surface-dwelling fish where they would be the most vulnerable to strikes. Graham et al. (2015) reports that humphead wrasse are most often encountered on outer reef slopes and reef passes/channels at depths of only a few meters to at least 60 m (Randall 1978); other reports document humphead wrasses to depths of up to 100 m (Russell 2004; Zgliczynski et al. 2013). Graham et al. (2015) further notes at that personal observations from NMFS biologists familiar with the species, documented observations on deep dives and that the species was caught at depths greater than 100 m and up to approximately 180 m by deep gillnet (G. Davis pers. comm. as cited in Graham et al. 2015). On impact, the parts of the payload and substrate will explode into numerous pieces from "aerosolized" bits to mid-sized rocks. The largest sized ejecta is likely to travel through the air slower than smaller and lighter pieces, and fall closer to the source. When ejecta hits the water, it slows down quickly before falling to the reef or substrate. Furthermore, ocean conditions are dynamic in the nearshore (i.e. waves, currents, etc.) and projectiles would lose the majority of their energy within a few inches of the surface. Humphead wrasse, even juveniles, are large and mobile and will likely flee from falling debris as it hits the water. It is unlikely that any humphead wrasse will be actually be contacted by ejecta.

7.4 Risk

This section analyzes the risk posed by the proposed action for populations of UES-protected marine species at USAKA due to exposure to direct impact and removal from the water as described above. Because this Opinion assumes mortality for all exposed individuals, regardless of the stressor, the risk assessment below focuses on the species impacts from the direct impact.

7.4.1 Risk for coral populations due to expected levels of action-related mortality

As described in the exposure analyses above, up to 10,404 colonies of 7 UES-consultation coral species (Table 9) could experience mortality from the payload strike on Illeginni Islet. This would be due to the combined exposure to direct payload impact, ejecta, and ground based shockwave. The USASMDC/ARSTRAT plans just one FE-2 flight test so this represents the maximum possible impact associated with this action.

Based on the best information available, we believe that these corals are all widely distributed around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of coral-occupied habitat at Illeginni, and likely below 1% of coral-occupied habitat at USAKA. As described above at 7.2, we further believe that the distribution and abundance of these coral species in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 10,404 colonies likely represent a tiny fraction of their species found at

Illeginni and across USAKA. Therefore, based on the best available information, we consider the risk negligible that project-related effects from direct payload impact, ejecta, and ground based shockwave would eliminate any of these species at USAKA, or appreciably reduce the likelihood of their survival and recovery at USAKA and across their global range.

7.4.2 Risk for top shell snails due to expected levels of action-related mortality

As described in the exposure and response analyses above, we expect up to 4 top shell snails could experience mortality as the result of a single direct payload impact, ejecta, and ground based shockwave. We believe that top shell snails are widely distributed at all of the USAKA islets around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of top shell snail-occupied habitat at Illeginni, and likely below 1% of top shell snail-occupied habitat at USAKA. As described above at 7.2, we further believe that the distribution and abundance of these mollusks in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 4 top shell snails likely represent a tiny fraction of their species found at Illeginni and across USAKA, and their loss would be virtually indistinguishable from natural mortality levels in the region. Therefore, based on the best available information, we consider the risk negligible that the effects of direct payload impact, ejecta, and ground based shockwave would eliminate this species at USAKA, or appreciably reduce the likelihood of its survival and recovery at USAKA and across their global range.

7.4.3 Risk for clams due to expected levels of action-related mortality

As described in the exposure and response analyses above, we expect up to 63 *H. hippopus* and 12 *T. squamosa* clams could experience mortality as the result of a single direct payload impact, ejecta, and ground based shockwave. We believe that both species of clams are widely distributed at all of the USAKA islets around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of clam-occupied habitat at Illeginni, and likely below 1% of clam-occupied habitat at USAKA. As described above at 7.2, we further believe that the distribution and abundance of these mollusks in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 75 clams likely represent a tiny fraction of their species found at Illeginni and across USAKA, and their loss would be virtually indistinguishable from natural mortality levels in the region. Therefore, based on the best available information, we consider the risk negligible that the effects of direct payload impact, ejecta, and ground based shockwave would eliminate this species at USAKA, or appreciably reduce the likelihood of its survival and recovery at USAKA and across their global range.

7.4.4 Risk for humphead wrasses due to expected levels of action-related mortality

As described in the exposure and response analyses above, we expect up to 108 humphead wrasses could experience mortality as the result of direct payload impacts from all four payload strikes, ejecta, and ground-based shockwave, but more likely minor injury if any, will occur. We believe that humphead wrasse are widely distributed at all of the USAKA islets around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of habitat at Illeginni, and likely below 1% of humphead wrasse-occupied habitat at USAKA. As described above at 7.2, we further believe that the distribution and abundance of these fish in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 108 humphead wrasse likely represent a tiny fraction of their species found at Illeginni and across USAKA, and their loss would be virtually indistinguishable from natural mortality levels in the region. Therefore, based on the best available information, we consider the risk negligible that the effects of direct payload impact, ejecta, and ground-based shockwave would eliminate this species at USAKA, or appreciably reduce the likelihood of its survival and recovery at USAKA and across their global range.

8 Cumulative Effects

The UES does not specifically describe "cumulative effects" for a biological opinion. However, Section 161 of the Compact provides that for U.S. Government activities requiring the preparation of an environmental impact statement (EIS) under NEPA, the U.S. Government shall comply with environmental standards that protect public health and safety and the environment that are comparable to the U.S. environmental statutes, including the Endangered Species Act. Although not all USAKA actions that require formal consultation also require the preparation of an EIS, such as this action, we analyze cumulative effects in all USAKA consultations as that term is defined in the ESA implementing regulations. Cumulative effects, as defined in the ESA, are limited to the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02). These effects do not include the continuation of actions described under the Environmental Baseline, and future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

The impacts of RMI coastal development, fisheries interactions, vessel groundings, direct take, marine debris, and global climate change are not only expected to continue, they are likely to intensify over time. The intensification of those impacts is expected to cause cumulative effects on UES-protected marine species at USAKA. Continued growth of the human population at Kwajalein Atoll would likely result in increased coastal development, fishing pressure, vessel traffic, and pollution of the marine environment.

Anthropogenic release of CO_2 and other greenhouse gases is considered the largest contributor to global climate change, and it is expected that the release of those gases is not only likely to continue, but the rate of their release is expected to increase during the next century (Brainard et al. 2011). Therefore, global climate change is expected to continue to impact UES-protected marine species and their habitats, especially on those species that are dependent on shallow coastal reefs and shorelines, such corals and marine mollusks.

There is uncertainty associated with the analysis of potential impacts of climate change on species and ecosystems (Barnett 2001). Effects of climate change will not be globally uniform (Walther et al. 2002) and information regarding the magnitude of future climate change is speculative and fraught with uncertainties (Nicholls and Mimura 1998). In particular, there is no comprehensive assessment of the potential impacts of climate change within the action area or specific to UES-protected marine species. In addition to the uncertainty of the rate, magnitude, and distribution of future climate change and its associated impacts on temporal and spatial scales, the adaptability of species and ecosystems are also unknown. Impact assessment models that include adaptation often base assumptions (about when, how, and to what conditions adaptations might occur) on theoretical principles, inference from observed observations, and arbitrary selection, speculation, or hypothesis (see review in Smit *et al.* 2000). Impacts of climate change and hence its 'seriousness' can be modified by adaptations of various kinds (Tol et al. 1998). Ecological systems evolve in an ongoing fashion in response to stimuli of all kinds, including climatic stimuli (Smit et al. 2000).

The effects of global climate change, the most significant of which for corals are the combined direct and indirect effects of rising sea surface temperatures and ocean acidification, are currently affecting corals on a global scale, particularly in parts of the Caribbean. The return frequency of thermal stress-induced bleaching events has exceeded the ability of many reefs and coral species to recover there. Brainard et al. (2011) report that those effects likely represent the greatest risk of extinction to ESA-candidate corals over the next century. Field observation and models both predict increasing frequency and severity of bleaching events, causing greater coral mortality and allowing less time to recover between events. However, predicting how global climate change may impact particular species remains poorly understood, especially in understudied areas such as USAKA.

The effects of global climate change could act synergistically on corals affected by the proposed action. The ability of impacted corals to respond to the effects of the proposed action could be reduced due to the effects of elevated temperatures and increased ocean acidity, and the longer it takes for impacted corals to recover from the effects of the proposed action, the more likely it becomes that the effects of climate change would synergistically impact those corals. However, the degree to which those synergistic impacts may affect corals over the time required for them to recover from project impacts is unknown.

The effects of global climate change could also act synergistically on mollusks affected by the proposed action. However, no specific information is currently available to assess the impacts. Changes in ocean temperature and chemistry, and rising sea level may be affecting these species because they depend on an exoskeleton that is comprised primarily of calcium carbonate. We expect that minimally, increased acidity could have effects that parallel those described for corals above.

Given the small area and low numbers of individuals expected to be adversely affected by the proposed action, the possible synergistic impacts of climate change combined with the effects of the proposed action are not expected to be significant for the corals and mollusk considered in this Opinion.

9 Integration and Synthesis of Effects

The purpose of this Opinion is to determine if the proposed action is likely to jeopardize the continued existence of UES-protected marine species at USAKA. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a UES-protected marine species at USAKA by reducing the reproduction, numbers, or distribution of that species. This Opinion considers the Effects of the Action within the context of the Status of the Species, the Environmental Baseline, and Cumulative Effects as described in Section 7 under "Approach".

We determine if reduction in fitness to individuals of marine consultation species that may result from the proposed action are sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the risk of reducing the likelihood of survival and recovery of UES-protected species). In order to make that determination, we use the population's base condition (established in the Status of Listed Species and Environmental Baseline sections of this Opinion), considered together with Cumulative Effects, as the context for the overall effects of the action on the affected populations at USAKA. The following discussion summarizes the probable risks the proposed action poses to corals, top shell snails, giant clams, and the humphead wrasse identified in Section 7.

9.1 Corals

As described in the Effects of the Action section, a total of up to 10,404 colonies of UES-consultation corals (7 species) could be killed through some combination of exposure to direct payload impact, ejecta, and ground based shock wave. Over 99% of the colonies are from two highly abundant and widely distributed species within USAKA; *Pocillopora meandrina* and *Heliopora coerulea*.

As discussed in the Status of Listed Species, abundance and trend data are lacking for these corals at USAKA. However, they are all widely distributed around the atoll, with four of the seven corals being known to occur at all USAKA islets. Others are known to occur on at least half of the USAKA islets. All seven species have also been observed at survey sites in the MAC, with three found at over 30 of the 35 sites. It is important to recognize that survey data for USAKA is far from complete. Only a small portion of the total reef area around the USAKA islets and MAC has been surveyed, and surveys to specifically identify and quantify these species are yet to be done. A recent survey was completed at Illeginni Islet in the MM III reef impact area, which is also the area that has been analyzed for impacts from the ARRW payload and the results suggest that the estimate for corals in the area may be lower than what has been estimated (NMFS 2017a). Additionally, NMFS conducted a survey in 2018 at two launch sites in preparation of the THAAD test (NMFS 2018).

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of fisheries interactions, direct take, and climate change are expected to continue and likely worsen in the future for these corals. However, the impact and time scale of these effects on the trajectory of the affected coral populations at USAKA, and across Oceania is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in the mortality of up to 10,404 coral colonies at Illeginni Islet. These coral colonies represent an extremely small fraction of the total number of colonies found at Illeginni, and even less around USAKA. The potential loss of these coral colonies is not expected to significantly impact reproduction or to impede the recovery of their species across USAKA and the MAC. Therefore, when taken in context with the status of these species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate any of the seven UES consultation corals considered in this Opinion from Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAKA including the MAC.

9.2 Top Shell Snail

As described in the Effects of the Action section, a total of up to 4 top shell snails could be killed through some combination of exposure to direct payload impact, ejecta, and ground based shock wave.

As discussed in the Status of Listed Species, top shell snails have been reported at all of the 11 USAKA islets as well as at 59 of 103 survey sites throughout Kwajalein Atoll including all four survey sites on Illeginni. It is important to recognize that survey data for USAKA is far from complete. Only a small portion of the total reef area around the USAKA islets has been surveyed, and surveys to specifically identify and quantify this species are yet to be done. As such, it is possible that the distribution and abundance of top shell snails at USAKA is higher than the current information can confirm.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, direct take, and climate change are expected to continue and likely worsen in the future for this species. However, the impact and time scale of these effects on the trajectory of the affected top shell snail populations at USAKA is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in death of up to four top shell snails at Illeginni. The affected snails would represent a small fraction of the total number of top shell snails found at Illeginni, and an even smaller proportion of the population across USAKA. The potential loss of four top shell snails across the area is not expected to significantly impact reproduction or to impede the recovery of this species across USAKA and the MAC. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate top shell snails at Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAKA including the MAC.

9.3 Giant Clams

As described in the Effects of the Action section, a total of up to 75 giant clams could be harassed, injured, or killed through some combination of exposure to direct payload impact, ejecta, and ground-based shock wave.

As discussed in the Status of Listed Species, the two clam species have been reported at most of the 11 USAKA islets, (9 for *H. hippopus* and 6 for *T. squamosa*) as well as at 9 and 24 respectively of 35 survey sites in the mid-atoll corridor. It is important to recognize that survey data for USAKA is far from complete. Only a small portion of the total reef area around the USAKA islets has been surveyed, and surveys to specifically identify and quantify this species are yet to be done.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, direct take, and climate change are expected to continue and likely worsen in the future for this species. However, the impact and time scale of these effects on the trajectory of the affected giant clam populations at USAKA is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in death of up to 75 giant clams (63 *H. hippopus* and 12 *T. squamosa*) at Illeginni. The affected clams would represent a small fraction of the total number of clams found at Illeginni, and an even smaller proportion of the population across USAKA. The potential loss of giant clams across the area is not expected to significantly impact reproduction or to impede the recovery of this species across USAKA and the mid-atoll corridor. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate giant clams at Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAKA including the mid-atoll corridor.

9.1 Humphead Wrasse

As described in the Effects of the Action section, a total of up to 108 humphead wrasses could be harassed, injured, or killed through some combination of exposure to direct payload impact, ejecta, and ground-based shock wave.

As discussed in the Status of Listed Species section, humphead wrasses are commonly observed at Kwajalein Atoll, and have been observed at 10 of the 11 surveyed islets since 2010. Observations suggest a broad but scattered distribution. It is important to recognize that survey data for USAKA is incomplete. Only a small portion of the total reef area around the USAKA islets have been surveyed, especially in deeper waters where humphead wrasse could live.

As discussed in the Environmental Baseline and Cumulative Effects section, the effects of coastal development, direct take, and climate change are expected to continue and for climate change in particular expect to worsen in the future. However, the impact and time scale of these effects on the trajectory of the humphead wrasse population at USAKA is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in the injury or death of up to 108 humphead wrasse (100 juveniles and 8 adults) at Illeginni. The affected individuals would represent a small portion of the total number of humphead wrasse found at Illeginni, and an even smaller proportion of the population across USAKA. The potential loss of humphead wrasses by the action is not expected to significantly impact reproduction or to impede the recovery of this species across USAKA and the MAC. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate humphead wrasses at Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAKA including the MAC.

10 Conclusion

After reviewing the current status of UES-protected marine species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our Opinion that the USASMDC/ARSTRAT's implementation of the FE-2 experimental flight test at the Reagan Test Site, USAKA, RMI is not likely to jeopardize the continued existence of any of the UES-protected corals considered in this Opinion, the top shell snail, humphead wrasse, or two species of giant clams. As described above in Section 3 and 4, no critical habitat has been designated or proposed for designation for any UES-protected marine species in the BOA or elsewhere in the RMI. Therefore, the proposed action would have no effect on designated or proposed critical habitat in the RMI. As described in Section 4, designated critical habitat has been identified near the launch site in the MHI for Hawaiian monk seals and MHI insular false killer whales. NMFS concludes the proposed action will have no adverse effects for Hawaiian monk seal critical habitat; and may affect, but is not likely to adversely affect or modify designated critical habitat for the MHI insular false killer whale.

11 Incidental Take Statement

The UES does not specifically describe "take" for a biological opinion. However, under the ESA "take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement (ITS). Although the ESA does not specifically apply to actions taken at USAKA, under section 161 of the Compact and the UES, the ESA provides the basis for determining the level of incidental take, so the ESA definitions will be used for this Opinion.

11.1 Anticipated Amount or Extent of Incidental Take

Based on the analysis in the accompanying Opinion we conclude that the FE-2 flight test at the USAKA RTS, would result in the take of 7 species of UES consultation corals, top shell snails, humpback wrasse, and two clam species. As described above in the exposure and response analyses, we expect that up to 10,404 colonies of UES consultation corals (as quantified in Table 10) could experience complete mortality, up to 4 top shell snails, 108 humphead wrasse, and up to 75 clams could be killed by the proposed action.

Table 10. Expected Take of Marine UES consultation species due to FE-2 flight test

Scientific Name	Species	Colonies or Individuals Affected
Corals		
Acropora microclados	No Common Name	17
A. polystoma	No Common Name	17
Cyphastrea agassizi	No Common Name	14
Heliopora coerulea	No Common Name	4,683
Pavona venosa	No Common Name	14
Turbinaria reniformis	No Common Name	14
Pocillipora meandrina	Cauliflower coral	5,658
Mollusks		
Tectus niloticus	Top Shell Snail	4
Hippopus	Giant clam	63
Tridacna squamosa	Giant clam	12
Fish		
Cheilinus undulates	Humphead wrasse	108 (8 adults/100 juveniles)

11.2 Effect or Impact of the Take

In the accompanying Opinion, we determined that this level of anticipated take is not likely to result in the jeopardy of any of the UES consultation species expected to be taken by the proposed action.

11.3 Reasonable and Prudent Measures

We believe the following reasonable and prudent measures, as implemented by the terms and conditions, are necessary and appropriate to minimize impacts of the proposed action and monitor levels of incidental take. The measures described below are non-discretionary and must be undertaken in order for the ITS to apply.

1. The USASMDC/ARSTRAT shall reduce impacts on UES-protected corals, top shell snails, clams and their habitats through the employment of best management practices and conservation measures.
2. The USASMDC/ARSTRAT shall record and report all action-related take of UES-consultation species.

11.4 Terms and Conditions

The USASMDC/ARSTRAT must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To meet reasonable and prudent measure 1 above, the USASMDC/ARSTRAT shall ensure that their personnel comply fully with the best management practices and conservation measures identified in the BA and below.
    a. The USASMDC/ARSTRAT shall ensure that all relevant personnel associated with this project are fully briefed on the best management practices and the requirement to adhere to them for the duration of this project.

b. In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to secure or remove from the water any substrate or coral rubble from the ejecta impact zone that may become mobilized by wave action as soon as possible.
    i. Ejecta greater than six inches in any dimension shall be removed from the water or positioned such that it would not become mobilized by expected wave action, including replacement in the payload crater.
    ii. If possible, coral fragments greater than six inches in any dimension shall be positioned on the reef such that they would not become mobilized by expected wave action, and in a manner that would enhance its survival; away from fine sediments with the majority of the living tissue (polyps) facing up.
    iii. UES consultation coral fragments that cannot be secured in-place should be relocated to suitable habitat where it is not likely to become mobilized.

c. In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to reduce impacts on top shell snails.
    i. Rescue and reposition any living top shell snails that are buried or trapped by rubble.
    ii. Relocate to suitable habitat, any living top shell snails that are in the path of any heavy equipment that must be used in the marine environment.

d. In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to reduce impacts on clams.
    i. Rescue and reposition any living clams that are buried or trapped by rubble.
    ii. Relocate to suitable habitat, any living clams that are in the path of any heavy equipment that must be used in the marine environment.

2. To meet reasonable and prudent measure 2 above:
    a. The USASMDC/ARSTRAT shall assign appropriately qualified personnel to record all suspected incidences of take of any UES-consultation species.
    b. The USASMDC/ARSTRAT shall utilize digital photography to record any UES-consultation species found injured or killed in or near the ocean target areas and/or at Illeginni. As practicable: 1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.
    c. In the event the payload impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to survey the ejecta field for impacted corals, top shell snails, and clams. Also be mindful for any other UES-consultation species that may have been affected.
    d. Within 60 days of completing post-test clean-up and restoration, provide photographs and records to the USAKA environmental office. USAKA and our biologists will review the photographs and records to identify the organisms to the

lowest taxonomic level accurately possible to assess impacts on consultation species.

e. Within 6 months of completion of the action, USAKA will provide a report to us. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.

12 Conservation Recommendations

The following conservation recommendations are discretionary agency activities provided to minimize or avoid adverse effects of a proposed action on UES-protected marine species or critical habitat, to help implement recovery plans, or develop information.

1. We recommend that the USASMDC/ARSTRAT continue to work with NMFS staff to conduct additional marine surveys around Illeginni Islet to develop a comprehensive understanding of the distribution and abundance of species that are there.
2. We recommend that the USASMDC/ARSTRAT consider constructing a berm, artificial Hesco Bastion (“Concertainer”), or Bremer wall, around the perimeter of the island above the beach line (see start of grass line in Figure 5 for example) at the impact site in order to reduce the amount of potential ejecta material which can enter the ocean from an impacting projectile. We understand that depending on impact characteristics ejecta may arch at a higher angle than a berm’s height. Additionally, consultation may be required with the USFWS for landbased activities. However, we believe it should be considered. This would reduce the risk to UES/ESA-listed species in the nearshore, allow for more precise definition of the target, and aid in the recovery of munition materials after impact.
3. We recommend the USASMDC/ARSTRAT equip USAG-KA personnel with metal detectors for recovery of projectile materials in the nearshore environment, if not already doing so. Furthermore, we recommend the USASMDC/ARSTRAT attempt to quantify the amount of recovered materials to determine the amount of tungsten that remains in the nearby environment.
4. We recommend that the USASMDC/ARSTRAT continue to work with NMFS staff to conduct marine surveys at additional sites around all of the USAKA islets and in the mid-atoll corridor to develop a more comprehensive understanding of the distribution and abundance of species and habitats at USAKA.
5. We recommend that the USAKA develop capacity and procedures for responding to marine mammal and turtle strandings.
    a. Acquire required permits and training to perform necropsies and/or to take and transport tissue samples.
    b. Develop professional relations with qualified federal agencies and universities to capitalize on samples and information gained at USAKA.
    c. Develop mechanisms to collect and disseminate the information.

Reinitiation Notice

This concludes formal consultation on the implementation of the FE-2 flight test program at the USAKA RTS, RMI. Reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law, and if:

1. The amount or extent of anticipated incidental take is exceeded;
2. New information reveals that the action may affect UES-protected marine species or critical habitat in a manner or to an extent not considered in this Opinion;
3. The action is subsequently modified in a manner that may affect UES-protected marine species or critical habitat to an extent, or in a manner not considered in this Opinion; or
4. A new species is listed or critical habitat designated that may be affected by the action.

13 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Supplement has undergone pre-dissemination review.

13.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the SSP, and USASMDC/ARSTRAT. Other interested users could include the citizens of RMI, USFWS, and NOAA. Individual copies of this Opinion were provided to the USASMDC/ARSTRAT. The format and naming adheres to conventional standards for style.

13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

13.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and reviewed in accordance with Pacific Islands Region ESA quality control and assurance processes.

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