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

May 2014

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National Environmental
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Environmental Assessment

U.S. Navy Testing of Hypervelocity Projectiles and an Electromagnetic Railgun at Wallops Flight Facility Wallops Island, Virginia

May 2014

Abstract

This Environmental Assessment (EA) identifies and evaluates the potential environmental impacts of installing a 5" powder gun and an electromagnetic (EM) railgun, testing hypervelocity projectiles (HVPs), integrating HVPs with the EM railgun, and integrating the HVP/EM railgun weapon system with combat systems equipment currently in use on U.S. Navy warships. Testing would advance the development of HVPs and the EM railgun, which will allow future ships to fire guns farther, beyond the range of shore guns. The proposed site for the guns is amidst NAVSEA's Surface Combat Systems Center, which is located on the National Aeronautics and Space Administration's Wallops Flight Facility on Wallops Island, Virginia. The guns would fire into the Virginia Capes Range Complex in the Atlantic Ocean, which is used by the Navy for training and testing activities. The EA assesses the impacts of the No Action Alternative and three alternative sites on Wallops Island, one of which is the preferred alternative. None of the alternatives would have significant impacts on the environment. Preparation of an environmental impact statement is not required.

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Acronyms and Abbreviations

AFTT	Atlantic Fleet Training and Testing Final Environmental Impact
FEIS/OEIS	Statement/Overseas Environmental Impact Statement
APE	Area of Potential Effect
BAMS	Broad Area Maritime Surveillance
C.F.R.	Code of Federal Regulations
DoD	Department of Defense
DoN	Department of the Navy
DPS	distinct population segments
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ELV	expendable launch vehicle
EM	Electromagnetic
EO	Executive order
ESA	Endangered Species Act
ESSM	Evolved Sea Sparrow Missile
HVP	Hypervelocity projectile
MMPA	Marine Mammal Protection Act
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NAVSEA	Naval Sea Systems Command
Navy	U.S. Department of the Navy
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NSWCDD	Naval Surface Warfare Center Dahlgren Division
OEA	Overseas environmental assessment
ONR	Office of Naval Research
OPAREA	Operating area
PK	peak noise level
RDT&E	Research, development, test and evaluation
R-6604	Restricted airspace over and near WFF
SCSC	Surface Combat Systems Center

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SEMARNAT	Secretary of Environment and Natural Resources, Mexico
SHPO	State Historic Preservation Officer
SM-3	DoD Standard Missile Rocket Launcher 3
SRIPP	Shoreline Restoration and Infrastructure Protection Program
U.S.	United States
U.S.C.	United States Code
UAS	unmanned aerial or aircraft system
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VAC	Virginia Administrative Code
VACAPES	Virginia Capes Range Complex
W-386	VACAPES warning area near WFF
WFF	Wallops Flight Facility

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Executive Summary

The Navy is proposing to install a 5" powder gun and an electromagnetic (EM) railgun, test hypervelocity projectiles (HVPs), integrate HVPs with the EM railgun, and integrate the HVP/EM railgun weapon system with combat systems at the Naval Sea Systems Command's (NAVSEA's) Surface Combat Systems Center (SCSC), which is located at the National Aeronautics and Space Administration's (NASA's) Wallops Flight Facility (WFF) on Wallops Island, Virginia (Figure ES-1). The guns would fire into the Virginia Capes Range Complex in the Atlantic Ocean, which is used by the Navy for training and testing activities (Figure ES-2).

ES.1 Background

The Navy's Office of Naval Research (ONR) is carrying out the second phase of a multi-year Railgun Innovative Naval Prototype program to develop and mature the science and technologies supporting future naval EM railgun weapon systems. The EM railgun is a revolutionary long-range naval gun that is expected to fire precision-guided HVPs to distances greater than 100 nautical miles – farther and faster than any preceding gun. Rather than using gunpowder and rocket motors for propulsion, the railgun uses electrical power to propel projectiles. Among the technical challenges is to design, develop, fabricate, test, and demonstrate HVPs compatible with both standard naval guns and future EM railgun systems. Railgun science and technology have advanced sufficiently so that NAVSEA's Directed Energy and Electric Weapon Systems Program Office proposes to move beyond the laboratory to conduct systems-level demonstrations by firing from a land range into a sea range.

ES.2 Purpose and Need

The purpose of the Proposed Action is to advance HVP and EM railgun technology from research, development, test, and evaluation to an acquisition program designed to meet warfighting needs. The need for the Proposed Action is to enable the Navy to meet current and future mission-related warfare requirements of providing gunfire support for anti-air warfare, anti-surface missions, and naval surface fire support missions. The proposed HVP/EM railgun weapon system would extend naval surface fire support missions, such as amphibious landings and shore bombardments, to 50 to 100 nautical miles from the current 13-nautical mile range of the 5"/54 gun found on Navy ships today. The extended range would allow ships to operate well offshore, beyond the reach of shore guns, keeping sailors and Marines safer. It would also meet the Innovative Naval Prototype Phase II program objective to advance EM railgun system technology for transition to an acquisition program.

ES.3 Proposed Action

The Proposed Action is to: install a 5" powder gun and an EM railgun, test hypervelocity projectiles, integrate HVPs with the EM railgun, and integrate the HVP/EM railgun weapon system with combat systems equipment currently in use on U.S. Navy warships. Two Navy guns would be installed on WFF's Wallops Island:

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- A MK 45 Mod 4 Proof of Concept 5" powder gun to test HVPs. Supporting facilities, including personnel command shelters and a radar facility would also be installed. Projectiles would be fired at speeds up to 2,908 miles per hour (4,680 kilometers per hour) or 0.8 miles per second (1.3 kilometers per second) and ranges of approximately 35 nautical miles. Projectiles are anticipated to be guided and include telemetry. Typical gun range instrumentation is expected to be used.
- An EM railgun that is currently under development. The EM railgun and a pulsed power system would be installed near the powder gun. It would be used to fire HVPs for various system-level demonstrations at speeds up to 4,474 miles per hour (7,200 kilometers per hour) or 1.2 miles per second (2.0 kilometers per second) and ranges to 100 nautical miles.

Three types of projectiles would be tested:

- Inert, which would contain no explosives and would be used to test guidance and control.
- Kinetic energy dispensing variant, which would be used against air targets. This variant would contain ≤0.2 pound (≤0.1 kilogram) of explosives to burst the casing of the projectile and dispense tungsten pellets.
- High-explosive variant, which would contain ≤2 pounds (≤0.9 kilogram) of explosives. High explosive projectiles would be used against water surface targets and are intended to burst and fragment just prior to striking the target. Underwater explosions are not planned and would only occur in abnormal or test failure conditions.

Table ES-1 shows the proposed average annual number of projectiles to be used in the five program years. Inert projectiles would be the main type of projectile used – 100 percent in the first and second years, approximately 67 percent in the third and fourth years, and approximately 80 percent in the fifth year. Kinetic energy projectiles would comprise zero projectiles in the first and second years, approximately 27 percent or fewer of projectiles in the third and fourth years, and approximately 16 percent or fewer of the total projectiles tested in the fifth year. High explosive projectiles would not be tested in the first two years, but would comprise approximately 7 percent or fewer of projectiles in the third and fourth years, and approximately 4 percent or fewer of the total projectiles tested in the fifth year. Testing typically would take place in daylight hours but firing may occasionally take place at night based on mission requirements and WFF's testing schedule for other programs.

Table ES-1 Average Annual Number of Projectiles by Program Year

Projectile Types	Year 1	Year 2	Year 3	Year 4	Year 5
Inert	100	100	100	100	200
Kinetic Energy	0	0	40	40	40
High Explosive	0	0	10	10	10
Total Number	100	100	150	150	250

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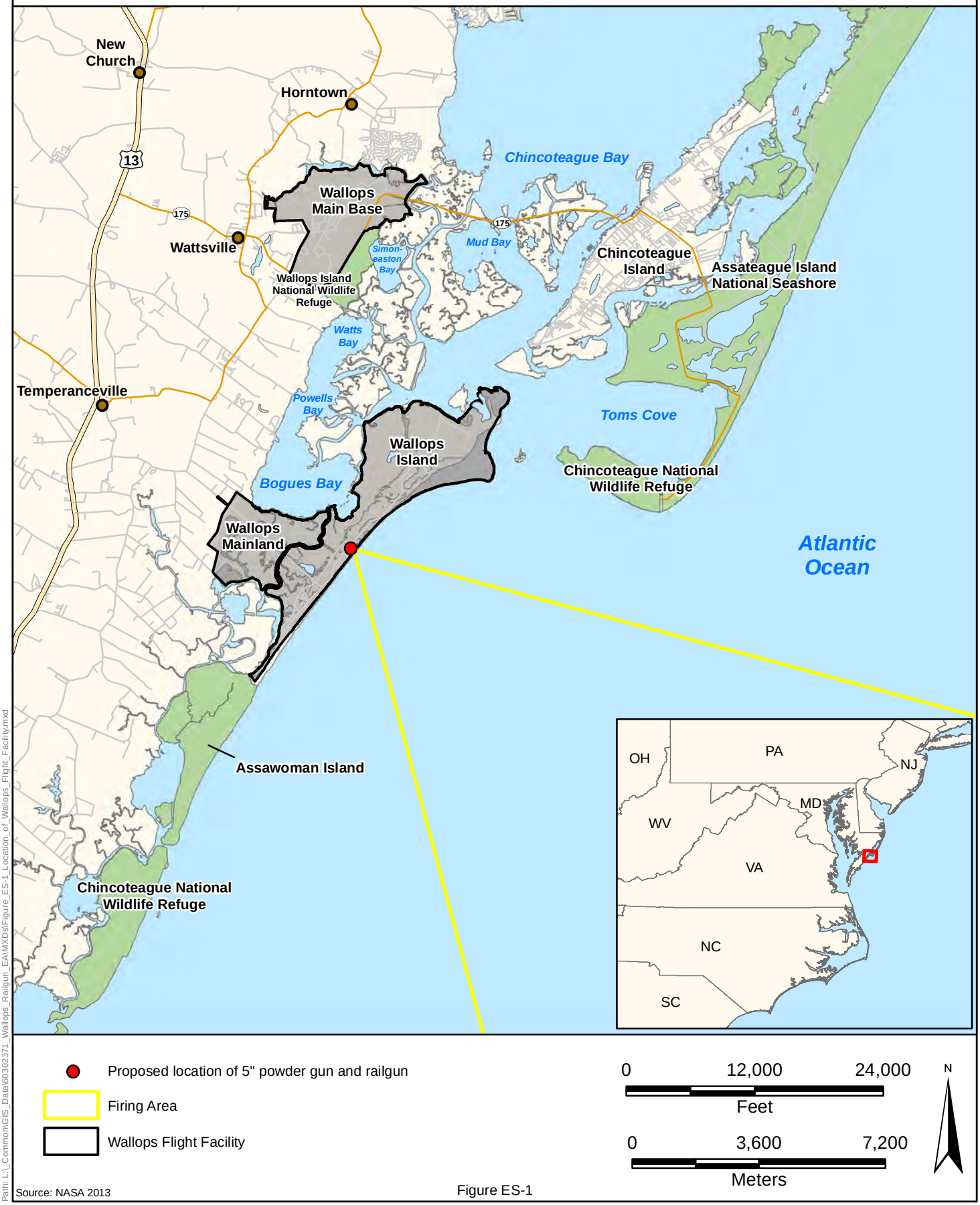
Location of Wallops Flight Facility



Source: NASA 2013

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Figure ES-1

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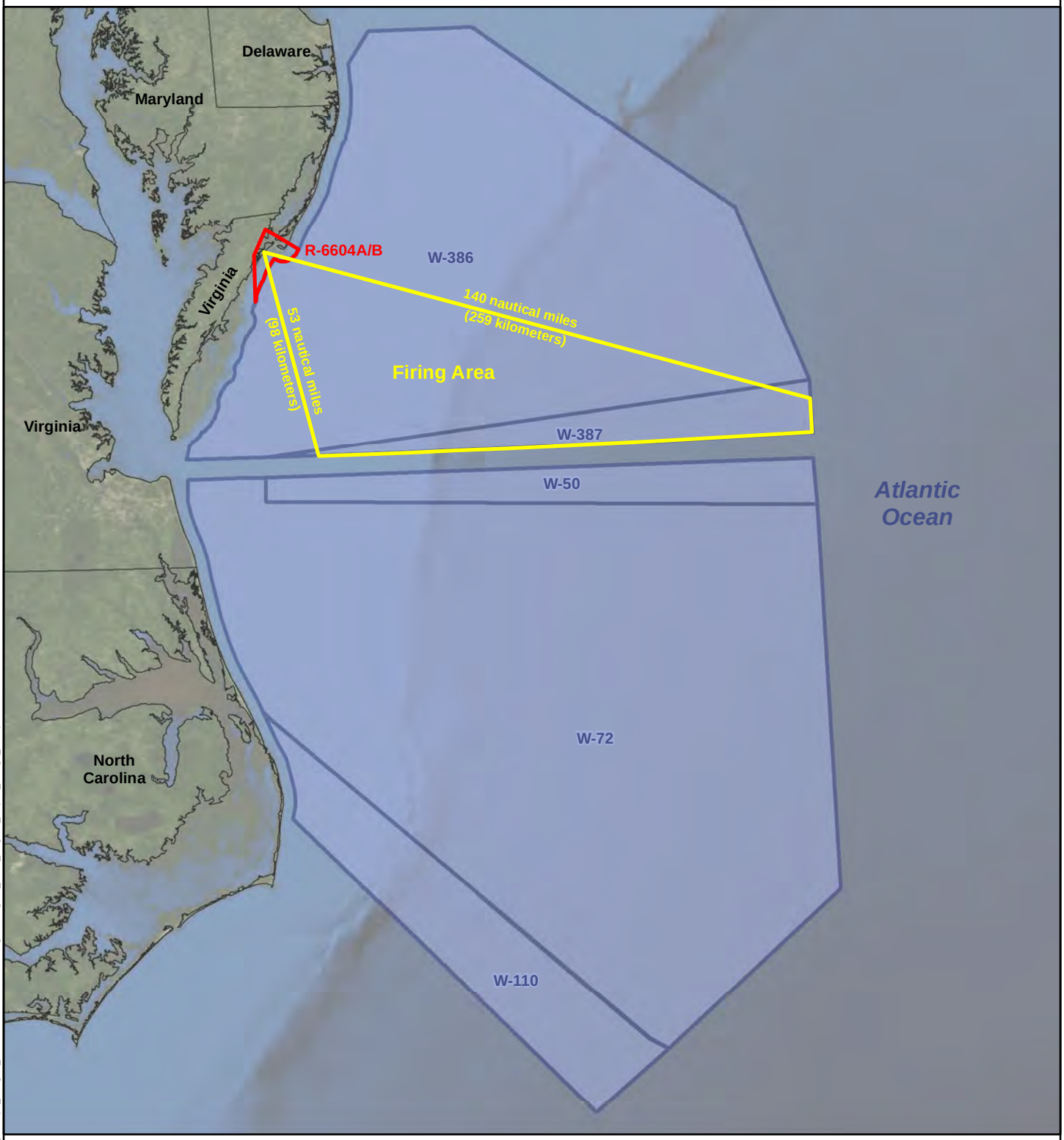
Virginia Capes Range Complex



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Source: NASA 2013

Figure ES-2

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Each projectile has four aluminum sabots that surround the projectile and hold it in place while it is in the gun. Each sabot petal is 22 inches by 3.5 inches (56 centimeters by 9 centimeters) and weighs approximately 3.5 pounds (1.6 kilograms). While currently made entirely of aluminum, in the future the sabot would likely transition to a lighter carbon-composite material. When a projectile is fired, the sabots come off and hit the water from a minimum of 600 feet (183 meters) to a maximum of 1 nautical mile from the gun in the direction of the target. The titanium pusher plate holds pressure in to propel the projectile out of the gun, detaching and hitting the water from a minimum of 600 feet (183 meters) to a maximum of 3 nautical miles from the gun in the direction of the target. The pusher plate is a disc, 5 inches x 1.5 inches in size and weighs 2.2 pounds (1 kilogram).

Because railgun projectiles are launched using electrical energy, they have an armature that propels the projectile down the rail while conducting the electrical pulse to propel the projectile out of the gun. Armatures weigh approximately 5.5 to 6.6 pounds (2.5 to 3.0 kilograms) and are made of aluminum. They come off the projectile after firing, hitting the water a minimum of 600 feet (183 meters) to a maximum of 3 nautical miles from the gun in the direction of fire.

Figure ES-3 illustrates the proposed nearshore (within 3 nautical miles of the shoreline) firing area. Projectiles would be fired on bearings within this area, and sabot petals, pusher plates, and armatures would fall into the areas indicated on the map. The wing-like shape of the sabot petals can cause them to drift in the air away from the firing line before settling into the water, as indicated on the figure. The target areas are from 5 nautical miles up to approximately 35 nautical miles from the 5” powder gun and up to approximately 100 nautical miles for the railgun, within the firing area shown in Figure ES-2.

ES.4 Alternatives

Test Site Selection Criteria

ONR’s current Future Naval Capabilities HVP program requirements focus on the development of a guided projectile that can be used in both the future Navy railgun and the current inventory of Navy Fleet 5” gun systems. To transition the HVP program from an RDT&E program to an acquisition program, additional testing and systems integration of the HVP must be accomplished. Such testing must take place at sites compatible with testing both the future Navy railgun and current Navy Fleet gun systems. Equally important, the test site must have the ability to integrate the gun systems with existing Navy ship combat systems.

Based on the HVP program test objectives, a land-based test location where the following four criteria are met was required:

1. Situated adjacent to a sea range controlled by the Department of Defense capable of supporting projectile flight distances of at least 100 nautical miles.
2. Supports projectile firings from fleet-relevant gun systems, including 5” guns and EM railguns.
3. Incorporates a fire control radar capable of SPY-1 systems operations, enabling the immediate acquisition of the projectile upon leaving the gun barrel and capable of integrating alternative fire control sensor systems for projectile acquisition and tracking purposes.

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4. Accommodates current fleet-relevant combat systems interfaces with existing MK 160 Gun Fire Control Systems.

The only installation that met all of the criteria listed above was NASA's WFF at Wallops Island, Virginia.

Site Alternatives

The proposed sites to place the railgun and the 5" gun are amidst NAVSEA's SCSC, which is a shore activity located on Wallops Island. SCSC provides highly technical engineering and training support to the Fleet, and their facilities include the radars and combat system capabilities necessary to meet mission requirements for the HVP/EM railgun program.

The Navy identified three site alternatives on WFF's Wallops Island using two criteria:

1. Site that is available for long-term use.
2. Close enough to the Navy's AEGIS SPY-1 radar facility on Wallops Island to allow immediate acquisition (tracking) of the projectile (HVP Program Criterion 4).

Figure ES-4 shows the AEGIS SPY-1 radiofrequency pattern in relation to the three alternative sites at WFF. The three sites – Pad 4, Pad 5, and the Elevated Road – meet all four HVP Program criteria as well as the two WFF site-related criteria. All potential sites south of Pad 4 and north of the Elevated Road were eliminated from consideration; they did not meet HVP Program criterion 3/site criterion 2 because they are located too far from the AEGIS SPY-1 radar beam to allow immediate acquisition of the projectile.

The three selected sites carried forward are available for long-term use. Acquisition (tracking) of the projectile would be slowest at Pad 4, but it is still a reasonable site alternative. Gun tests at the Elevated Road site would cause traffic delays during test events, but it is still a reasonable site alternative. Pad 5 allows for quick acquisition of the projectile and has no traffic problems associated with it. Therefore, Pad 5 is the Preferred Alternative.

ES.5 Environmental Consequences

The environmental consequences of testing and systems integration of HVPs with an EM railgun were evaluated for the following resources: land use; range operations; noise; air quality; socioeconomics; cultural resources; health and safety; geomorphology, sediments, and soils; water resources; terrestrial biological resources; aquatic biological resources; protected species; and utilities. Table ES-2 (see page ES-XIII) lists the environmental consequences for each of the resource areas assessed in the EA and summarizes their impact on the associated resources.

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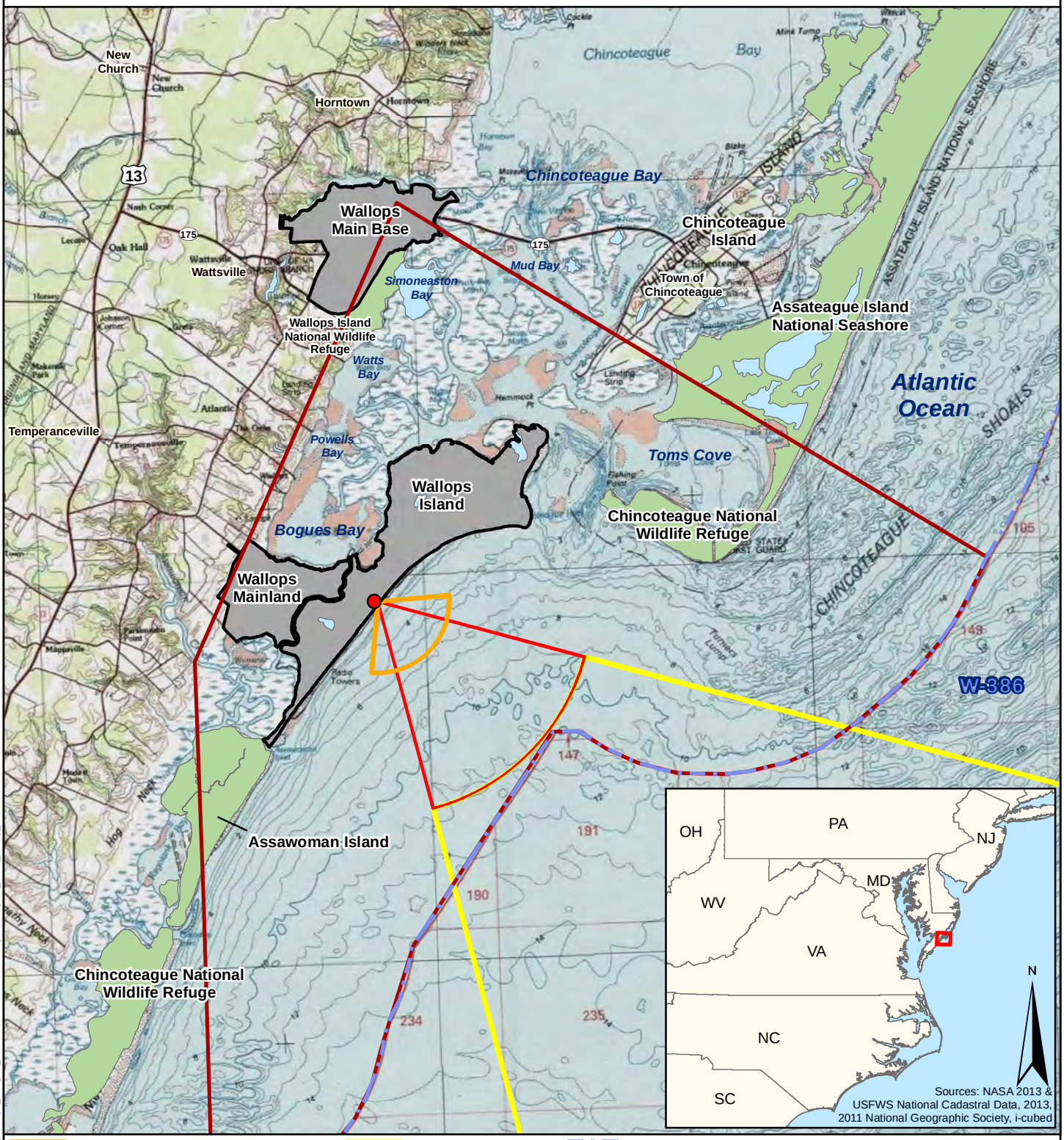
Proposed Nearshore Firing Area



Source: NASA 2013

Figure ES-3

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Wallops Island Alternative Sites

Source: NASA 2013

Figure ES-4

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Table ES-2
Summary of Impacts by Resource

Resource	No Action	Pad 5 (Preferred Alternative)	Pad 4 Alternative	Elevated Road Alternative
Land Use	No Impact	• Consistent with existing land use • Consistent with NASA Master Plan and Accomack County Plan • No significant impacts	Same as Preferred Alternative	Same as Preferred Alternative
Range Operations	No Impact	• Based on number of shots and WFF's standard operating procedures for clearing test areas, no significant impacts	Same as Preferred Alternative	Same as Preferred Alternative
Noise	No Impact	• Noise from gun fire would not affect any sensitive uses • Protective measures included in standard operating procedures would provide protection for personnel and the public • Noise and vibration levels from gun fire would have no significant impacts	Same as Preferred Alternative	Same as Preferred Alternative
Air quality	No Impact	• General Conformity Rule does not apply because Accomack County is in attainment for criteria air pollutants • Air emissions from construction not significant; erosion and sediment control measures would minimize fugitive dust • Emissions from guns not significant • Greenhouse gas emissions not significant • No significant impacts	Same as Preferred Alternative	Same as Preferred Alternative
Socioeconomics	No Impact	• No disproportionately high and adverse human health or environmental effects on minority and low-income populations • No disproportionate environmental health or safety risks to children • Closure of all or part of the danger zone from 80	Same as Preferred Alternative	Same as Preferred Alternative

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Resource	No Action	Pad 5 (Preferred Alternative)	Pad 4 Alternative	Elevated Road Alternative
		hours in program year 1 to 190 hours in program year 5 would not have significant effects on maritime transport, recreational boating, or commercial and recreational fishing • No significant socioeconomic impacts		
Cultural Resources	NEPA: No Impact Section 106: No Effect	• NEPA: No impact on two National Register-eligible resources located more than two miles away on north end of Wallops Island • Section 106: No effect on the two eligible resources	Same as Preferred Alternative	Same as Preferred Alternative
Health and Safety	No Impact	• All applicable federal and state, NASA, WFF, DoD, and Navy occupational safety and environmental regulations would be followed • Explosives stored outside of safety arcs, away from test area • Personnel protected from EM fields by minimum safety distance • No significant health and safety impacts with protective measures • Handling, processing, storage, and disposal of hazardous materials in accordance with federal and state requirements • No significant waste management/hazardous materials impacts	Same as Preferred Alternative	Same as Preferred Alternative
Geomorphology, Soils, and Sediments	No Impact	• Best management practices would be implemented during construction to minimize soil erosion and runoff • The small amount of expended materials settling to the sea floor bottom would not disturb	Same as Preferred Alternative	Same as Preferred Alternative

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Resource	No Action	Pad 5 (Preferred Alternative)	Pad 4 Alternative	Elevated Road Alternative
		sediments outside the natural range of events • No practicable alternative to construction and operation in 100-year floodplain; sensitive facilities would be elevated above flood level on pilings; displacement of flood waters minimal • No significant impacts on geology, topography, soils, floodplains, bathymetry, or sediments		
Water Resources	No Impact	• Best management practices would be implemented during construction to minimize erosion and runoff • A stormwater plan will be prepared and implemented • No significant impacts on surface water, marine waters, stormwater, or groundwater	Same as Preferred Alternative	Same as Preferred Alternative
Terrestrial Biological Resources	No Impact	• Pad 5 is a developed area with limited vegetation and no attractive wildlife habitat • No wetlands are present • Wildlife would not be exposed to elevated electromagnetic fields • No sabots, pusher plates, or armatures would fall onshore • Noise and light may startle individual animals, but there would be no population-level impacts • No significant impacts	Same as Preferred Alternative, except final design would require avoiding nearby wetlands	Same as Preferred Alternative, except final design would require avoiding nearby wetlands
Aquatic Biological Resources	No Impact	• Sabots, pusher plates, and armatures are unlikely to strike fish or other aquatic life • Expended material would cover a negligible amount of seafloor • No sediment or water quality impacts	Same as Preferred Alternative	Same as Preferred Alternative

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Resource		No Action	Pad 5 (Preferred Alternative)	Pad 4 Alternative	Elevated Road Alternative
			• No significant impacts		
Protected Species	**Plants**	NEPA: No Impact ESA: No Effect	• ESA-listed seabeach amaranth is not present at WFF but suitable habitat exists, so surveys are conducted annually • NEPA: No impact • ESA: No effect	• NEPA: No impact • ESA: No effect	• NEPA: No impact • ESA: No effect
	Sea Turtles Nesting	NEPA: No Impact ESA: No Effect	• ESA-listed nesting sea turtles and hatchlings may be disoriented by light, if any turtles nest near guns during night time testing • If turtles nest in front of guns, mitigation being considered is to avoid firing at night until hatching takes place, to use turtle-friendly site lighting, and to keep the site dark when not testing at night. • WFF monitors sea turtles and implements protective measures including nest protection and hatching procedures • NEPA: No significant impacts • ESA: May affect, but is not likely to adversely affect	• NEPA: No significant impacts • ESA: May affect, but is not likely to adversely affect	• NEPA: No significant impacts • ESA: May affect, but is not likely to adversely affect

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Resource		No Action	Pad 5 (Preferred Alternative)	Pad 4 Alternative	Elevated Road Alternative
	Birds	Piping Plover and Red Knot NEPA: No Impact ESA: No Effect	*Piping plover* • Gun noise may startle birds, but would not have any significant effects on fitness • If ESA-listed piping plovers nest in 1,000-foot (300-meter) band on beach in front of guns, mitigation being considered is to avoid firing until hatching takes place • If piping plovers forage in a 300-foot (100-meter) band on the beach in front of the guns, mitigation being considered is to avoid firing until they vacate the area • WFF monitors nests and implements protective measures including nest protection and hatching procedures • NEPA: No significant impacts ESA: May affect, but is not likely to adversely affect *Red knot* • Noise may startle birds, but would not impede foraging during migration • If ESA-candidate red knots forage in a 300-foot (100-meter) band on the beach in front of the guns, mitigation being considered is to avoid firing until they vacate the area • NEPA: No significant impacts • ESA: Not likely to jeopardize *Migratory Birds* • NEPA: No significant impact	• NEPA: No significant impacts • ESA: May affect, but is not likely to adversely affect and not likely to jeopardize	• NEPA: No significant impacts • ESA: May affect, but is not likely to adversely affect and not likely to jeopardize
	Fish, Sea Turtles (at-	NEPA: No	• Probability of an Atlantic sturgeon, sea turtle, or	• NEPA: No	• NEPA: No

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Resource		No Action	Pad 5 (Preferred Alternative)	Pad 4 Alternative	Elevated Road Alternative
	sea), Marine Mammals	Impact ESA: No Effect	marine mammal strike is negligible • No impacts on sediments or water quality • NEPA: No significant impacts • ESA: May affect, but is not likely to adversely affect	significant impacts • ESA: May affect, but is not likely to adversely affect	significant impacts • ESA: May affect, but is not likely to adversely affect
	Essential Fish Habitat	No Impact	• Low probability of direct hits • Expended materials would not affect substrate • No impacts to sediment or water quality • No significant impacts	Same as Preferred Alternative	Same as Preferred Alternative
Utilities		No Impact	• Projected increase in demand for utilities would not exceed their planned capacities • No significant impacts	Same as Preferred Alternative	Same as Preferred Alternative
Cumulative Impacts		No Impact	• Proposed projects would cumulatively increase activity levels on Wallops Island and on ranges but not expected to have significant impacts • Increased activity not expected to affect protected species because activities sporadic and WFF monitors effects • Increase in noise-making events not expected to have significant impacts • No significant impacts	Same as Preferred Alternative	Same as Preferred Alternative

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ES.6 Monitoring, Protective, and Mitigation Measures

In order to minimize the environmental impacts of current activities and missions taking place at WFF, NASA, the Navy, and other tenants have developed protective and mitigation measures. *Monitoring* and *protective measures* are ongoing actions taken to protect sensitive resources, but are not implemented in response to the impact findings of this EA. In contrast, *Mitigation measures* would be implemented specifically in response to the Proposed Action or the impact findings described in Chapter 3 of this EA. The protective measures currently in place would continue to be used as the main means of mitigating environmental and safety risks.

Health and Safety Protective Measures

Health and safety protective measures include:

- All activities proposed under the Proposed Action will adhere strictly to all Navy and NASA health, safety, and environmental protocols.
- All activities proposed will adhere strictly to all safety zones – i.e., danger zones, hazard arcs, and Airfield Safety Zones (R-6604A/B and W-386).
- Members of the public and personnel not involved in a test will be excluded from testing area and the affected portion of the Virginia Capes Operating Area prior to and during tests.
- The WFF Range Safety Officer will ensure that Wallops Range safety policy, criteria, and procedures are not violated during operations and the WFF Operations Safety Supervisor will ensure that the ground safety plan is implemented.
- As part of standard operating procedures, all personnel in the immediate firing vicinity will be in command shelters or buildings during testing.

WFF Protected Species Monitoring

In regard to protected species, WFF administers a *Protected Species Monitoring Plan* to manage threatened and endangered species in accordance with Section 7 of the Endangered Species Act (ESA). The monitoring plan details the methods and frequency of monitoring protected species within the property boundaries of Wallops Island. ESA-protected species covered by this plan include the loggerhead sea turtle, green sea turtle, leatherback sea turtle, piping plover, red knot, and seabeach amaranth. Other species of interest surveyed include at a minimum Wilson's Plover, American oystercatcher, and colonial nesting birds such as tern species. WFF confers with the U.S. Fish and Wildlife Service (USFWS) and the Virginia Department of Game and Inland Fisheries to determine which other species will be surveyed and to confirm survey methods. The monitoring plan also includes the marine mammal and sea turtle stranding program managed at WFF in cooperation with the Virginia Aquarium. WFF's monitoring plan includes mitigation measures, such as sea turtle and piping plover nest protection, that have been and will continue to be implemented, regardless of whether the Proposed Action is implemented.

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Possible Mitigation Measures

If night time testing is required, the following mitigation measures are being considered to protect nesting sea turtles and hatchlings from light disturbances:

- Keeping the gun site dark when not in use (i.e., no outside security lights would be turned on).
- Using turtle-friendly lighting during night-firing events (e.g., amber light-emitting diodes [LED], low-pressure sodium, or other lighting approved by WFF).
- If a sea turtle were to nest in front of the test area where lighting may disorient hatchlings, night operations could cease during the approximately two-week hatching window. The beach would be routinely monitored for nests during nesting season in order to predict hatching time.

In the event that a piping plover nests in front of a gun, i.e., within an approximate 1,000-foot (300-meter) band along the beach, the following mitigation measure is being considered:

- Suspending testing until the chicks hatch or until it is determined that the nest has failed. Nests would be monitored following the *Protected Species Monitoring Plan*.

Piping plovers and red knots may forage along the shoreline in front of the guns. The following mitigation measure is being considered for foraging piping plovers and red knots:

- If a piping plover or red knot is observed within an approximately 330-feet (100-meter) band along the beach in front of the gun, testing would be temporarily suspended until the bird(s) moves out of this area. This distance is based on studies suggesting that only birds near the firing point may be disturbed. Monitoring would cease approximately fifteen to twenty minutes prior to testing to allow observers to return to a safe area.

The impact findings summarized in Table ES-2 were determined in the context of the existing environmental management processes and protective measures in place at WFF.

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1 Purpose and Need for the Proposed Action

1.1 Introduction

The Navy's Office of Naval Research (ONR) is carrying out the second phase of a multi-year Railgun Innovative Naval Prototype program to develop and mature the science and technologies supporting future naval electromagnetic (EM) railgun weapon systems. Among the technical challenges is to design, develop, fabricate, test, and demonstrate guided hypervelocity projectiles (HVPs) compatible with both standard large naval guns and future EM railgun systems. Railgun science and technology have advanced sufficiently so that the Naval Sea System's (NAVSEA's) Directed Energy and Electric Weapon Systems Program Office proposes to move beyond the laboratory to conduct systems-level demonstrations by firing from a land range into a sea range.

Hypervelocity Projectiles (HVPs)

HVPs travel more than five times the speed of sound (Mach 5 and higher) or greater than 3,840 miles per hour (6,150 kilometers per hour).

Therefore, the Proposed Action is to: install a 5" powder gun and an EM railgun; test HVPs; integrate HVPs with the EM railgun; and integrate the HVP/EM railgun weapon system with combat systems equipment currently in use on U.S. Navy warships. The proposed site for the guns is amidst NAVSEA's Surface Combat Systems Center (SCSC), which is located on the National Aeronautics and Space Administration's (NASA's) Wallops Flight Facility (WFF) on Wallops Island, Virginia (Figure 1-1). The guns would fire into the Virginia Capes Range Complex in the Atlantic Ocean, which is used by the Navy for training and testing activities (Figure 1-2).

5" Powder Gun

The Navy may test a 5"/54 or a 5"/62 gun, using gun powder to propel the projectiles. The first number, 5", is the caliber (diameter of the bore). The second number, 54 or 62, is the barrel length, which is described in multiples of the diameter of the bore. For example, 5"/62 means the gun has a 5-inch-diameter (12 centimeter) bore and has a barrel 5 x 62 inches = 310 inches (12 x 157 centimeters = 787 centimeters) long. Mark45 (MK45) is the 45th version of the 5" gun. Mod 4 is the 4th modification of the MK 45 design.

In accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] §§ 4321-4370h); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [C.F.R.] §§ 1500-1508); Navy regulations implementing NEPA (32 C.F.R. § 775), an environmental assessment (EA) is required to evaluate the impacts of the Proposed Action. The Navy is the lead agency for the Proposed Action with NASA serving as a cooperating agency.

1.2 Background

The EM railgun is a revolutionary long-range naval gun that is expected to fire precision-guided HVPs to ranges greater than 100 nautical miles – farther and faster than any preceding gun. Rather than using gunpowder and rocket motors for propulsion, the railgun uses electrical power to propel projectiles. Magnetic fields created by high electrical currents accelerate a sliding metal conductor, or armature, between two rails to launch projectiles at 4,500 to 5,600 miles per hour (7,242 to 9,012 kilometers per hour) or 1.2 to 1.6 miles per second (2.0 to 2.5 kilometers per second). In contrast, the standard gun used on Navy ships – the MK 45 5"/54 gun – has a range

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of slightly more than 13 nautical miles and a muzzle velocity of 1,785 miles per hour (2,873 kilometers per hour) or 0.5 miles per second (0.8 kilometers per second) (Navy ONR 2008, 2012).

Muzzle Energy and Muzzle Velocity

Muzzle energy is the kinetic (moving) energy of a projectile as it is expelled from the muzzle of a gun. The heavier the projectile and/or the faster it moves, the higher the muzzle energy and the more damage the projectile will inflict on its target. A megajoule is a measurement of energy associated with a mass traveling at a certain velocity. In simple terms, a one-ton (907 kilogram) vehicle moving at 100 miles per hour (161 kilometers per hour) equals a megajoule of energy. **Muzzle velocity** is the speed at which a projectile leaves the muzzle of a gun.

With their increased velocity and extended range, EM railguns, when installed on Navy ships in the 2020s, will give sailors a multi-mission capability, allowing them to conduct precise naval surface fire support for land strikes, ship defense, and surface warfare to deter enemy vessels. The extended range will allow ships to operate well offshore, beyond the reach of shore guns, keeping sailors and Marines safer. The ability of the railgun to deliver persistent, time-critical, precision strikes without the use of propellants will revolutionize war-fighting capabilities from the sea. Navy planners are targeting an initial 50- to 100-nautical mile firing capability with the potential for expansion up to 220 nautical miles. Figure 1-3 illustrates future railgun mission capabilities.

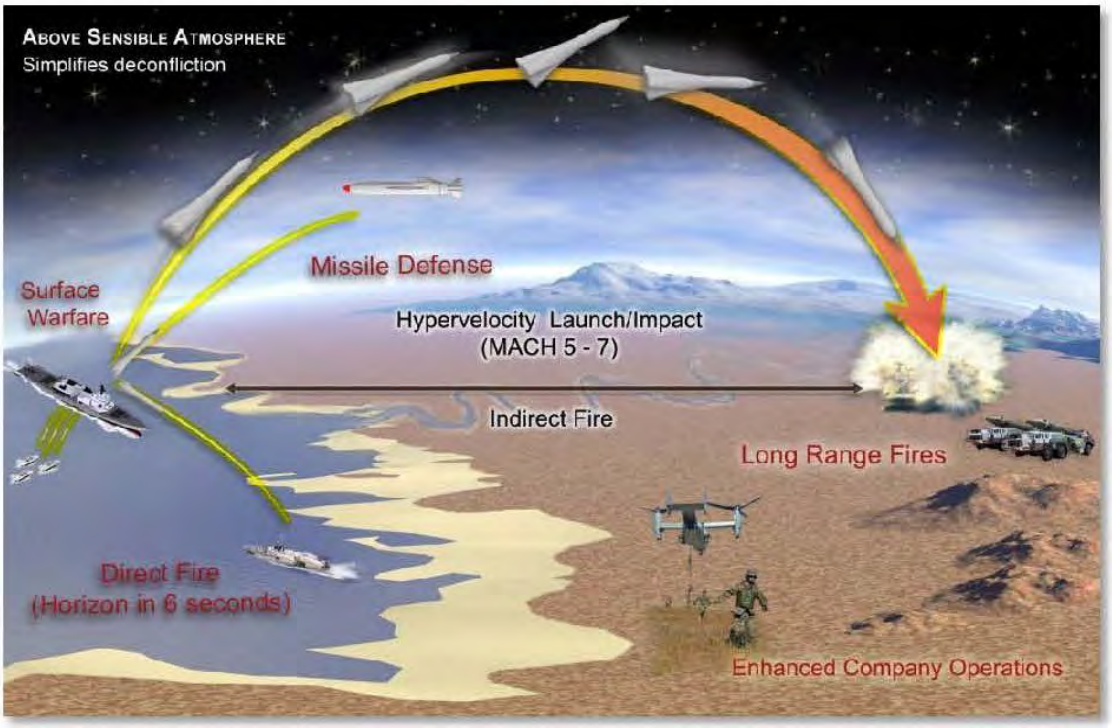

Figure 1-1: Future railgun mission capabilities (ONR 2013).

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Location of Wallops Flight Facility

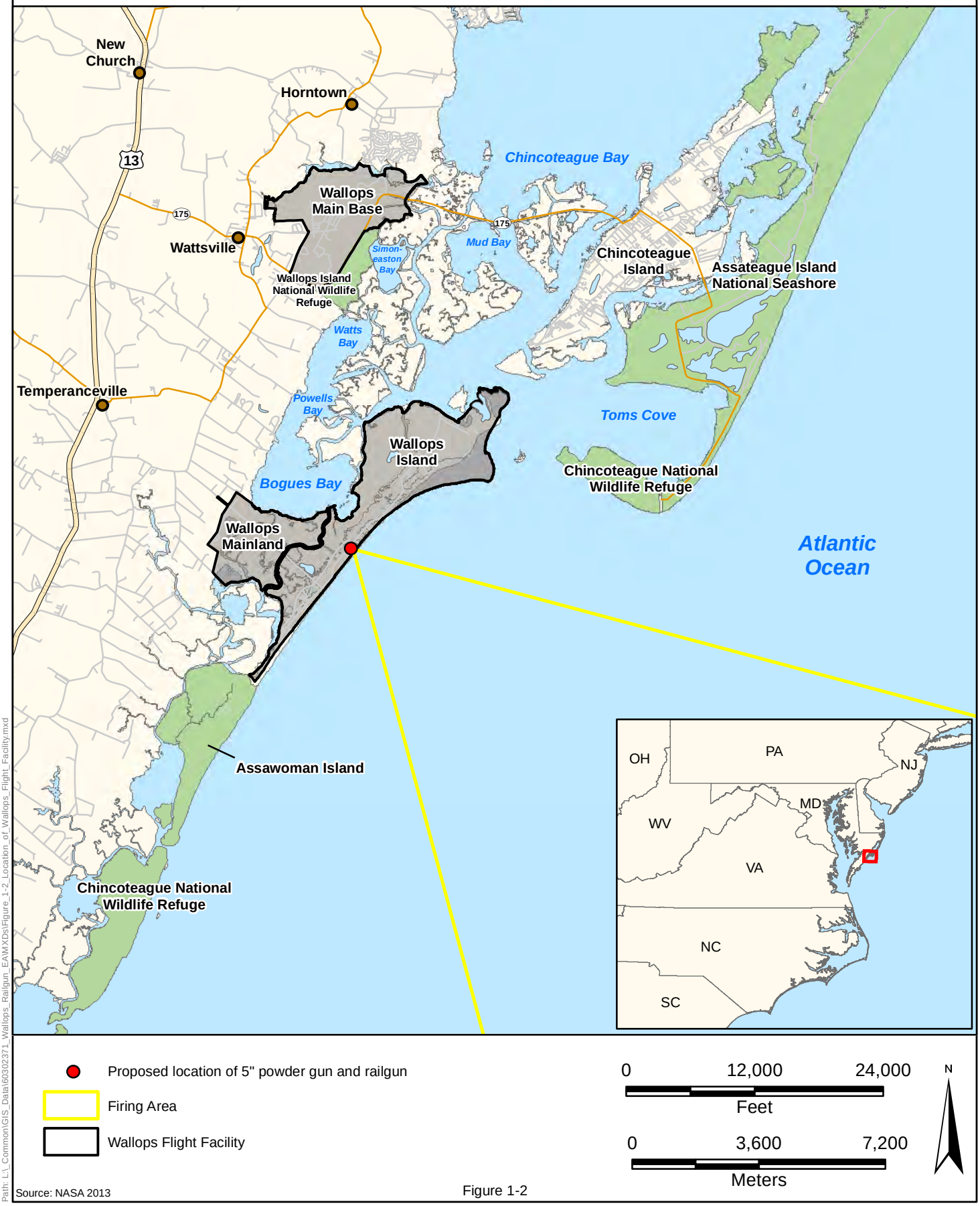

Figure 1-2

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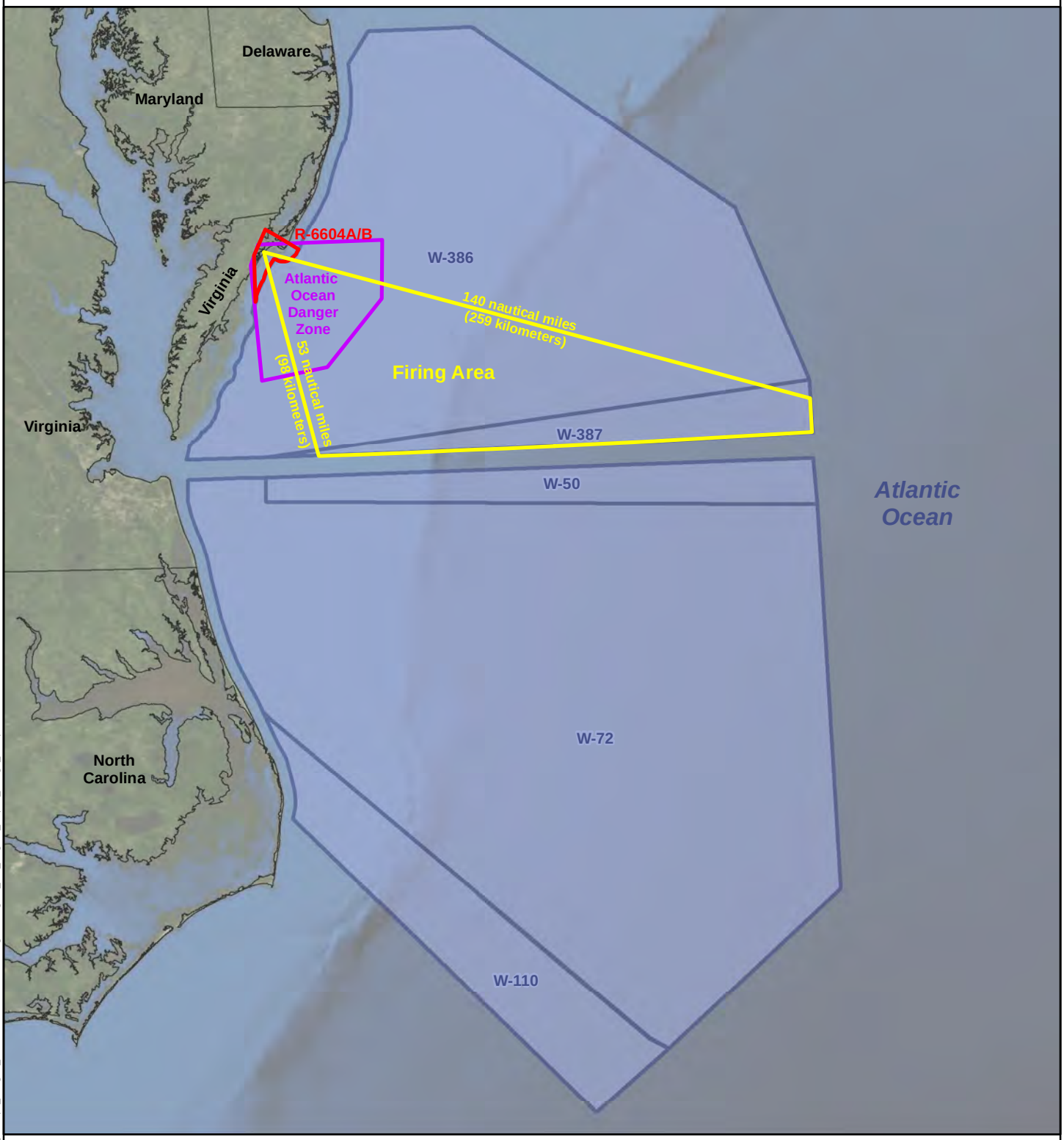
Virginia Capes Range Complex



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Source: NASA 2013

Figure 1-3

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Because of the velocity with which projectiles are fired from railguns, they destroy targets by kinetic energy – the sheer force of the impact. The projectile reaches its target at speeds that require only a small energetic charge akin to that found in automobile airbags to dispense its payload (Navy ONR 2011). Kinetic projectiles break into fragments – each one of them traveling at lethal velocities – which destroy targets on impact. Other projectiles may contain tungsten pellets that bombard a target at lethal velocities. High explosive projectiles may include up to 2.0 pounds (0.9 kilogram) of explosives to disperse fragments or pellets with a force similar to a projectile fired at higher muzzle energy. This amount of explosives is considerably less than that used in standard 5" explosive projectiles. In addition, railgun projectiles require no propellant. Thus, handling, storing, and using railgun projectiles will be safer because of the reduced amounts of explosives.

Railgun research began in the 1980s as part of the Strategic Defense Initiative, which was seeking long-range weapons to intercept intercontinental ballistic missiles in space. In 1985, the U.S. Army began research to develop a mobile, ground-based EM system capable of defeating the armored combat vehicles of the future. Army-sponsored research at the University of Texas Institute for Advanced Technology led to significant progress in the area of railgun barrel life, which enabled the development of railguns.

The Naval Science and Technology Corporate Board chartered the Railgun Innovative Naval Prototype program in 2005. The goal during Phase I was a proof-of-concept demonstration of a railgun firing at 32 megajoules of energy. A future weapon system operating at this energy level would be capable of launching a projectile 100 nautical miles (Navy ONR 2013).

In 2006, the Navy built the Electromagnetic Launch Facility at Naval Support Facility Dahlgren, Virginia to expand railgun research, design, test, and evaluation capabilities. A refurbished 8-megajoule Strategic Defense Initiative launcher was transferred from the Army and installed in the new facility operated by Naval Surface Water Center Dahlgren Division (NSWCDD). A 2007 railgun prototype in the Electromagnetic Launch Facility is shown in Figure 1-4. In the following years, the Navy installed and tested higher-power railguns and increasingly more powerful banks of electrical capacitors that create a pulse of electricity to power the guns (Navy 2009). By 2008 NSWCDD had fired a 10-megajoule shot (Navy ONR 2008). Following rapid advances in railgun technology and components, on December 10, 2010 NSWCDD fired a world-record 33-megajoule shot from a railgun, reaching and exceeding the Navy goal set in 2005 (Navy ONR 2010).

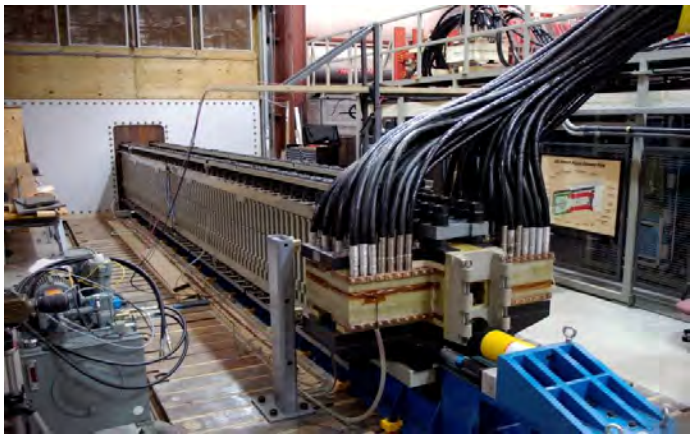

Figure 1-4: Railgun in the Electromagnetic Launch Facility at Naval Support Facility Dahlgren in 2007.

Phase II of the Railgun Innovative Naval Prototype program, begun in 2012, has a goal of advancing the technology for transition from research, design, test, and evaluation to an acquisition program for a weapon system. Phase II technology efforts will include:

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- Platform integration: this aspect of the program focuses on designing and developing railgun components including compatible HVPs to work outside the laboratory on ships and other potential platforms.
- Projectile development: the railgun/HVP program objectives, which will be the focus of this EA.

The Navy took a step towards meeting the Phase II Railgun Innovative Naval Prototype goals in 2012 by evaluating two next-generation defense industry-designed prototype railgun launchers at the Electromagnetic Launch Facility at Naval Support Facility Dahlgren. These prototypes more closely resemble a traditional gun than the 2007 railgun shown in Figure 1-4 and indicate the progress being made towards railgun designs that can be deployed on ships. Figure 1-5 shows the gun selected by the Navy for future development. An advanced version of the fixed gun shown in Figure 1-5 is now under development and would be used for the railgun/HVP program at WFF. This next railgun iteration will be useable outdoors, able to elevate to fire long distances, and have the ability to swivel to fire in more than one direction.

Figure 1-5: 32-megajoule prototype railgun in the Electromagnetic Launch Facility in 2012. The pulsed power system, composed of banks of electrical capacitors, is behind the gun.

1.3 Purpose and Need

The purpose of the Proposed Action is to advance HVP and EM railgun technology from research, development, test, and evaluation to an acquisition program designed to meet warfighting needs by testing HVPs from WFF with 5” guns and an EM railgun, integrating HVPs and an EM railgun into a weapons system, and integrating the HVP/EM railgun weapon system with current fleet-relevant combat systems.

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The need for the Proposed Action is to enable the Navy to meet current and future mission-related warfare requirements of providing gunfire support for anti-air warfare, anti-surface missions, and naval surface fire support missions. Figure 1-1 illustrates these missions by showing a ship-based railgun firing at an enemy missile (anti-air warfare); firing directly at approaching enemy vessels (anti-surface mission); and firing long-range at enemy targets on land (shore bombardment) to support amphibious landings (naval surface fire support). The proposed HVP/EM railgun weapon system would extend naval surface fire support missions, such as amphibious landings and shore bombardments, to 50 to 100 nautical miles from the current 13-nautical mile range of the 5"/54 gun found on Navy ships today. It would also meet the Innovative Naval Prototype Phase II program objective to advance EM railgun system technology for transition to an acquisition program.

There have been numerous studies, including the *Quadrennial Defense Review* (DoD 2001) and the *Joint Vision 2020* (Joint Chiefs of Staff 2000) that specify the need for long-range, time-critical strike capability in our nation's defense inventory. "Hypervelocity weapons" for attacking time-critical targets, the ability to defeat "bunkers and hardened targets," and low-cost "volume fires" are repeatedly cited as being critical to transforming the military's war-fighting capability (Roberts 2002).

Guns on World War II Naval battleships could fire more than 25 nautical miles in amphibious and shore-bombardment operations. After these battleships were decommissioned following the Cold War, the Navy has been criticized for failing to provide a substitute capability in the form of long-range artillery aboard surface combatants (Erwin 2003). The 5" guns available today, which fire projectiles that can hit targets about 13 nautical miles away, do not fully satisfy the requirements of either the Marine Corps or the Navy. The Marine Corps requires long-range artillery (gun) support from the sea, and the modern Navy needs to operate farther from hostile shores than two decades ago because of exposure to longer-range enemy anti-ship weapons. The only weapon in the Fleet today that can reach extended distances from a ship is the Tomahawk missile. The Navy and the Marine Corps would benefit from also having less-costly, rapid-fire, long-range artillery available. With the potential to deliver lethal, inexpensive, and fast projectile strikes, naval HVP/railgun weapon systems offer a solution for high-volume firing and rapid strikes after a target is identified.

1.4 Cooperating Agency

NASA has served as a Cooperating Agency in preparing this EA. Under NEPA, a Cooperating Agency is another federal, state, local, or tribal government agency having jurisdiction by law and/or special expertise regarding the Proposed Action or its potential environmental effects. As the federal landowner at WFF, NASA possesses both jurisdiction by law as well as special expertise pertaining to the environmental resources within and adjacent to WFF. Moreover, as a federal agency, NASA has its own NEPA policies and procedures (14 C.F.R. 1216.3) with which it must comply. As such, this EA has been prepared to satisfy NASA's NEPA obligations as well as the Navy's. The NASA action considered in this EA is its granting the Navy use of land, infrastructure, and the research range at WFF. In response to the Navy's request for such uses, through the authorities granted to it by the National Aeronautics and Space Act (Pub. L. No. 111–314; 124 Stat. 3328 [Dec. 18, 2010]), NASA would either; 1) enter into a new interagency agreement with the Navy for the subject proposal; or 2) issue a use permit under an existing NASA-Navy agreement to allow for the installation and operation of the HVP/EM railgun

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systems. In either case, NASA's authorization would specify the terms and conditions under which the HVP program must operate when at WFF.

1.5 Related Environmental Analysis, Documentation, and Permitting

The following documents include environmental analysis of previous or ongoing activities that support the Railgun Innovative Naval Prototype program, testing and training activities. These include NASA activities at Wallops Island, activities at the Virginia Capes Range Complex, and research, develop, test, and evaluation at NSWCDD relevant to the Proposed Action.

- *Environmental Assessment for Construction and Operation of an Electromagnetic Railgun Research, Development, Test and Evaluation Facility (MILCON P-306), Naval Support Facility Dahlgren* (Navy 2009)
- *Final Programmatic Environmental Impact Statement, Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program* (NASA 2010)
- *Atlantic Fleet Training and Testing Final Environmental Impact Statement/Overseas Environmental Impact Statement* (AFTT FEIS/OEIS) (Navy 2013a)
- *Final Environmental Assessment, Wallops Island Post-Hurricane Sandy Shoreline Repair* (NASA 2013)
- *Final Environmental Impact Statement, Outdoor Research, Development, Test & Evaluation Activities, Naval Surface Warfare Center, Dahlgren Division* (Navy 2013b)

In addition, the Navy and NASA have prepared and obtained related U.S. Army Corps of Engineers permits, Clean Water Act (33 U.S.C. § 1251) Sections 401 and 404 water quality certifications, and Coastal Zone Management Act (16 U.S.C. § 1451, et seq., as amended) federal coastal consistency determinations, as required. They have coordinated with other agencies regarding regulatory compliance with state and federal laws (e.g., U.S. Fish and Wildlife Service and the National Marine Fisheries Service), as appropriate for the documents listed above.

The EA for the Proposed Action will not include an in-depth analysis of in-water impacts from projectiles striking locations within the Virginia Capes Operating Area (OPAREA). That analysis is included in the AFTT FEIS/OEIS (Navy 2013a), which evaluates the impacts from at-sea training and testing activities and is incorporated by reference in this EA.

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1.6 Organization of the EA

- Chapter 1 describes the background, purpose and need for the Proposed Action.
- Chapter 2 describes the Proposed Action in more detail as well as the Navy's alternative site selection process.
- Chapter 3 describes the existing conditions of resources that may potentially be affected by the Proposed Action at and in the vicinity of the project site as well as the environmental consequences of implementing the Proposed Action on these resources.
- Chapter 4 addresses cumulative impacts of the Proposed Action when considered with other past, present, and future actions nearby.
- Chapter 5 lists the references used in preparing this document.
- Chapter 6 lists the preparers and reviewers of this report.

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2 Proposed Action and Alternatives

Section 2.1 describes the Proposed Action and Section 2.2 describes the alternatives selection process.

2.1 Proposed Action

The Proposed Action is to: install a 5" powder gun and an EM railgun on WFF's Wallops Island; test hypervelocity projectiles (HVPs); integrate HVPs with the EM railgun; and integrate the HVP/EM railgun weapon system with combat systems equipment currently in use on U.S. Navy warships. This requires firing from a land range that has Navy combat systems equipment installed at targets on a sea range controlled by DoD. The program is intended to design, develop, fabricate, test, and demonstrate a guided HVP compatible with both conventional MK 45 gun systems and future 20- to 32-megajoule EM railgun systems.

ONR and the NAVSEA Directed Energy and Electric Weapon Systems Program Office plan to conduct two phases of tests/demonstrations:

- In Phase I, a MK 45 Mod 4 Proof of Concept 5" powder gun would be installed on WFF's Wallops Island. HVPs would be fired from the powder gun at speeds up to 2,908 miles per hour (4,680 kilometers per hour) or 0.8 miles per second (1.3 kilometers per second) and at ranges of approximately 35 nautical miles. Projectiles are anticipated to be guided and include telemetry. Typical gun range instrumentation is expected to be used. The primary purpose of using a powder gun would be to mature the projectile technologies for use with the railgun. Secondarily, the projectiles developed could be used in 5" guns to increase their range, precision, and lethality. Figure 2-1 shows the MK45 Mod 4 5"/62 powder gun being used for tests at the White Sands Missile Range in New Mexico.
- In Phase II, a railgun that is currently under development would be installed on WFF's Wallops Island near the powder gun along with a pulsed power system used to fire the gun. HVPs would be fired from a 32-megajoule railgun for various system-level demonstrations at speeds up to 4,474 miles per hour (7,200 kilometers per hour) or 1.2 miles per second (2.0 kilometers per second) and ranges to 100 nautical miles. Projectiles are anticipated to be guided and include telemetry. Typical gun range instrumentation is expected to be used. The primary demonstration would be to employ a radar to identify a stationary air target and "close the loop" with an appropriate guidance system to strike the target. Initially, the targets would be "virtual" or computer-simulated. Other demonstrations would be conducted within the limits of the hardware and range. These would include system-level long range and lethality work.

Phase I and II may occur concurrently and Phase I testing is not required for Phase II testing.

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Figure 2-1: MK45 Mod 4 5"/62 powder gun at White Sands

Three types of projectiles would be tested:

- Inert variant, which would contain no explosives and would be used to test guidance and control.
- Kinetic energy dispensing variant, which would contain ≤0.2 pound (≤0.1 kilogram) of explosives and be used against air targets. This variant would burst the casing of the projectile and dispense tungsten pellets.
- High-explosive variant, which would contain ≤2 pounds (≤0.9 kilogram) of explosives and would be used against water surface targets. They are intended to burst and fragment just prior to striking the target. Underwater explosions are not planned and would only occur in abnormal or test failure conditions.

Table 2-1 shows the proposed average number of projectiles to be used annually by program year. Inert projectiles would be the main type of projectile used – 100 percent in the first and second years, approximately 67 percent in the third and fourth years, and approximately 80 percent of the total in the fifth year. Kinetic energy projectiles would comprise zero projectiles in the first and second years, approximately 27 percent or fewer of projectiles in the third and fourth years, and approximately 16 percent or fewer of the total projectiles tested in the fifth year. High explosive projectiles would not be tested in the first two years, but would comprise approximately 7 percent or fewer of projectiles in the third and fourth years, and approximately 4 percent or fewer of the total projectiles tested in the fifth year.

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Table 2-1 Average Annual Number of Projectiles by Program Year

Projectile Types	Year 1	Year 2	Year 3	Year 4	Year 5
Inert	100	100	100	100	200
Kinetic Energy	0	0	40	40	40
High Explosive	0	0	10	10	10
Total Number	100	100	150	150	250

Figure 2-2 is a diagram of an inert HVP to be used in the 5" gun. The dark gray shape is the projectile itself, which has two fixed fins and two maneuverable fins to direct its flight; the lighter gray shapes are four aluminum sabots that surround the projectile and hold it in place while it is in the gun. When the projectile is fired, the sabots hit the water at distances conservatively delimited as from a minimum of 600 feet (183 meters) to a maximum of 1 nautical mile from the gun in the direction of fire. Figure 2-3 shows the sabot petals flying away during launch and one sabot petal separated from the projectile. The titanium pusher plate holds pressure in to propel the projectile out of the gun and then hits the water a minimum of 600 feet (183 meters) to a maximum of 3 nautical miles away from the gun in the direction of fire. The pusher plate is a disc, 5 inches x 1.5 inches (12.7 centimeters x 3.8 centimeters) in size and weighs 2.2 pounds (1 kilogram).

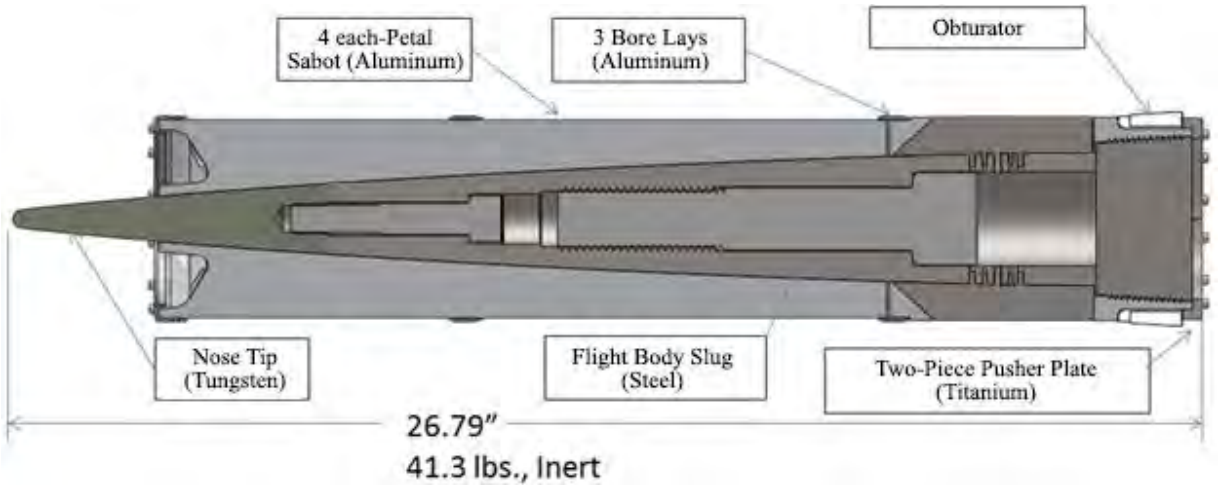

Figure 2-2: Inert 5" gun HVP. The dark gray projectile, which has fins, is surrounded by aluminum sabots that hold it in place in the gun. The pusher plate traps pressure during the launch.

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Figure 2-3: Sabot petals flying off the projectile after the projectile is launched. A single petal is depicted on the right.

Each sabot petal is 22 inches by 3.5 inches (56 centimeters by 9 centimeters) and weighs approximately 3.5 pounds (1.6 kilograms). While currently made entirely of aluminum, in the future the sabot would likely transition to a lighter carbon-composite material.

The projectiles that will be used in the railgun are similar to the 5" projectile pictured in Figure 2-2. However, because railgun projectiles are launched using electrical energy, they have an armature that propels the projectile down the rail while conducting the electrical pulse to propel the projectile out of the gun. Armatures weigh approximately 5.5 to 6.6 pounds (2.5 to 3.0 kilograms) and are made of aluminum. They come off the projectile after firing, hitting the water a minimum of 600 feet (183 meters) to a maximum of 3 nautical miles away from the gun in the direction of fire.

Figure 2-4 illustrates the proposed nearshore (within 3 nautical miles of the shoreline) firing area. Projectiles would be fired on bearings within this area, and sabot petals, pusher plates, and armatures would fall into the areas indicated on the map. The wing-like shape of the sabot petals can cause them to drift in the air away from the firing line before settling into the water, as indicated on the figure. The target areas are from 5 nautical miles up to approximately 35 nautical miles from the 5" powder gun and up to approximately 100 nautical miles for the railgun, within the firing area shown in Figure 1-2.

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Proposed Nearshore Firing Area

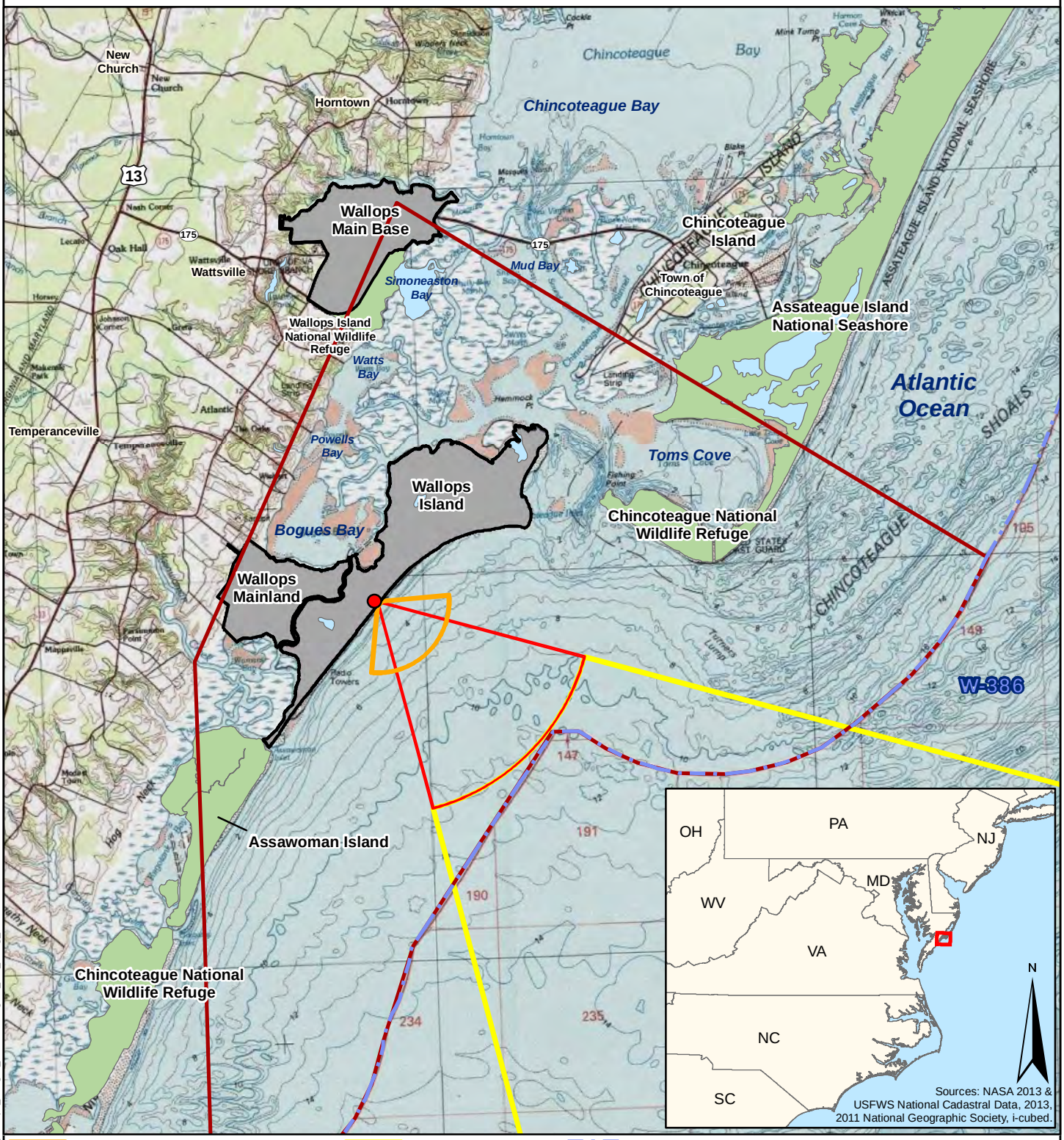

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Figure 2-4

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2.2 Description of Alternatives

2.2.1 Development and Evaluation of Alternatives

HVPs and railguns are being tested in three phases, guided by the requirements of each phase. Phase I and II may occur concurrently and Phase I testing is not required for Phase II testing. In the first phase, the Navy has been and continues to perform RDT&E on HVPs and railguns. Tests have been performed at the Electromagnetic Launch Facility at Naval Support Facility Dahlgren, where the railguns fire into the open environment constrained by the limits of the Potomac River Test Range, which has a maximum firing range of 40,000 yards (36,576 meters or approximately 20 nautical miles).

For the second phase, which is the current requirement, ranges that can accommodate a 100-nautical mile firing range in the at-sea conditions in which the HVP and HVP/EM railgun weapon system would be employed are required. For the last phase, in the future, the Navy will require ranges that can accommodate firing 200 nautical miles or more.

2.2.1.1 Preliminary Office of Naval Research 2008 Range Survey

In 2008, ONR surveyed DoD Major Range and Test Facility Bases to locate suitable ranges to meet Railgun Innovative Naval Prototype program requirements. Questions asked of range managers included: the extent of previous experience testing hypervelocity and high altitude projectiles and/or missiles; environmental planning documentation; range dimensions and ability to meet safety requirements; power and heat rejection; existing capabilities and range availability; necessary range improvements; and cost innovations. Of the 18 ranges queried, six responded; the other ranges could not meet enough of the requirements to warrant a detailed reply (Navy ONR 2009).

NAVSEA's Directed Energy and Electric Weapon Systems Program Office invited personnel from the six ranges that responded to attend and present at its Railgun Range Conference in December 2008. The initial screening criteria for evaluating range suitability were: 1) ability to accommodate the range of the projectiles (200+ nautical miles for the 64-megajoule railgun); 2) a prevailing maritime environment; 3) ability to fire at targets on land to study projectile accuracy and lethality; and 4) adequate power to operate the railgun. The six ranges represented at the conference were:

- Pacific Missile Range Facility, located at Barking Sands, Kauai, Hawaii
- Ronald Reagan Ballistic Missile Test Site, Kwajalein Atoll, Marshall Islands
- WFF, Wallops Island, Virginia
- Point Mugu, Southern California Range Complexes, Point Mugu, California
- White Sands Missile Range, New Mexico
- Yuma Proving Ground, Arizona.

Three ranges met the majority of the requirements, and representatives from these ranges presented at the conference: the Ronald Reagan Ballistic Missile Defense Test Site, the Pacific

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Missile Range Facility, and WFF (Navy ONR 2009). Figure 2-5 shows the location of these three ranges.

2.2.1.2 Office of Naval Research Naval Capabilities HVP Program Requirements

In the years after the conference, ONR's scenarios for future use of the railgun evolved from a sole focus on the naval surface fire support mission using 64-megajoule railguns firing to 200 nautical miles or more to include other missions, such as air and missile defense, the use of 20- to 32-megajoule railguns to fire 100 rather than 200 nautical miles, and the potential use of HVPs not only in railguns but in conventional naval guns to extend their firing range.

ONR's current Future Naval Capabilities HVP program requirements focus on the development of a guided projectile that can be used in both the future Navy railgun and the current inventory of Navy Fleet 5" gun systems. To transition the HVP program from an RDT&E program to an acquisition program, additional testing and systems integration of the HVP must be accomplished. Such testing must take place at sites compatible with testing both the future Navy railgun and current Navy Fleet gun systems. Equally important, the test site must have the ability to integrate the gun systems with existing Navy ship combat systems.

Based on the HVP program test objectives, a land-based test location where the following four criteria are met is required:

a. Situated adjacent to a DoD-controlled sea range space capable of supporting projectile flight distances of at least 100 nautical miles.
b. Supports projectile firings from fleet-relevant gun systems, including 5" guns, and EM railguns.
c. Incorporates a fire control RADAR capable of SPY-1 systems operations, enabling the immediate acquisition of the projectile upon leaving the gun barrel and capable of integrating alternative fire control sensor systems for projectile acquisition and tracking purposes.
d. Accommodates current fleet-relevant combat systems interfaces with existing MK 160 Gun Fire Control Systems.

2.2.1.3 Evaluation of Alternative Facilities/Ranges

Of the three installations/ranges that made presentations about their capabilities to support the HVP program at ONR's 2008 conference, the only installation that met all of the criteria listed above was NASA's WFF at Wallops Island, Virginia, as shown in Table 2-2. WFF is adjacent to the Navy's Virginia Capes Range Complex and is the site of the Navy's SCSC activity, which includes the required Navy Fleet-relevant gun fire control radar and combat systems.

While the Pacific Missile Range Facility in Hawaii and the Ronald Reagan Ballistic Missile Test Site at Kwajalein Atoll in the Marshall Islands have DoD-controlled sea ranges and land-based sites that support projectile firings from fleet-relevant guns (criteria a and b), they do not have the SPY-1 radar used by the Navy nor current Navy combat systems interfaces with existing MK 160 Gun Fire Control Systems (criteria c and d). Therefore, they did not meet the HVP program test objectives or criteria for installation/range selection and were eliminated from further consideration.

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Range Alternatives

Ranges considered for Railgun
Innovative Naval Prototype Program

0 2,400 4,800
Miles

0 3,800 7,600
Kilometers

N

Source: NASA 2013

Figure 2-5

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Table 2-2 Criteria Met at Each Global Location

Criterion	Global Location		
	Wallops Island	Pacific Missile Range Facility	Reagan Ballistic Missile Test Site
a	met	met	met
b	met	met	met
c	met	not met	not met
d	met	not met	not met

NASA's WFF was the only facility to meet the HVP program criteria. Figures 1-2 and 1-3 show its location on Virginia's Eastern Shore, fronting on the Atlantic Ocean. It is adjacent to the Virginia Capes Range Complex, which offers a maritime range where targets can be deployed and the air space and surface waters can be controlled during test events.

2.2.2 Wallops Flight Facility Alternative Sites

The proposed sites to place the railgun and the 5" gun are amidst NAVSEA's SCSC, which is a shore activity located on Wallops Island. SCSC provides highly technical engineering and training support to the Fleet. SCSC has high-fidelity combat systems and platform sensors, along with the ability to connect with ships, aircraft, and other land-based sites for surface Navy testing, training, and support of deployed surface combat systems, advanced systems under development, warfare systems integration, interoperability, and at-sea testing and exercises. SCSC facilities include the radars and combat system capabilities necessary to meet mission requirements for the HVP/EM railgun program.

The Navy identified three site alternatives on WFF's Wallops Island using two criteria:

1. Site that is available for long-term use.

2. Close enough to the Navy's AEGIS SPY-1 radar facility on Wallops Island to allow immediate acquisition (tracking) of the projectile (HVP program criterion c).

Figure 2-6 shows the AEGIS SPY-1 radiofrequency pattern in relation to the three alternative sites at WFF. The three sites – Pad 4, Pad 5, and the Elevated Road – meet all four HVP program criteria as well as the two WFF site-related criteria. All potential sites south of Pad 4 and north of the elevated road were eliminated from consideration; they could not meet HVP program criterion c/site criterion 2 because they are located too far from the AEGIS SPY-1 radar beam to allow immediate acquisition of the projectile.

The three selected sites that will be carried forward are available for long-term use. Acquisition (tracking) of the projectile would be slowest at Pad 4, but it is still a reasonable site alternative. Gun tests at the Elevated Road site would cause traffic delays during test events, but it is still a reasonable site alternative. Pad 5 allows for quick acquisition of the projectile and has no traffic problems associated with it. Therefore, Pad 5 is the Preferred Alternative.

The three site alternatives on Wallops Island evaluated in this EA are described below.

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2.2.2.1 Pad 5 Site (Preferred Alternative)

The Preferred site, Pad 5, a thick slab of concrete underlain by deep pilings, was used in the past by NASA as a rocket launching pad (Figure 2-7). Most recently, it was used by the Navy to launch supersonic Navy Vandal rockets from a dual-rail launcher into W-386, the Virginia Capes Range Complex warning area, where the rockets were intercepted by fire from Navy ships. Pad 5 includes a paved area measuring approximately 41,000 square feet (3,809 square meters), bounded by an open area consisting of maintained grasses and scrub brush. Since 2008, the site has been used for storage. Two storage buildings, W-49 and W-50, are present on the site; buildings V-3, W-54, and W-40 are located behind Pad 5, across Island Road.

In Phase 1, electrical and communications cables would be installed in conduit underground and lighting on poles would be added around the perimeter of the site. A disturbed area north of Pad 5 would be filled with gravel, as shown in Figure 2-7 and Figure 2-8, a conceptual site plan. A 5" Navy powder gun would be brought to the site and installed on the gravel. As an example of the installation of the gun on Wallops Island, Figure 2-9 shows a 5"/62 powder gun being installed at the White Sands Missile Range. Two 12-foot wide by 24-foot long by 6-inch (3.6-meters wide by 7.3-meters long by 15-centimeter) thick steel plates with a one-foot (0.3 meter) overlap would make up the 47-foot (14-meter) long foundation, weighing 67,000 pounds (30,348 kilograms). The spider mount and the gun would weigh an additional 50,000 pounds (22,679 kilograms). An additional 120,000 pounds (54,430 kilograms) of weight may be placed on the front of the steel plate for additional stabilization. The gun when fired at zero degrees elevation would apply 80,000 pounds (36,287 kilograms) of shear force on the plates.

In addition to the powder gun, during Phase I the following facilities and equipment would be installed on the site:

- Two hardened personnel/command shelters (approximately 10 x 20 feet [3 x 6 meters])
- Storage shelters (approximately 8 x 20 feet [2.4 x 6 meters])
- Radar instrumental power van
- Mobile Weibel radar

Because the site is located within a 100-year floodplain, most of the facilities would be elevated to avoid damage during storm surges. Pilings would be driven into the ground and platforms and structures would be built or placed on top of them. The elevation of the structures may be seen in Figure 2-10, which is a schematic of the Pad 5 site plan. All of Wallops Island is within a 100-year floodplain, so no sites above flood level are available (see Section 3.8 for more background on flood levels).

In Phase 2, a railgun and associated pulsed power system would be installed on Pad 5 on elevated platforms. As illustrated in Figures 2-7, 2-8, and 2-10, the command shelters, where personnel would operate the guns, would be located approximately 180 feet (55 meters) behind the guns.

The personnel who would operate the guns would not be stationed at WFF, but rather would come to the site during the time periods the guns would be operated. They would typically be on site for one to two weeks for every round of firing.

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Wallops Island Alternative Sites

AEGIS SPY-1 Radar Beam
Pad 4 Alternative
Pad 5 Alternative
Elevated Road Alternative

0 450 900
Feet

0 140 280
Meters

N

Source: NASA 2013

Figure 2-6

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EA\MXDs\Draft EA-OEA Figures\Figure_2-6_Alternative_Sites.mxd

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Pad 5 Site Alternative

Source: NASA 2013

Figure 2-7

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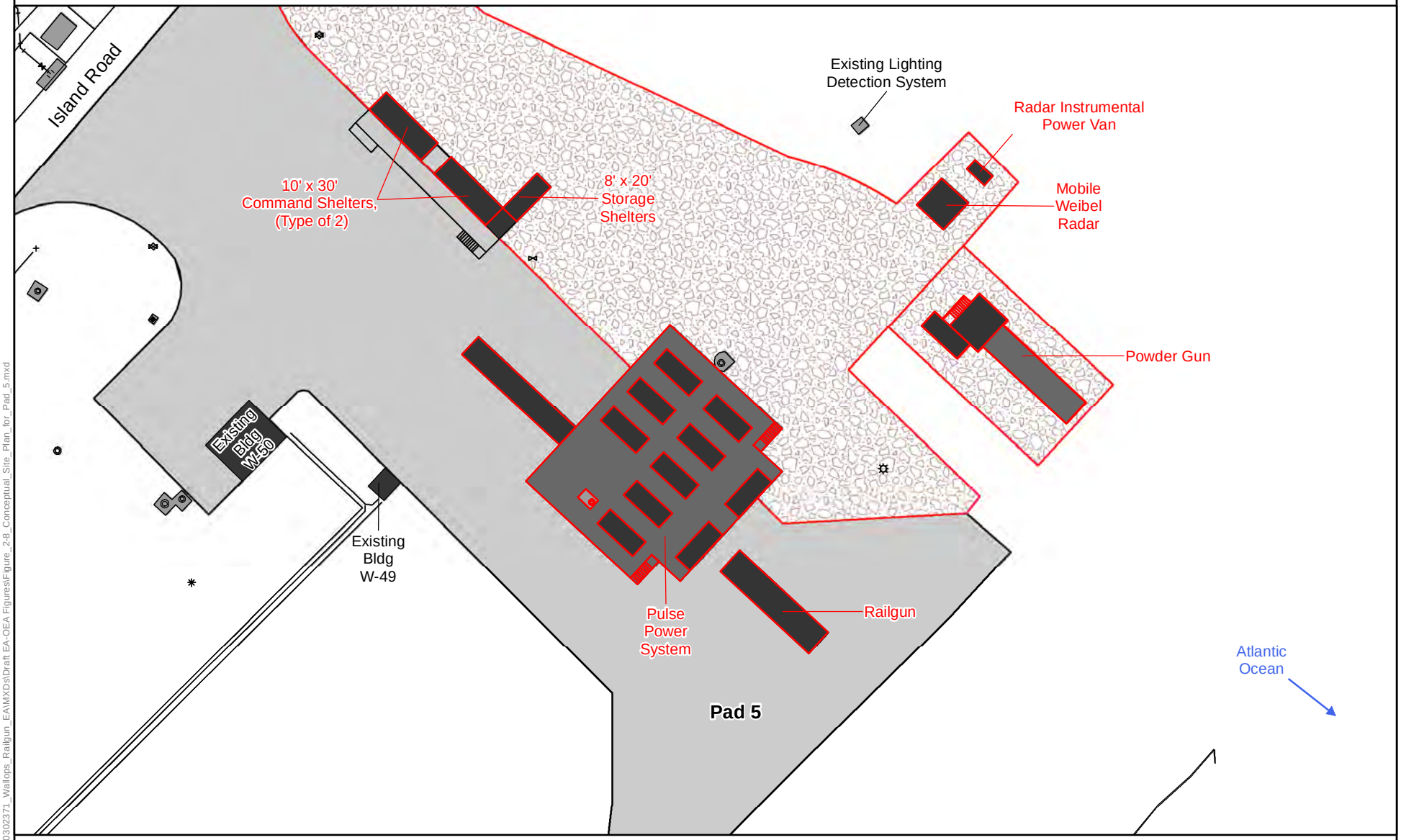
Conceptual Site Plan for Pad 5



Source: NASA 2013

Figure 2-8

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Figure 2-9: Powder Gun Installation at the White Sands Missile Range

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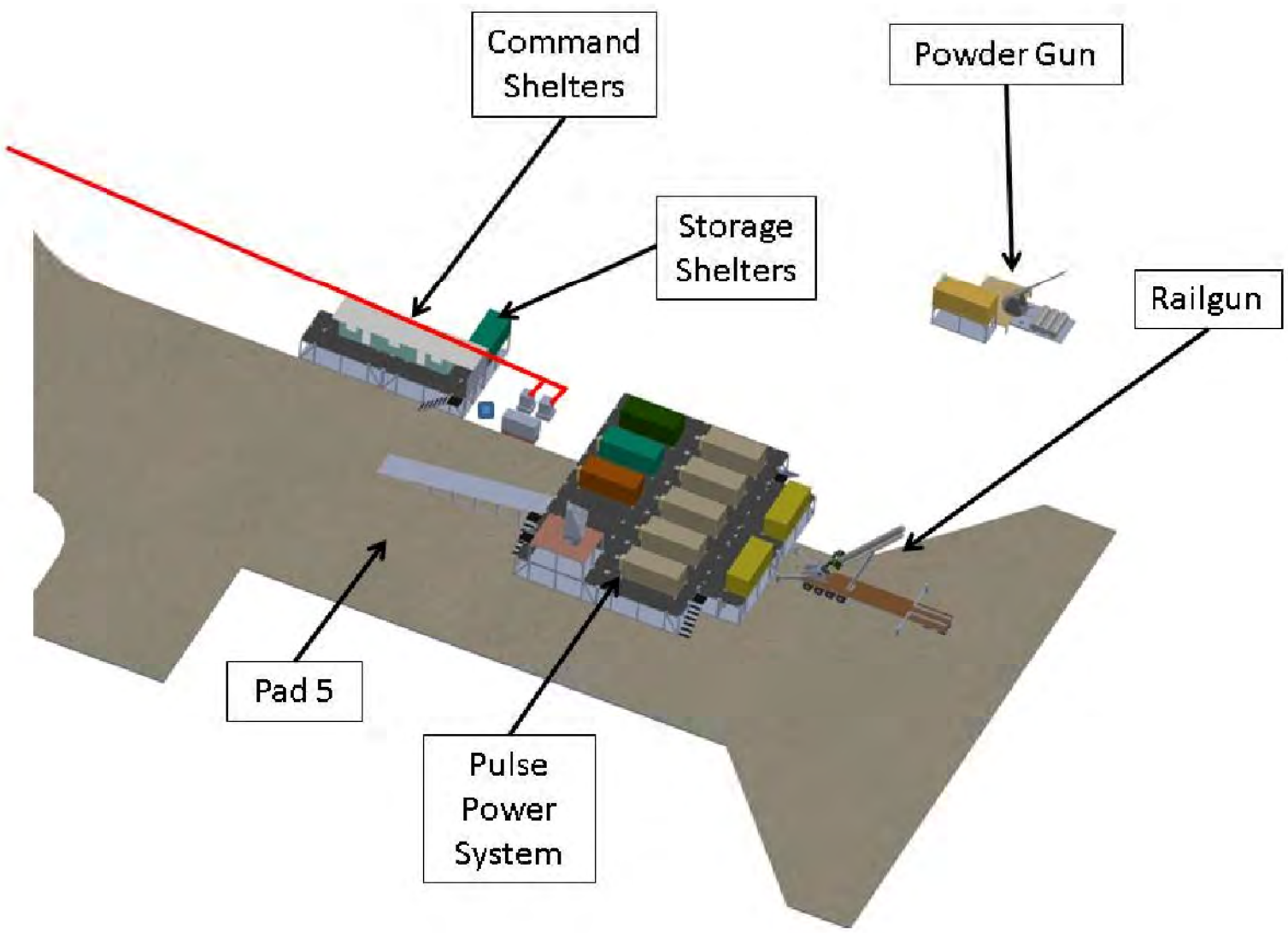
Proposed Site Layout for Pad 5



Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EAM\XDs\Figure_2-10_Proposed_Site_Layout_for_Pad_5.mxd

Figure 2-10

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2.2.2.2 Pad 4 Site

Pad 4 is also a former rocket launch pad. The paved area of Pad 4 measures approximately 41,000 square feet (3,809 square meters) and is flanked by open areas consisting of maintained grasses and scrub brush. Figure 2-11 is a conceptual layout for the facilities on the Pad 4 site. The facilities would be the same as described for Pad 5.

2.2.2.3 Elevated Road Site

The Elevated Road site is a partially paved area located adjacent to Pad 5. Pavement atop the ridge on the Elevated Road site encompasses approximately 17,825 square feet (1,656 square meters). The paved area at this site is also bounded by open areas consisting of maintained grasses and scrub brush. Figure 2-12 is a conceptual layout for the facilities on the Elevated Road site. The facilities would be the same as described for Pad 5.

2.2.2.4 No Action Alternative

This alternative assumes that the Proposed Action would not be implemented. While not a reasonable alternative from the Navy's perspective, it is considered in accordance with NEPA, to provide a baseline for evaluating the effects of the three site alternatives.

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Pad 4 Site Alternative

Pad 4 Alternative

AEGIS SPY-1 Radar Beam

0 200 400
Feet

0 60 120
Meters

N

Source: NASA 2013

Figure 2-11

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EA\MXDs\Draft EA-OEA Figures\Figure_2-11_Pad_4_Site_Alternative.mxd

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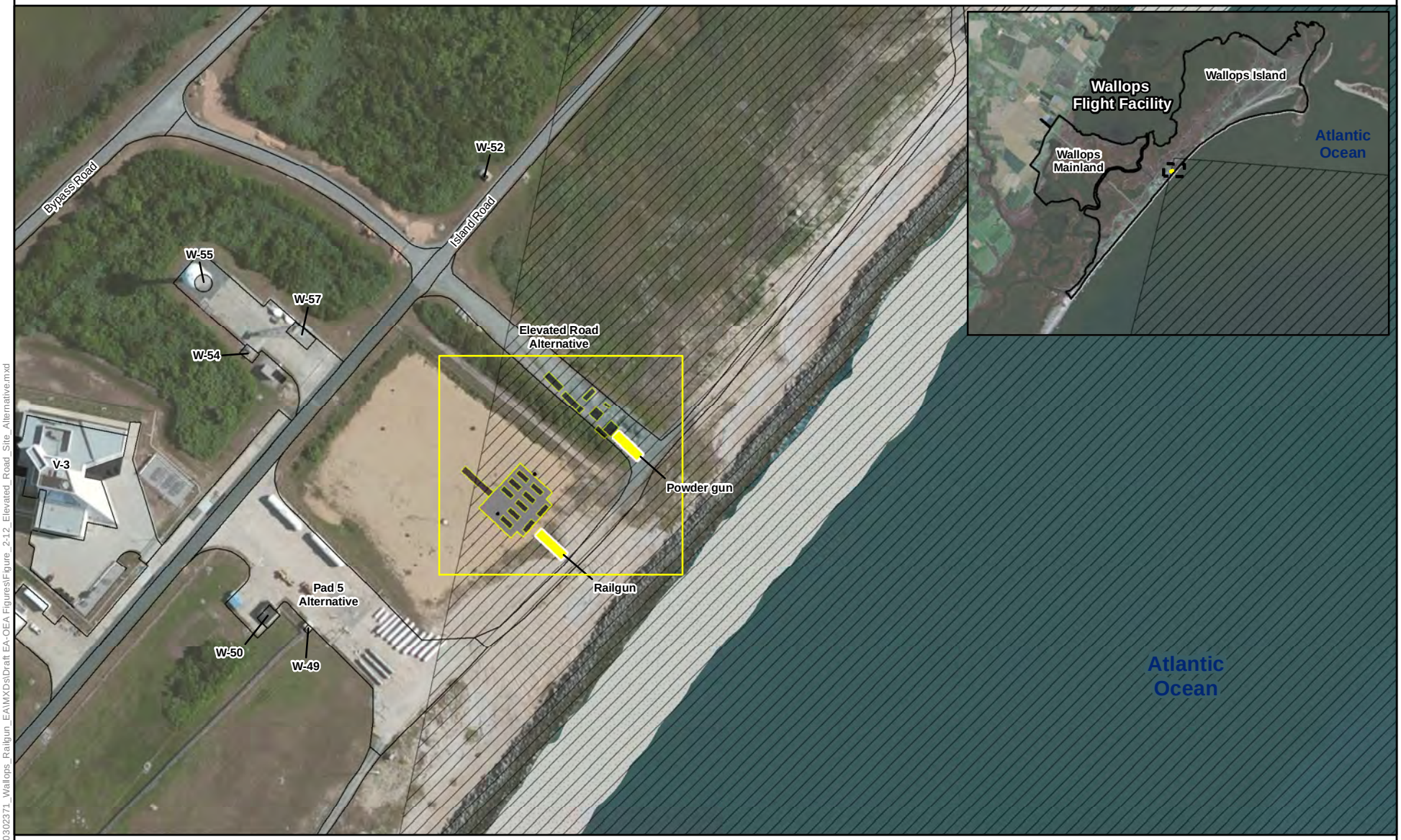
Elevated Road Site Alternative



Elevated Road Alternative

AEGIS SPY-1 Radar Beam

0 200 400
Feet

0 60 120
Meters

N

Source: NASA 2013

Figure 2-12

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EAIMXDs\Draft EA-OEA Figures\Figure_2-12_Elevated_Road_Site_Alternative.mxd

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3 Affected Environment and Environmental Consequences

This chapter describes the existing, potentially affected environment at the proposed site locations at WFF and the anticipated impacts on the environment. The Proposed Action is the same for all action alternatives as described in Section 2.2.

Sections 3.1 through 3.13 address land use, range operations, noise, air quality, socioeconomics, cultural resources, health and safety, geomorphology, water resources, terrestrial biological resources, aquatic biological resources, protected species, and utilities respectively.

Consistent with the Council on Environmental Quality's regulations, the significance of the anticipated impacts is assessed taking into account context and intensity. Context refers to the affected environment. For the Proposed Action, the location of each alternative, as shown in Figure 2-6, is the context. Because the action alternative locations are close to one another, the context is similar for all three alternatives. Intensity refers to the severity of the action's impacts on the environment. Intensity is in part a function of the context in that the same impacts may be more severe if affecting a sensitive, pristine, or unique environment than a previously disturbed or resource-poor one. The affected environment evaluated in this EA consists primarily of test and launch area and the adjacent waters, which are routinely used for activities such as those included in the Proposed Action.

With regard to intensity, it should be noted that most of the impacts of the Proposed Action would be repeated during the year. On days when testing occurs, the impacts could be of short duration or last throughout the day. The beach area and nearshore waters where most impacts would occur constitute an ever-changing, dynamic environment that continuously experiences the effects of wind, waves, and tides, facilitating the absorption of impacts (e.g., settlement of military expended materials on the sea floor) with no or negligible long-term consequences.

For each resource, the EA describes the existing environment and whether the anticipated impacts of the alternatives would have no impacts, less than significant impacts, or significant impacts. This analysis covers onshore and nearshore impacts, as in-water impacts from projectiles striking locations within the Virginia Capes OPAREA (offshore) are included in the AFTT FEIS/OEIS (Navy 2013).

3.1 Land Use, Plans and Coastal Zone Management

Land use generally refers to human modification of the land, often for residential or economic purposes. It can also refer to use of land for preservation or protection of natural resources such as wildlife habitat, vegetation, or other unique features. Human land uses include residential, commercial, industrial, agricultural, or recreational uses; natural features are protected under designations such as national parks, national forests, wilderness areas, or other designated areas. Land uses are frequently regulated by management plans, policies, and ordinances that determine the types of uses that are allowable or required to protect specially designated or environmentally sensitive attributes.

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3.1.1 Affected Environment

3.1.1.1 Land Use, Plans and Coastal Zone Management

WFF is located in Accomack County, Virginia in the northern area of Virginia's Eastern Shore on the Delmarva Peninsula. As may be seen on Figure 1-1, the facility is divided into three distinct land areas: Main Base, Wallops Mainland, and Wallops Island. Main Base is largely developed and consists of various land uses, dominated by airfield operations and administrative uses. Wallops Mainland is home to long-range radar, communications, and optical tracking facilities. Wallops Mainland consists mostly of marshland. The area between Wallops Mainland and Wallops Island is separated by the Virginia Inside Passage (a public waterway); a bridge connects the two.

Wallops Island

WFF's Wallops Island is a 6.5-square mile (16.8-square kilometer) coastal barrier island separated from the mainland by tidal marshes and waterways. Wallops Island includes launch and testing facilities, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, tracking facilities, an unmanned aerial systems airstrip, a Resource Conservation and Recovery Act-permitted open burning area for off-specification rocket motors, Navy SCSC facilities, and other related support structures. Wallops Island is zoned as agricultural by Accomack County (Accomack County 2008).

There is one main area designated for recreational use on Wallops Island, a beach area north of the seawall/dune and south of the beach cable barrier. This area is open after operational hours to permanently-badged WFF employees and their guests. The northern portion of this recreational area is closed annually from March through August during piping plover nesting season (NASA 2008). A second area, the marsh under the Wallops Island Bridge, is open year round; however, it may only be accessed via boat. All other recreational resources are accessed either by vehicle or foot.

Wallops Island is near a number of areas managed for conservation purposes. Located approximately 4.5 miles (7.3 kilometers) northeast of the SCSC area of Wallops Island is Assateague Island, which is home to the Assateague Island National Seashore, managed by the U.S. Park Service, and the Chincoteague National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service (USFWS; Figure 1-1). Immediately south of Wallops Island is Assawoman Island, a 1,420-acre (580-hectare) parcel also managed as part of the Chincoteague refuge by the USFWS. A string of undeveloped barrier islands, managed by the Nature Conservancy as part of the Virginia Coast Reserve, extends down the coast to the mouth of the Chesapeake Bay.

The Wallops Island National Wildlife Refuge, located north of Wallops Island, is under the jurisdiction of the USFWS. This refuge, which is not open to the general public, consists of approximately 373 acres (151 hectares) of mostly salt marsh and some forested land across Route 175 from Main Base. Additionally, the USFWS, through the Chincoteague National Wildlife Refuge, has an agreement with NASA to use Wallops Island on a non-interference basis for research and management of declining wildlife species in need of special protection.

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Alternative Sites

Pad 5, Pad 4, and the Elevated Road site are located in the middle of Wallops Island near the ocean in an area designated as Operations Range in the WFF master plan (NASA 2008) (see Section 3.1.2.1 below). The three sites are located between Island Road and the beach and are comprised of paved areas flanked by minimally-developed, sparsely-vegetated parcels (Figure 2-6). None of the sites support permanent facilities or activities, but Pad 5 has been used to store materials since 2008. The Elevated Road site is the northernmost of the alternative sites and consists of an approximately 400-foot-long by 50-foot-wide (122-meter-long by 15-meter-wide) paved surface atop an embanked ridge that extends perpendicular to Island Road. Pad 5, located immediately south of the Elevated Road site, and Pad 4, approximately 675 feet (206 meters) further to the south, are comprised of approximately 41,000-square-foot (3,809-square-meter) and 36,000-square-foot (3,345-square-meter) concrete pads, respectively. Immediately west of the Elevated Road site and Pad 5 on the opposite side of Island Road is the Navy's dual band radar facility. The Navy's AEGIS facility is located approximately 0.25 mile (0.4 kilometer) north of the Elevated Road site, while Building W-20 (Blockhouse) is located immediately south of Pad 4 (Figure 2-6).

Surrounding Area

Rural farmland and small villages make up the land uses west of Wallops Island (Accomack County 2008). Open farmland and forest dominate the landscape. Assawoman is an unincorporated community 3.3 miles (5.3 kilometers) northwest of the facility (measured from Pad 5). Rural villages near Wallops Island are Atlantic, 3.8 miles (6.1 kilometers) northwest of the facility; Temperanceville, 5.0 miles (8.0 kilometers) northwest; and Mappsville, 5.4 miles (8.7 kilometers) west. Each of these villages has a population of fewer than 1,000 people (U.S. Census Bureau 2013, DP-1 Profile of General Population and Housing Characteristics 2010). Area businesses include fuel stations, retail stores, markets, and restaurants.

The Town of Chincoteague, located approximately 1 mile (1.6 kilometers) northeast of Wallops Island, on Chincoteague Island, is the largest community in the area, with 2,941 permanent residents in 2010 (U.S. Census Bureau 2013, DP-1 Profile of General Population and Housing Characteristics 2010). The island attracts a large tourist population during the summer months, when the island population swells to approximately 15,000 (Town of Chincoteague 2010). Numerous hotels and restaurants, as well as other seasonally-based tourist businesses, can be found on Chincoteague Island.

3.1.1.2 Plans

NASA Goddard Space Flight Center Master Plan

The *NASA Goddard Space Flight Center Master Plan* was prepared in 2008 to provide a framework for future facilities development at NASA Goddard Space Flight Center's Greenbelt Campus and WFF. With regard to WFF, the plan inventories natural and man-made resources; analyzes their conditions, functional relationships and constraints; and identifies current and future research and activity program requirements. Based on this information, the plan presents three future development alternatives for WFF. The preferred alternative would maintain, and in some cases decrease, the existing amounts of some land uses on the installation while substantially increasing land devoted to fabrication and aircraft operations.

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On Wallops Island, the preferred alternative proposes changes to land use designations to permit concurrent hazardous activities. Land designated as Operations Range would be relocated to the southern portion of the island while assembly and integration uses, along with an unmanned aerial vehicle runway, would be moved to the north and designated as Process/Integration and Operations Aircraft, respectively.

Accomack County Comprehensive Plan

The current *Accomack County Comprehensive Plan* was adopted in 2008 and is currently being updated. It is intended to guide the future social, economic and physical development of Accomack County to ensure the provision of adequate, quality, community facilities and the maintenance of a healthy, safe, orderly, and harmonious environment (Accomack County 2008). The following goals are presented in the comprehensive plan and are intended to shape and support growth, development, and quality of life in Accomack County:

- Have a strong, viable, rural community proud and supportive of its history, diversity, bountiful resources, traditional industries, and vision for the future.
- Have safe, clean, convenient, and efficient community services and facilities for transportation, recreational opportunities, government services, and disposal of wastes.
- Have a balanced, safe, and desirable patter of land use that protects and conserves agricultural land, forest land, groundwater, surface water, wetlands and other valuable resources, providing an excellent resource base for wildlife habitat, recreation, agriculture, seafood industries, and tourism.

With respect to land use, the comprehensive plan presents objectives and policies that are intended to guide future growth and development toward existing population centers and previously-developed areas so as to minimize the extension of public facilities (water, sewer, and other utilities), encroachment on natural areas, and inappropriate development (such as housing and schools) in proximity to WFF. As illustrated in the plan's Future Land Use Map, areas containing and adjacent to WFF are primarily designated as either conservation or agricultural (Accomack County 2008).

3.1.1.3 Coastal Zone Management

The Coastal Zone Management Act (CZMA) of 1972 (16 USC § 1451, et seq., as amended, and 15 C.F.R. Subpart C) provides assistance to the 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 federal projects that affect land uses, water uses, or the resources of a state's coastal zone must be consistent to the maximum extent practicable with the enforceable policies of that state's federally-approved coastal management plan.

The Commonwealth of Virginia has developed and implemented a federally-approved Coastal Zone Management Program describing current coastal legislation and enforceable policies. The enforceable policies are based on current state and federal environmental regulatory programs. As a federal property, Dahlgren is statutorily excluded from the CZMA's definition of the Commonwealth of Virginia's "coastal zone" (16 U.S.C § 1453 [1]). If, however, a proposed action would affect coastal resources or uses beyond the boundaries of the federal property, the CZMA Section 307 federal consistency requirement applies. The Virginia Coastal Zone

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Management Program's nine enforceable policies for the coastal zone area include: fisheries management, subaqueous lands management, air pollution control, wetlands management, dunes management, non-point source pollution control, point source pollution control, shoreline sanitation, and coastal lands management.

3.1.2 Environmental Consequences

3.1.2.1 No Action Alternative

Under the No Action alternative, the Proposed Action would not be implemented. Therefore, there would be no impact on land use or related plans.

3.1.2.2 Pad 5 Alternative (Preferred Alternative)

The Pad 5 Alternative would be implemented amidst the NAVSEA SCSC at WFF Wallops Island, in an area designated as Operations Range on the Existing and Future Land Use Maps in the *NASA Goddard Space Flight Center Master Plan*. The operations of the Pad 5 Alternative would be similar to, and would not conflict with, other operations occurring at NAVSEA SCSC, and they would be consistent with the intent of the Operations Range designation. The Pad 5 Alternative would not encroach upon, conflict with, or require the re-designation of land uses outside the boundaries of WFF, nor would its implementation prevent the fulfillment of the goals and objectives of the *NASA Goddard Space Flight Center Master Plan* or the 2008 *Accomack County Comprehensive Plan*. For these reasons, the Pad 5 Alternative would have no significant impacts on land use and plans at WFF Wallops Island or Accomack County.

The Navy submitted a Federal Coastal Consistency Determination to the Virginia Department of Environmental Quality for the Proposed Action (a copy is included in Appendix B). This consistency determination analyzes the Proposed Action in light of the Virginia Coastal Zone Management Program's enforceable policies. The Navy determined that the Proposed Action would have less than significant effects on land and water uses and natural resources of the Commonwealth of Virginia's coastal zone and is consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Zone Management Program. The Virginia Department of Environmental Quality concurred with this assessment (a copy of their response is included in Appendix B) provided that all applicable permits and approvals are obtained as described in the response. The Navy would obtain all applicable permits and approvals. Therefore, impacts on coastal zone resources and uses would be less than significant and consistent with the Virginia Coastal Zone Management Program's enforceable policies.

3.1.2.3 Pad 4 Alternative

Impacts on land use, plans, and coastal zone management resulting from the implementation of the Pad 4 Alternative would be the same as those described for the Pad 5 Alternative, with the following exception: the Navy SCSC has proposed to use Pad 4 to test the DoD SM-3 interceptor missile system. The use of Pad 4 for the Proposed Action evaluated in this EA would conflict with its proposed use for testing the DoD SM-3 system and make the site's use for testing that system impossible. This would also prevent the full implementation of the preferred alternative presented in the *NASA Goddard Space Flight Center Master Plan*. However, this conflict would be addressed as planning by the Navy SCSC for the two proposed projects continues, and an acceptable alternate site for testing of the DoD SM-3 system would be identified at WFF if the

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Pad 4 Alternative is implemented. Thus, there would be no significant impacts on land use, plans, or coastal zone management.

3.1.2.4 Elevated Road Alternative

No significant impacts on land use, plans, or coastal zone management would result from the implementation of the Elevated Road Alternative, for the same reasons described in Sections 3.1.2.2 and 3.1.2.3.

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3.2 Range Operations

Just as the use of the nation's highway system is governed by traffic laws and rules for operating vehicles, the safe, orderly, and compatible use of the nation's airspace is made possible through a system of flight rules and regulations, airspace management actions, and air traffic control procedures. The National Airspace System is designed and managed to protect aircraft operations around most airports and along air traffic routes connecting these airports, as well as within special areas where activities such as military flight testing and training are conducted. The Federal Aviation Administration has the overall responsibility for managing the system and accomplishes this through close coordination with state aviation and airport planners, military airspace managers, and other organizations. The Federal Aviation Administration assigns responsibility for units of airspace to air route traffic control centers.

There are four types of airspace: controlled, uncontrolled, special use, and other. Special use airspace has defined dimensions where activities must be confined because of their nature, or where limitations may be imposed upon aircraft operations that are not a part of those activities. Categories of special use airspace within the National Airspace System include restricted areas and warning areas. Restricted areas separate potentially hazardous activities, such as air-to-ground training, from other aviation activities. General aviation or civilian aircraft must have permission from air traffic control to enter a restricted area when it is active or "hot." A warning area is airspace of defined dimensions, extending from three nautical miles outward from the U.S. coast that contains an activity that may be hazardous to nonparticipating aircraft.

The Navy historically uses areas along the east coast of the United States for training and testing. These areas were designated by the Navy into geographic regions and termed "range complexes." A range complex is a designated set of specifically-bounded geographic areas and encompasses surface sea space, undersea space, land ranges, and overlying airspace delineated for military training and testing activities. Range complexes provide controlled and safe environments where military ship, submarine, and aircraft crews can train in realistic conditions. The combination of undersea ranges and operating areas with land training ranges, safety landing fields, and nearshore amphibious landing sites is critical to realistic training, which allows electronics on the range to capture data on the effectiveness of tactics and equipment—data that provide a feedback mechanism for training evaluation.

Range complexes include established operating areas (OPAREAs), which are ocean areas defined by geographic coordinates with defined surface and subsurface areas and associated special use airspace. OPAREAs include danger zones and restricted areas. A danger zone is a defined water area used for gunnery, bombing, rocket firing, or other especially hazardous military activities, normally for the armed forces (33 C.F.R. § 334). Danger zones are established pursuant to the statutory authority of the Secretary of the Army and are administered by the U.S. Army Corps of Engineers. Danger zones may be closed to the public on a full-time or intermittent basis. A restricted area is a defined water area for the purpose of prohibiting or limiting public access to the area (33 C.F.R. § 334). Restricted areas generally provide security for government property and also provide protection to the public from the risks of damage or injury arising from the government's use of that area.

The National Oceanic and Atmospheric Administration issues nautical charts that reflect designated danger zones and restricted zones. In accordance with 33 C.F.R. § 72, the U.S. Coast

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Guard, Department of Homeland Security publishes marine information pertaining to waterways. Notices to mariners provide information to private and commercial vessels on temporary closures. These navigational warnings are disseminated by broadcast notices on maritime frequency radio, weekly publications by the appropriate U.S. Coast Guard Navigation Center, and global positioning system navigation charts. They provide information about duration and location of closures due to activities that are potentially detrimental to surface vessels. Vessels are responsible for being aware of designated danger areas in surface waters and any notices to mariners that are in effect. Operators of commercial or recreational vessels have a duty to abide by maritime requirements as administered by the U.S. Coast Guard.

3.2.1 Affected Environment

3.2.1.1 Airspace and Sea Space

R-6604A/B is NASA-controlled airspace that overlies all of Wallops Island, the majority of Mainland, and a portion of the Main Base runways (Figure 1-2). This restricted area is comprised of two independent airspace units that may be activated individually or together; R-6604A and R6604B. Flight altitudes range from the surface to a ceiling of unlimited altitude. NASA is the agency using R-6604A/B; i.e., the agency whose activity within the restricted area necessitated the area being so designated (14 C.F.R. § 73.15).

The Virginia Capes Range Complex consists of the Virginia Capes OPAREA and several associated special use airspaces, as well as established mine warfare training areas located within the lower Chesapeake Bay and off the coast of Virginia. The shore boundary of the complex roughly follows the shoreline from Delaware to North Carolina, and the seaward boundary extends 155 nautical miles into the Atlantic Ocean. The Virginia Capes OPAREA encompasses surface and subsurface sea space offshore of the states of Delaware, Maryland, Virginia, and North Carolina. The Navy uses the OPAREA for air-to-air, air-to-surface, surface-to-air, and surface-to-surface missile, gunnery, and rocket exercises.

The Virginia Capes Range Complex includes special use airspace overlying the Virginia Capes OPAREA. Warning areas within the complex include W-50, W-386, W-387, W-72, and W-110. NASA-controlled R-6604A/B connects to the Virginia Capes OPAREA offshore warning area W-386. The proposed firing area would overlie portions of restricted area R-6604A/B and warning area W-386 (Figure 1-2). W-386 flight altitudes range from the surface to a ceiling of unlimited altitude.

The U.S. Army Corps of Engineers designated a danger zone immediately offshore from Wallops Island (33 C.F.R. § 334). In October 2012, the Corps expanded the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet, Virginia to a 30-nautical mile sector (Figure 1-3) necessary to protect the public from hazards associated with WFF's rocket launch operations (U.S. Army Corps of Engineers 2012).

3.2.1.2 Management

NASA has control responsibility for R-6604A/B and relinquishes control to the Washington Air Route Traffic Control Center when the restricted area is inactive. The restricted area is available for NASA's use 24 hours a day, seven days a week. Non-participating aircraft must contact the WFF Range Control Center or the Washington Air Route Traffic Control Center to obtain clearance to transit through any portion of R-6604A/B when activated.

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The Navy Fleet Area Control and Surveillance Facility, Virginia Capes controls the offshore warning areas, including W-386. W-386 is available for the Navy's use, with hours of use being intermittent. As a designated air traffic control facility, Navy Fleet Area Control and Surveillance Facility, Virginia Capes is responsible for all aircraft (general, military, and commercial) operating within its area of responsibility, the scheduling of offshore warning areas and military OPAREAs, and the preparation of notices to airmen and notices to mariners for broadcast by the Federal Aviation Administration and U.S. Coast Guard, respectively. The facility also has authority to coordinate services and firing notices, issue weekly target and operating schedules, and prescribe necessary additional regulations governing matters within the Virginia Capes Range Complex.

Close coordination among the Fleet Air Control and Surveillance Facility, NASA, and the Federal Aviation Administration air traffic control facilities enables effective, real-time, joint use of R-6604A/B and the Virginia Capes Range Complex warning areas. When in use by NASA or the Navy, R-6604A/B and W-386 are "hot" and the airspace is closed to all nonparticipating users. When not in use, R-6604A/B and W-386 are "cold" and the airspace is returned to the National Airspace System, allowing civilian aircraft to transit through R-6604A/B or W-386.

R-6604A and R-6604B are activated frequently, as shown in Table 3.2-1. R-6604A is the airspace unit that overlies Wallops Island, the southern end of Assateague Island, and the Assateague Island National Seashore/Chincoteague National Wildlife Refuge, and extends seaward, connecting to W-386. R-6604A was activated on 324 days during fiscal year 2013, on average about 17 hours per day. The restricted area was not activated on 11 weekdays and 15 weekend or holiday days during the fiscal year. In fiscal year 2013, WFF released R-6604A to the National Airspace System for potential use by civil aviation during approximately 37.6 percent of the hours in the year and released R-6604B 74.9 percent of the hours.

Commercial and general aviation flights normally do not fly through R-6604A/B, but may request permission to enter the restricted area when it is available to shorten their transits. Both commercial and general aviation operators normally stay out of the restricted area at all times. Commercial airliners fly along long-established routes that do not cross R-6604A/B, and general aviation pilots, although they do have the option of checking whether the restricted area is active when planning their flights, very rarely do so. In the event of an emergency, however, any commercial or general aviation aircraft may contact the WFF Range Control Center or the Washington Air Route Traffic Control Center and request and be granted permission to fly through the controlled air space.

Because offshore airspace outside the U.S. territorial limit (more than 12 nautical miles from the coast) is located in international airspace, the procedures outlined in International Civil Aviation Organization Document 4444, *Rules of the Air and Air Traffic Services* are followed. The Federal Aviation Administration 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 Air Route Traffic Control Center.

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Table 3.2-1: R-6604A and R-6604B Utilization in Fiscal Year 2013

Utilization	R-6604A	R-6604B
Total Operations	548	378
Total Days –		
Scheduled	328	246
Activated	324	242
Utilized	324	242
Total Hours –		
Scheduled	5,457	2,196
Activated	5,443	2,182
Utilized	5,443	2,182
Total Hours Returned to National Airspace System	3,292	6,554
Source: NASA 2013a, 2013b.		

Most of the waterways in the vicinity of Wallops Island are accessible to commercial and recreational vessels; however, some areas are restricted. These restrictions can be permanent or temporary. As well as having the authority to designate maritime danger zones, the U.S. Army Corps of Engineers may set specific requirements, limit access, and control navigation activities within those waters by closing the danger zone to the public on a full-time or intermittent basis (33 C.F.R. § 334). During closure, light beacons, stationary warning balloons, and patrol watercraft and aircraft warn the public to remain out of the danger zone until the designated area is clear. Persons and vessels may enter and operate in the danger zone at all times when warning signals are not displayed (33 C.F.R. § 334.130). WFF closes the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet infrequently. Portions or the entirety of the danger zone were activated five times during calendar year 2013 (West 2013).

NASA has range control authority and determines range clearance procedures. Prior to NASA's use of the Virginia Capes Range Complex warning areas and closure of a portion or the entirety of the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet, the U.S. Coast Guard establishes avoidance areas, issues broadcast notices to mariners over maritime frequency radio, and distributes flyers with details of the exercise to local marinas, fish houses, and other maritime entities that use the danger zone waterways. WFF publishes on its website a notice to mariners that specifies the avoidance areas and the closure schedule, and, during exercises, flies the exercise trajectory and uses SPY, airport, and marine radar for range surveillance. The U.S. Coast Guard conducts surveillance of the exercise ranges, reports dangerous areas to ships and boats operating in the ranges, patrols and clears the ranges, and issues an all-clear after testing.

3.2.2 Environmental Consequences

This airspace and sea space analysis considers the potential impacts to general and civil aviation and to commercial and recreational vessel operations from implementation of the Proposed Action at the three site alternatives on Wallops Island. Impacts on air and maritime traffic are considered with respect to the potential for disruption of transportation patterns and systems, and

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changes in existing levels of airspace and sea space safety. Impacts to range operations might occur if an action has potential to result in a decrease in the number of flights that could be accommodated within established operational procedures and flight patterns, or requires airspace or sea space modification.

3.2.2.1 No Action Alternative

Under the No Action Alternative, there would be no testing of HVPs using the powder gun or railgun. Operational missions and activities would remain at current levels and within previously established ranges. All operational missions and activities under the No Action Alternative have been covered by previous NEPA documents; therefore, there would be no impact to range operations.

3.2.2.2 Pad 5 Alternative (Preferred Alternative)

Table 2-1 shows the proposed average annual number of projectiles to be used over the five program years. Tests would take place over one- or two-day periods, with firings averaging five projectiles per test day. The Navy would fire the 5" powder gun or the EM railgun during approximately 20 days annually in the first and second years, approximately 30 days annually in the third and fourth years, and approximately 50 days annually in the fifth year. Generally, the Navy would schedule testing to occur on weekdays – i.e., during those times of the week when the probability of clearing the range is highest, because the level of recreational use of the Atlantic Ocean waters off Wallops Island is lowest. A typical day of testing would be about 8 hours long but could be shorter or longer.

NASA has range control authority and would have full operational control over HVP tests at WFF, with authority to decide whether to fire or not fire the projectiles. When a powder gun or EM railgun is ready to fire, the Navy would request and would need permission from NASA before firing the gun. WFF has standard operating procedures for clearing testing areas before initiating hazardous activities.

The WFF Range Safety Officer would develop a flight safety plan for each HVP test. The firing of HVPs would require activation of:

- R-6604A
- The Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet
- W-386

An in-depth analysis of the effects of projectile firing on range operations within the Virginia Capes OPAREA and W-386 is included in the AFTT FEIS/OEIS (Navy 2013), which is incorporated by reference in this EA.

The increased use of R-6604A that would occur under the Pad 5 Alternative, compared to existing and no action conditions, would have negligible effects on non-military airspace users because the proposed gun firing would not increase activation of R-6604A substantially. Rather, gun firing typically would occur within blocks of time otherwise scheduled by WFF. R-6604A currently is activated most days during the year, as shown in Table 3.2-1 and discussed in Section 3.2.1.2, and was released for potential use by civil aviation during only 37.6 percent of the hours in fiscal year 2013. Commercial and general aviation flights normally do not fly through R-6604A and normally stay out of the restricted area at all times.

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Gun firing would increase activation of portions or, less likely, the entirety of the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet. The flight safety plans would establish a hazard area and, as needed, a caution area for each projectile. Each hazard area would encompass a corridor or a cone extending from the gun along the firing azimuth and a buffer of specified radius around the target area. If established for a projectile, the caution area would extend from the gun along the firing azimuth to a distance beyond the hazard area. During a test, no vessels would be allowed within the hazard area and only a specified number of vessels would be allowed in the caution area.

During a test, vessels would be excluded from that part of the danger zone that is overlain by the hazard area specified in the operative flight safety plan, and the number of vessels in the caution area would be controlled. Depending on the configurations of the hazard area and caution area, vessel movement through Chincoteague Inlet occasionally may be temporarily stopped or restricted.

To support HVP testing, WFF would restrict vessel movements near Wallops Island for several hours and, if required, would stop vessel movement through Chincoteague Inlet typically for 30 to 60 minutes per projectile firing. Based on a median value of 45 minutes per firing, vessel movements through the inlet could be restricted approximately 80 hours annually in the first and second years, approximately 110 hours annually in the third and fourth years, and approximately 190 hours annually in the fifth year. WFF may allow passage through the hazard area and through Chincoteague Inlet during gaps between firings, providing the gaps are of sufficient duration to allow safe transit across the area.

Several factors would contribute to minimizing the effects of increased activation of the danger zone on commercial and recreational vessel operations. First, NASA works with the public and adjusts the azimuth of the firing to avoid major boating corridors and fishing areas. Second, as is the case with all danger zone restrictions, information on the time and duration of each test would be made available in advance through flyers and notices to mariners over maritime frequency radio and on the WFF website. Boaters and fishermen in the area are familiar with WFF's range restrictions and are aware that they might need to shift the timing and location of their activities. Third, gun firing would be intermittent and would include long periods during which vessels may be allowed to pass under controlled conditions through the hazard area and through Chincoteague Inlet, consistent with the Navy's and NASA's policy to make all reasonable efforts to minimize public inconvenience. Finally, activation of only parts of the danger zone – not all of its area – would allow vessels to move freely in the unrestricted part, outside the hazard area and caution area. During such closures, a portion of the danger zone may not be accessible to commercial or recreational boaters or may require that vessels go around the edge of the hazard area when it is restricted.

Based on the annual number of shots and WFF's standard operating procedures for clearing testing areas, testing of HVPs with the powder gun and EM railgun would have no significant impacts on range operations under the Pad 5 Alternative.

3.2.2.3 Pad 4 Alternative

The testing performed under the Pad 4 Alternative would be identical to the tesing under the Pad 5 Alternative, except testing would be located about 1,020 feet (310 meters) south of Pad 5. The difference in location would have no impact on range operations, as the need to activate R-6604A, the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet, and W-

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386 would be identical. Based on the annual number of shots and WFF's standard operating procedures for clearing testing areas, testing of HVPs with the powder gun and EM railgun would have no significant impacts on range operations under the Pad 4 Alternative.

3.2.2.4 Elevated Road Alternative

The testing performed under the Elevated Road Alternative would be identical to the tesing under the Pad 5 Alternative, except testing would be located about 280 feet (85 meters) north of the Pad 5. The difference in location would have no impact on range operations, as the need to activate R-6604A, the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet, and W-386 would be identical. Based on the annual number of shots and WFF's standard operating procedures for clearing testing areas, testing of HVPs with the powder gun and EM railgun would have no significant impacts on range operations under the Elevated Road Alternative.

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3.3 Noise and Vibration

3.3.1 Noise Fundamentals and Criteria

Noise is unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment. Noise is one of the most common environmental issues associated with military operations such as gun firing, explosions, and aircraft operations.

Sound, expressed in decibels (dB), is created by vibrations travelling through a medium such as air or water. All noise generated by firing covered in this EA would be airborne. Noise from projectiles entering the water in the Virginia Capes Operating Range is incorporated by reference in the AFTT FEIS/OEIS (Navy 2013). A sound level of 0 dB is the approximate threshold of human hearing and is barely audible under extremely quiet conditions. By contrast, normal speech has a sound level of approximately 60 dB. Sound levels above 100 dB begin to be felt inside the human ear as discomfort. The threshold of pain for sound exposure in people with normal hearing is in the range of 110 to 130 dB (Berglund and Lindvall 1995). The minimum change in the sound level of individual noise events that an average human ear can detect is about 3 dB. On average, a person perceives a doubling (or halving) of a sound's loudness when there is a 10 dB change in sound level.

A number of factors affect sound as the human ear perceives it. These include the actual level of sound, the frequencies involved, the period of exposure to the sound, and changes or fluctuations in sound levels during exposure. In order to correlate the frequency characteristics from typical sound sources to the perception of the human ear, several frequency networks (systems of measuring units) have been developed. The most common sound frequency-weighting networks are the following:

- **A-weighted Scale** – The human ear cannot perceive all pitches or frequencies equally well. Reflecting this fact, measures can be adjusted, or weighted, to compensate for the human lack of sensitivity to low-pitched and high-pitched sounds. This adjusted measurement unit is known as the A-weighted decibel, or dBA. The dBA is used to evaluate sound from transportation activities (traffic and aircraft) and from small-arms firing.
- **C-weighted Scale** – The C-weighted scale measures more of the low-frequency components of sound than does the A-weighted scale. This unit, symbolized as dBC, is used for evaluating impulse sound and vibrations generated by heavy weapons such as artillery, mortars, and explosive charges.

Note that sound levels in one scale cannot be added or compared mathematically to levels in another scale.

Commonly used metrics for ordnance noise include:

- **Peak Sound Level** – The peak sound level (dBP) is an un-weighted scale that can be used to measure event sound from small-arms and heavy artillery firing and explosives.
- **Day-Night Sound Level** – The day-night average sound level is useful to account for the difference in response to sounds that occur during sleeping hours as compared to waking hours. This indicator is defined as the average sound level in decibels during a 24-hour

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period, with a 10-dB weighting (penalty) applied to nighttime sound levels. The 10-dB nighttime weighting accounts for the fact that sounds at night are perceived to be louder because there are usually fewer sounds occurring at that time. This metric is typically used for measuring average sound levels on an annual basis.

In addition to the frequency weighting, another important factor that is considered when sound is characterized and analyzed is whether the sound is continuous or impulsive (instantaneous). Continuous sound includes the sound generated by highways, construction sites, and heavy urban traffic. Impulsive sound includes such things as explosions or gun firing. All sound generated by firing the powder gun or railgun would be impulsive sound. Given the limited number of firing events associated with the Proposed Action (as summarized in Table 2-1), the unweighted dBP is considered an appropriate metric to use to assess event peak noise from impulsive sound sources.

Continuous noise is fundamentally different from impulse noise and noise threshold criteria for the two types differ. For example, permanent damage to unprotected ears due to continuous noise occurs at approximately 85 dB with an eight-hour-per-day exposure while the threshold for permanent damage to unprotected ears due to impulse noise is approximately 140 dB peak noise, with 100 exposures per day (Pater 1976).

3.3.2 Peak Noise Guidance

Relevant guidelines for addressing the event peak noise evaluated in this EA are described below.

3.3.2.1 Navy Noise Guideline on Ordnance Blast Noise

The Navy has established the Range Air Installations Compatible Use Zones program procedures (Chief of Naval Operations Instruction 3550.1, August 7, 1998) to protect public health, safety, and welfare, and to prevent encroachment from degrading the operational capability of air-to-ground ranges. This guidance provides a general direction of using the DoD's Blast Noise Prediction (BNOISE) program to establish ordnance blast noise contours for range planning purposes.

3.3.2.2 Army Ordnance Noise Guidelines

For impulsive event peak noise, the amount of annoyance depends on the time of day the noise takes place, whether the person is indoors or outdoors at the time, duration, repetitions, abruptness of onset or cessation, and the noise climate or background noise against which a particular noise event occurs. The annoyance and complaint potential from single events, particularly from a large weapon such as firing a 5" gun, is highly subjective. An infrequent loud event from large weapon firing can lead to complaints. Therefore, it is useful to look at individual peak noise levels when evaluating the impact of infrequent loud events.

The Army has established noise complaint risk guidelines applicable to large weapon firing events, as shown in Table 3.3-1 (Army 2007). These guidelines are considered in the evaluation of potential noise effects around the proposed test site from both powder gun and railgun firing noise events in terms of PK 15(met) noise levels. The metric PK 15(met) accounts for statistical variation in received single event peak noise level that is due to weather. It is the calculated peak noise level, without frequency weighting, expected to be exceeded by 15 percent of all events.

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Table 3.3-1: Risk of Complaints by Level of Peak Noise

Risk of Noise Complaints	Large Caliber Weapons Noise Limits (dB) PK 15(met)
Low	<115
Medium	115-130
High	130-140
Risk of physiological damage to unprotected human ears and structural damage claims	>140
Source: Army (2007).	

Based on Army guidelines, a predicted sound level of 115 dB is considered to have a low risk of noise complaints, 115-130 dB has a medium risk, 130-140 dB has a high risk, and over 140 dB there is a risk of physiological damage to unprotected human ears and structural damage claims. Therefore, 140 dBP is considered to have potential significant peak noise impact to exterior sensitive uses.

3.3.2.3 Occupational Safety and Health Act Limit

The Occupational Safety and Health Act of 1970 regulates noise impacts to workers, and establishes thresholds for a safe work environment. The Occupational Safety and Health Act standard (29 C.F.R. § 1910.95) provides an occupational noise exposure threshold of 140 dBP for regulating impulsive noise exposure to workers.

3.3.2.4 Accomack County Code

The Accomack County Code provides noise threshold guidelines based on the different zoning districts within the county (Accomack County 2001). However noise levels specified in the County Code do not apply to the impulsive noise that would be generated by the Proposed Action.

3.3.3 Vibration Fundamentals and Criteria

The low-frequency impulsive sound pressure generated by large-caliber gun firing can cause structures to vibrate. Vibration is an oscillatory motion which can be described in terms of displacement, velocity, or acceleration. Because the motion is oscillatory, there is no net movement of the vibration element and the average of the motion descriptors is zero. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement and acceleration is the rate of change of the speed. Because of the nature of oscillatory motion, building structures can only physically vibrate in the low frequency range, typically below 80 hertz. Consequently, only the low-frequency sound pressure component can cause potential building structure vibration.

There are several different methods that can be used to quantify the amplitude or extent of vibrations, including peak particle velocity measured in inches per second (in/sec) to determine the maximum instantaneous positive or negative peak of the vibration signal. Peak particle

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velocity is often used in the monitoring of blasting vibration because it bears a relation to the stresses that are experienced by buildings.

Vibration may be transmitted through the ground or through the air, as described in the following sections.

3.3.3.1 Ground-Borne Vibration

The shaking of houses and other structures is commonly attributed to ground-borne vibration. Ground-borne vibration originates from an event – such as an earthquake or a detonation – that radiates vibration energy into the ground. When the energy reaches a structure, the face of the nearest foundation or underground building wall responds to the ground-borne vibration and waves of energy move throughout the building. The magnitude of the ground-borne building vibration is a function of the:

- Power of the energy source.
- Distance from the source.
- Response characteristics of the transmitting media (rock/soil).
- Response characteristics of the building itself.

The U.S. Bureau of Mines conducted an 18-month study at the McAlester Army Ammunition Plant (Siskind 1989) and found that ground-borne vibration dominates structural vibration close to the source while airborne vibration dominates at greater distances. For example, the Bureau of Mines found that for a 100-pound (45-kilogram) detonation the ground-borne vibration was the dominant cause of building vibration if the building is located less than 500 feet (152 meters) from the detonation point. At distances greater than 500 feet (152 meters), the airborne sound wave was the dominant cause of the vibration. The powder gun's net explosive weight is close to 20 pounds (9 kilograms). The closest distances from the powder gun to the nearest buildings (Building V-3 for Pad 5 and the Elevated Road; W-20 for Pad 4) are 576 feet (176 meters) for the Pad 5 Alternative, 347 feet (106 meters) for the Pad 4 Alternative, and 742 feet (226 meters) for the Elevated Road Alternative. Based on the lower net explosive weight of the powder gun when compared to the Bureau of Mines detonation and the distance to each alternative, ground-borne vibration is anticipated to be negligible, would have no significant impacts, and is not discussed further.

3.3.3.2 Airborne Vibration

Airborne vibration can cause structural shaking and window rattling, which can concern and annoy occupants. More powerful airborne vibrations can damage structures, such as by breaking glass panes and cracking plaster, or even damaging the basic structure. A U.S. Bureau of Mines study (Siskind et al. 1980) correlated airborne vibration levels from use of explosives with the peak sound pressure levels likely to cause potential structural damage. As shown in Table 3.3-2, homeowners became concerned about structural damage at peak sound levels measured in peak decibels (dBP) far below those actually capable of causing such damage. The correlations shown in Table 3.3-2 provide only a general picture of the relationship between vibration levels and the peak sound level. The actual correlation is dependent on the specific structure type and condition. In Table 3.3-2, the worst case – a structure most likely to sustain damage from vibration – is likely to be one with poorly-fitted, loose window glass and walls already cracked

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or stressed by structural settling and/or deterioration, for example as the result of age, prior leaks, or storm damage.

Table 3.3-2
Response to Airborne Vibration Levels

Response	Vibration Level (in/sec)	Peak Decibels (dBP)
Concern by homeowner about structural rattling and possible damage	0.1	120
Glass and plaster cracks (worst case*)	0.5	134
Gypsum wallboard (worst case*)	0.75	141
Structural damage to lightweight superstructure	>2.0	175
Note: * Worst case = Poorly fitted loose window glass and/or walls already under stress through structural settling, deterioration, age, or earlier damage. Source: Siskind et al. 1980.		

For the purposes of this EA, the peak noise at or exceeding 140 dBP at off-WFF structures and 175 dBP at on-WFF structures is considered to result in a potentially significant vibration impact.

3.3.4 Affected Environment

Ongoing activities that generate noise at WFF include:

- Institutional support projects – construction, demolition and ongoing routine or recurring facility maintenance activities.
- Operational missions – airfield operations from the Main Base, science missions, rocket launch activities, and development tests and exercises for the Navy.

Based on ambient noise data collected in October 2011 by Blue Ridge Research and Consulting for WFF, the noise environments at the Mainland and Wallops Island are relatively quiet with the dominant noise sources being naturally occurring wind and wave action, resulting from the coastal location (Blue Ridge Research and Consulting 2011). Activities that generate noise above ambient conditions include aircraft flight operations and rocket launch activities from NASA, Navy and the Mid-Atlantic Spaceport. Noise generated from airfield operations is mostly over lands zoned for agricultural use around the Main Base. Rocket activities generate the greatest noise levels on Wallops Island. Trajectories for rockets launched from WFF follow a predominantly southeastern course over the Atlantic Ocean. Noise generated by existing rocket launch activities is short-term in duration and similar to the proposed powder gun firing noise.

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3.3.5 Environmental Consequences

3.3.5.1 No Action Alternative

Under the No Action Alternative, operational missions and activities would remain at current levels and there would be no testing of the powder gun or railgun. All operational missions and activities under the No Action Alternative would remain the same; therefore, there would be no additional noise impacts from HVP and railgun testing under this alternative. There would be no impact due to implementation of the No Action Alternative.

3.3.5.2 Pad 5 Alternative (Preferred Alternative)

The testing of HVPs using a 5" powder gun and integration of HVPs with the EM railgun would generate impulsive noise.

5"/62 Powder Gun Noise and Vibration

Navy guidance provides for the use of the DoD's BNOISE program to establish ordnance blast-noise contours. BNOISE2 is the most recent version of BNOISE, an Army-developed computer program that calculates blast-noise exposure contours resulting from specified activities involving large guns and high-explosive charges. BNOISE2 considers the type of weapon and ammunition, the number and time (day/night) of rounds fired, range attributes, weather, assessment procedures, and various metrics. It accounts for the spectra and directivity of both muzzle blast and projectile bow shock, which facilitates accurate calculation of propagation and sound frequency weighting. The source parameter values are based on empirical data, while the propagation algorithms are based on sophisticated calculations and experimental data.

The 5"/62 powder gun firing event peak-noise was predicted using BNOISE2. The 5"/62 gun was selected for modeling because it generates more noise than the 5"/54 gun; thus it is the conservative worst case for 5" guns. The BNOISE2-defined average weather and propagation conditions were used to account for the average behavior of sound intensity as it propagates from the projectile firing position.

The propellant charge for the 5"/62 gun could range from 18.25 pounds (8.3 kilograms) net explosive weight to 26 pounds (11.8 kilograms) net explosive weight for the Extended Range Guided Munitions that may be used for tests under the Proposed Action in order to provide over-the-horizon range and improved lethality. The BNOISE2 model does not include data for 5"/62 guns, so a 155mm (approximately 6" caliber) Howitzer gun was selected from the guns available in the BNOISE2 model inventory to simulate peak noise levels for the 5"/62 powder gun. The BNOISE2 model assumes the 155mm gun has a propellant charge of 20.3 pounds (9.2 kilograms) net explosive weight versus 18.5 pound (8.4 kilograms) net explosive weight for the 5"/54 gun. The next largest gun in the model inventory, the 8" caliber, assumes a propellant charge of 78.6 pounds (35.7 kilograms) net explosive weight, which would be three to four times larger than the net explosive weights of the proposed HVPs fired from a 5"/62 gun. Therefore, the 155mm gun results in a closer representation of 5"/62 noise levels than the other choices. The noise modeling was done using the conservative PK15 overcast weather conditions where noise is amplified by clouds, which compensates for the 155mm gun's net explosive weight being lower than for the Extended Range Guided Munitions proposed.

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Peak blast noise levels in dBP from powder gun firing depicted in PK 15(met) contours were predicted using BNOISE2 for the following powder gun firing scenarios[1]:

- Firing a projectile along a low-angle trajectory directly toward a target located 5 miles (8 kilometers) away (Figure 3.3-1).
- Firing a projectile along a high-angle, parabolic trajectory toward a target located 5 miles (8 kilometers) away (Figure 3.3-2).
- Firing a projectile along a low-angle trajectory directly toward a target located 25 miles (40 kilometers) away (Figure 3.3-3).
- Firing a projectile along a high-angle, parabolic trajectory toward a target located 25 miles (40 kilometers) away (Figure 3.3-4).

These target distances were selected to cover the closest target distance proposed (5 nautical miles) and the maximum target distance in the BNOISE2 model for the 155mm Howitzer gun. The noise level shown in Figures 3.3-1 to 3.3-4 is the PK 15(met), accounting for statistical variation due to weather, which is expected to be exceeded by 15 percent of all events.

The powder gun noise contours shown in Figure 3.3-1 through Figure 3.3-4 indicate that:

- Impacts on land would be similar among firing scenarios.
- Noise contour areas at or greater than 130 dBP are almost completely within WFF.
- Noise contour areas at or greater than 115 dBP are mainly within WFF. In only one scenario, firing directly at a target 5 miles (8 kilometers) away, shown in Figure 3.3-1, does the 115 dBP contour cross the most southern part of Assateague Island National Seashore/Chincoteague National Wildlife Refuge.
- Low-trajectory (direct) firing, particularly at closer distances, would have greater impacts above the water as compared to high-trajectory firing, because the bow shock wave is closer to the water surface under low-trajectory firing.
- Exterior noise levels of 140+ dBP would encompass the working areas that are adjacent to the firing position. Therefore, the workers within the 140+ dBP contour area would evacuate the area, stay indoors, or have hearing protection during each firing event, per WFF guidance.
- The noise level area of 130–140 dBP (i.e., high risk of complaints) would not extend into any noise-sensitive land uses.
- The 115–130 dBP exterior noise (i.e., potentially causing moderate risk of complaints) would not affect any sensitive land uses.

[1] Note: The BNOISE2 model does not provide the actual trajectory, but provides two firing options, either direct (low angle) firing or high angle (parabolic) firing.

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- The buildings around the project site are essentially within the noise level area of 140–150 dBP as shown in Figures 3.3-1 through 3.3-4. These buildings may be subject to airborne vibration during the firing event. However, these levels are well below the potential structure damage threshold of 175 dBP as summarized in Table 3.3-2. On-site buildings are solid structures with no poorly fitted loose window glass or walls already under stress. These buildings regularly experience vibration from on-site rocket testing. Therefore, the airborne vibration effects at existing buildings would not be significant.

EM Railgun Noise and Vibration

As compared to the powder gun using explosives to propel projectiles, the railgun uses EM energy to launch projectiles that can reach speeds of more than seven times the speed of sound. When the railgun fires, it lets out a crack as electricity arcs through the air like lightning (Borrell 2008). Because the EM railgun is still under development, with limited measurements of the gun firing noise, NSWCDD conducted two-phase peak-noise measurements from operation of the existing 32-megajoule rail gun system located in the Electromagnetic Launch Facility at Naval Support Facility Dahlgren, Virginia.

During Phase 1 measurements of the Railgun Innovative Naval Prototype program, a total of 255 rounds of shots were fired in three periods: October 2006 to January 2007; April 2007 to October 2008; and December 2008 to January 2009. A total of 862 peak noise samples were collected outside three buildings located at various distances from the launch site, as well as along the firing direction trajectory. For all Phase 1 noise measurements, the system was operating at power levels considerably below 32 megajoules because the electrical pulse forming network could not support higher power levels. Power levels increased from 0.8 megajoule in the early tests to 16 megajoules in the latter group of tests. The Phase 1 measurement data were used by NSWCDD to develop an empirical relationship for predicting the anticipated peak sound level as a function of distance and railgun energy power index. MATLAB Curve Fitting Toolbox was employed to analyze these sample data to derive a curve-fitting relationship. The predicted 32-megajoule peak noise contours are depicted in Figure 3.3-5 and do not reflect any projectile bow shock effects.

After the Railgun Innovative Naval Prototype program Phase 1 measurements, 573 shots were made from time to time with the railgun power set in a range of 0.2 and 33 megajoules. A total of 1,178 samples were collected at three locations, and these measurements generally correlate with the NSWCDD-established empirical relationship discussed above.

The predicted railgun peak noise is lower than powder gun noise, including the extent of the 115 dBP noise contour. Therefore, railgun firing is unlikely to cause noise complaints from sensitive land uses or result in potential significant vibration impacts.

It should be noted that loud noises are regularly generated at WFF during rocket launches. Standard operating procedures and protective measures would be followed during firing of the powder gun and EM railgun to ensure that no WFF personnel within the project area are outside of building structures without hearing protection during the proposed gun test.

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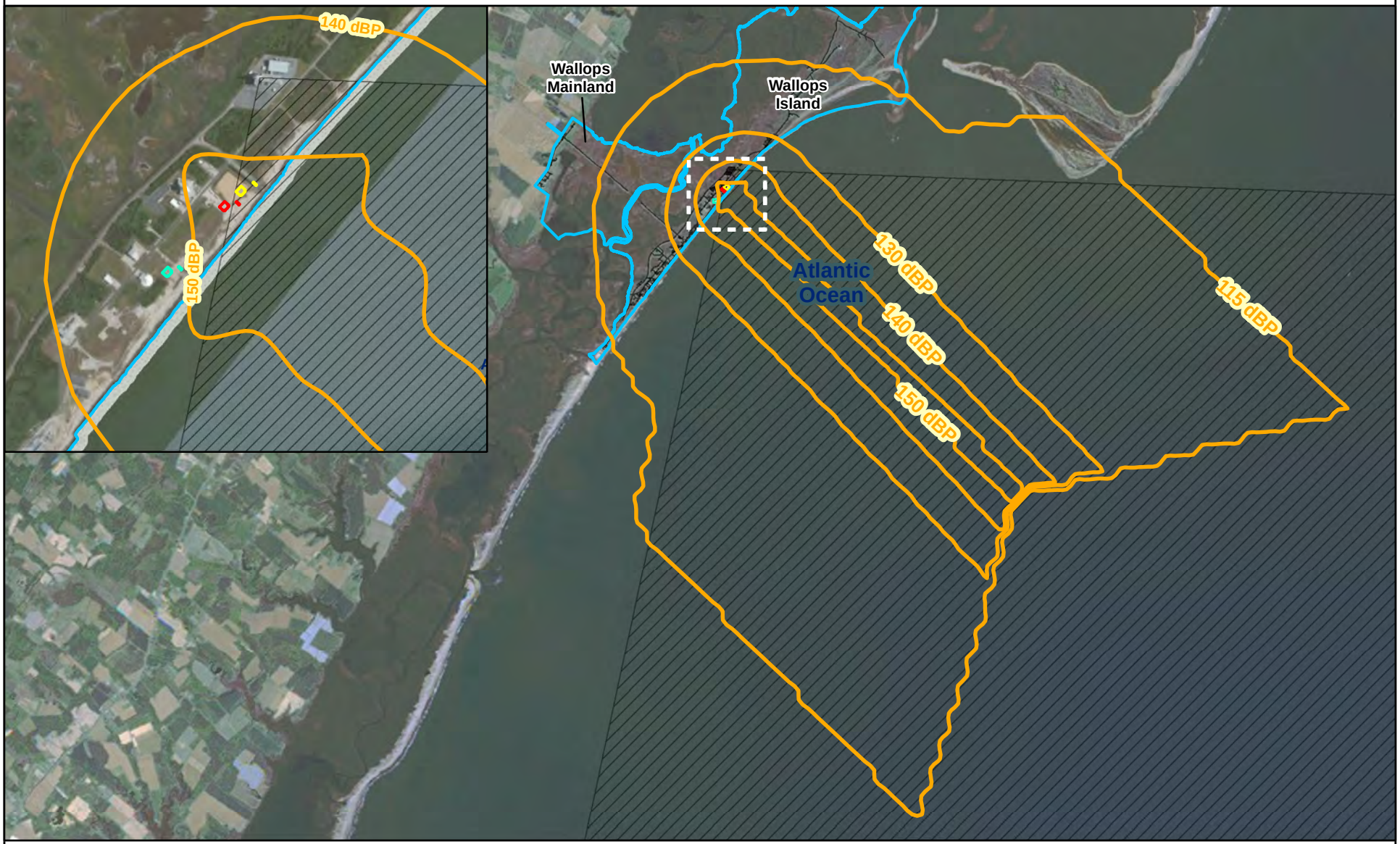
Peak Noise - Powder Gun Firing a Projectile 5 Miles along a Direct Trajectory



Source: ESRI Ortho-imagery.
Note: Modeling based on 155 mm gun firing from Pad 5 (Preferred Alternative).

Figure 3.3-1

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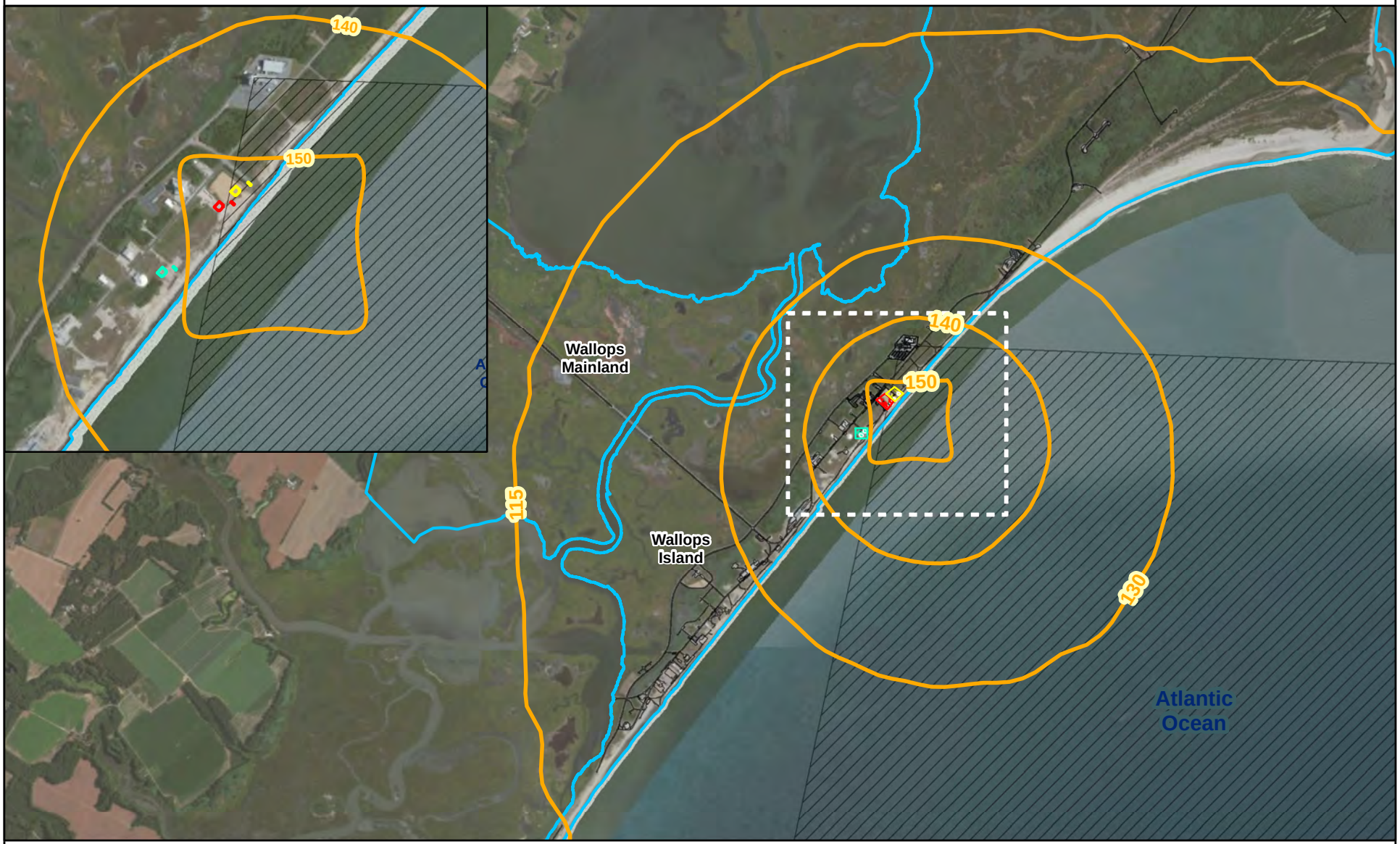
Peak Noise - Powder Gun Firing a Projectile 5 Miles along a Parabolic Trajectory



5-Mile High Angle Contour
Wallops Flight Facility
AEGIS SPY-1 Radar Beam
Pad 4 Alternative
Pad 5 Alternative
Elevated Road Alternative

0 3,500 7,000
Feet
0 1,000 2,000
Meters
N

Source: ESRI Ortho-imagery.
Note: Modeling based on 155 mm (approximately 6" caliber) gun firing from Pad 5 (Preferred Alternative).

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Figure 3.3-2

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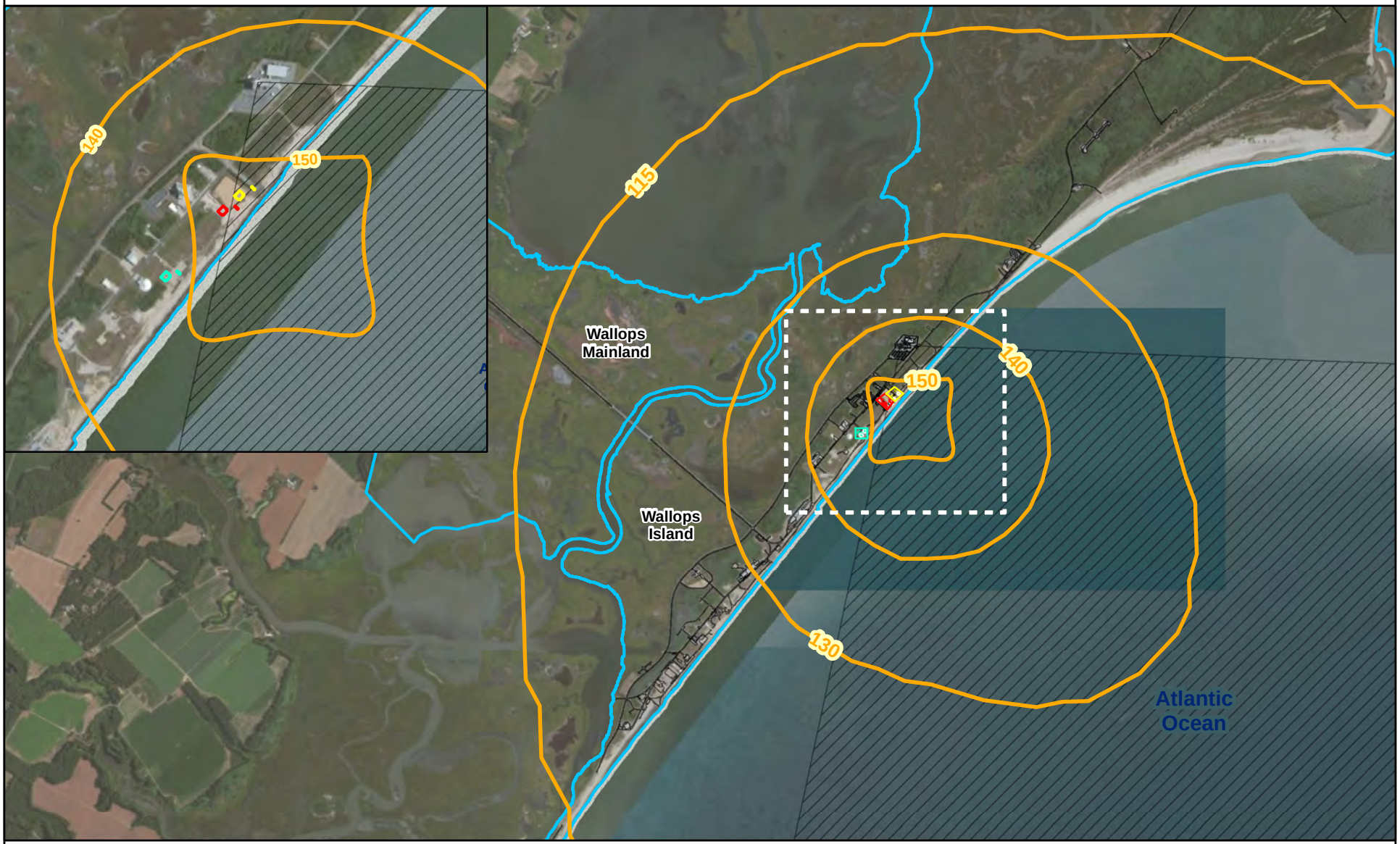
Peak Noise - Powder Gun Firing a Projectile 25 Miles along a Direct Trajectory



25-Mile Low Angle Contour
Wallops Flight Facility
AEGIS SPY-1 Radar Beam
Pad 4 Alternative
Pad 5 Alternative
Elevated Road Alternative

0 3,500 7,000
Feet
0 1,000 2,000
Meters
N

Source: ESRI Ortho-imagery.
Note: Modeling based on 155 mm (approximately 6" caliber) gun firing from Pad 5 (Preferred Alternative).

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Figure 3.3-3

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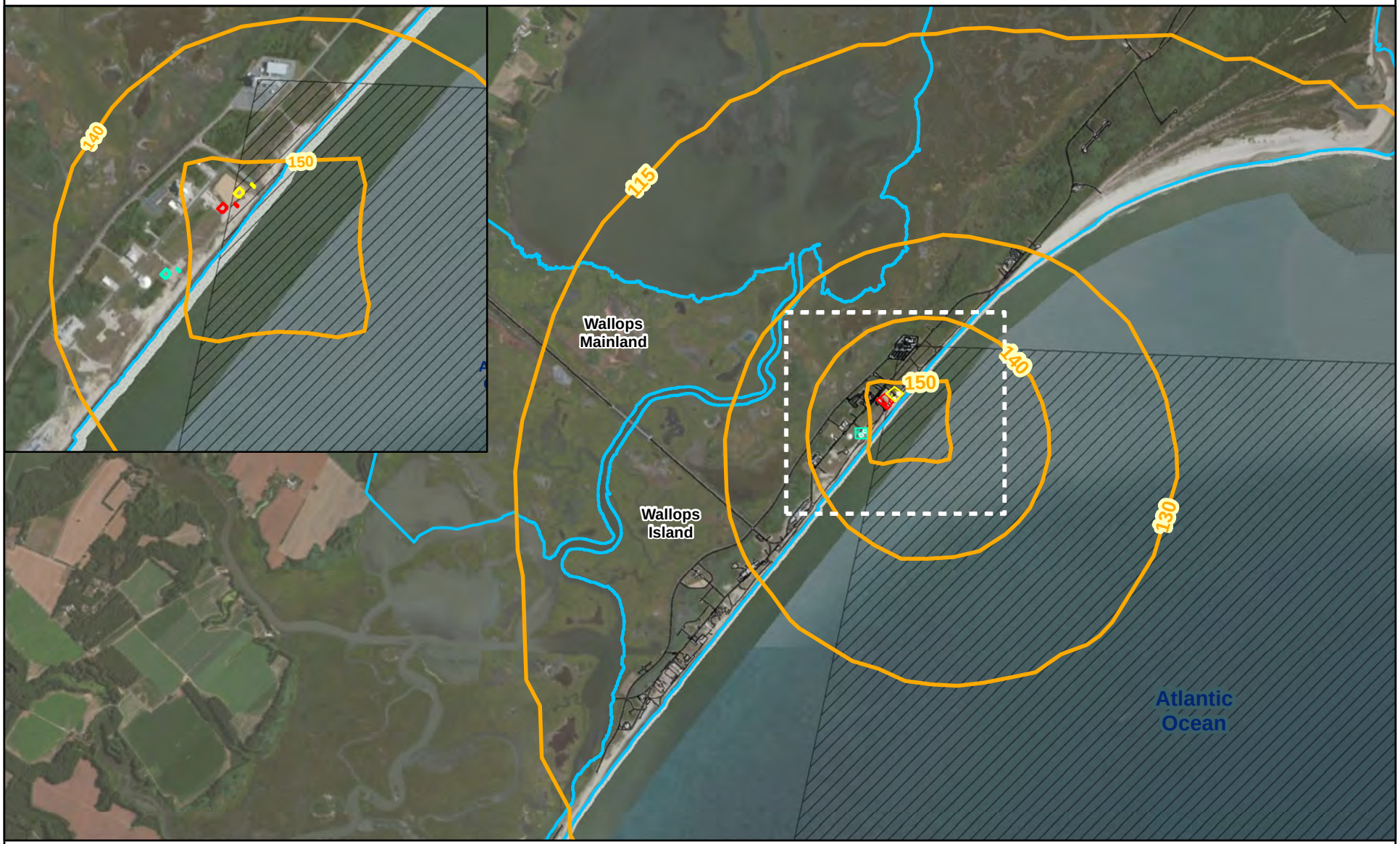
Peak Noise - Powder Gun Firing a Projectile 25 Miles along a Parabolic Trajectory



25-Mile High Angle Contour
Wallops Flight Facility
AEGIS SPY-1 Radar Beam
Pad 4 Alternative
Pad 5 Alternative
Elevated Road Alternative

0 3,500 7,000
Feet
0 1,000 2,000
Meters
N

Source: ESRI Ortho-imagery.
Note: Modeling based on 155 mm (approximately 6" caliber) gun firing from Pad 5 (Preferred Alternative).

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Figure 3.3-4

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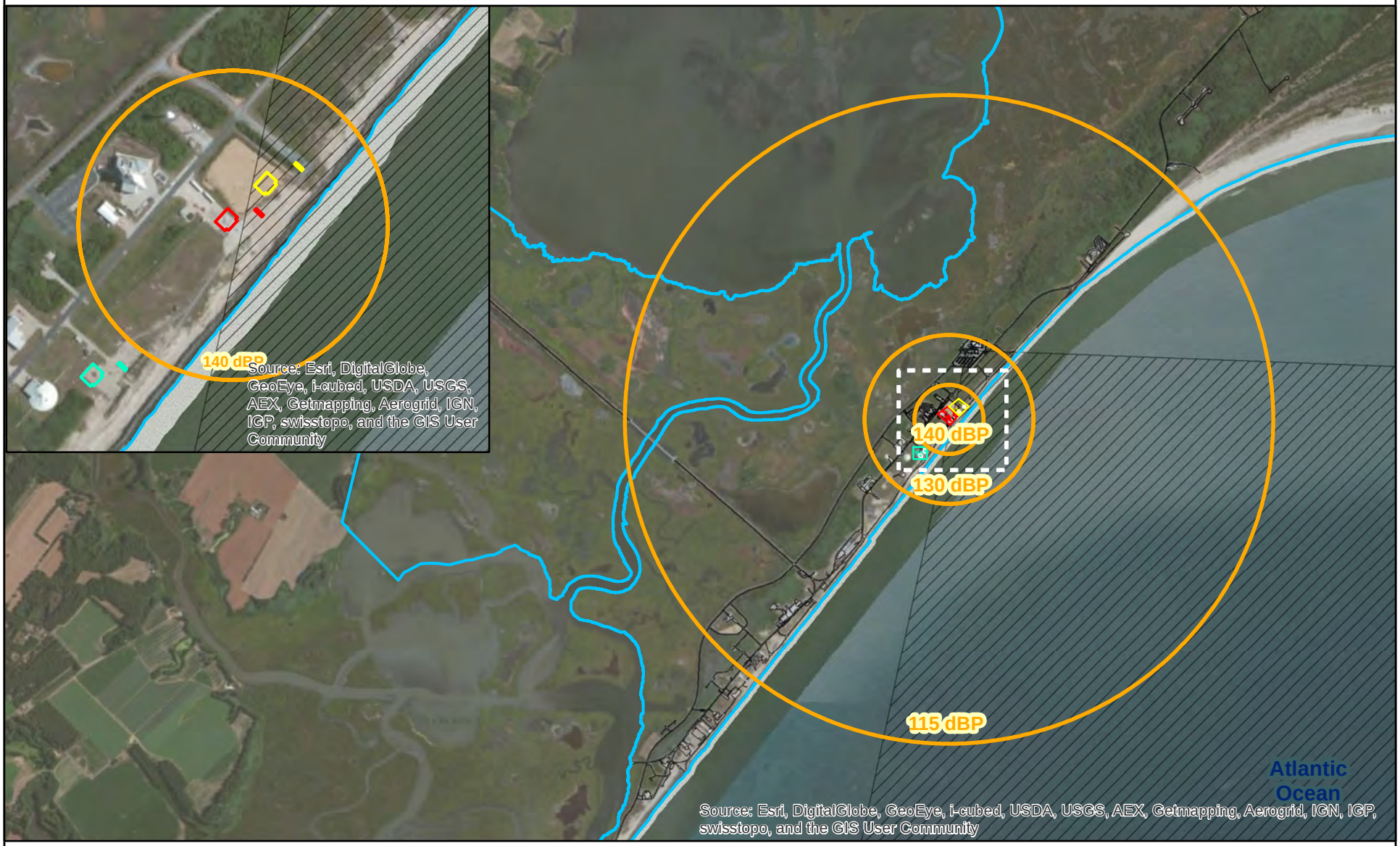
Peak Noise - 32-MJ EM Railgun Firing



32-MJ EM Railgun Firing Peak Noise
Wallops Flight Facility
AEGIS SPY-1 Radar Beam
Pad 4 Alternative
Pad 5 Alternative
Elevated Road Alternative

0 3,000 6,000
Feet

0 800 1,600
Meters

N

Source: ESRI Ortho-imagery.
Note: Modeling based on firing from Pad 5 (Preferred Alternative).

Path: B:\work\60308683_SPYMxd\

Figure 3.3-5

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Under the Pad 5 Alternative, noise impacts from HVP firing from the powder gun and railgun would not be significant with protective measures in place to mitigate noise impacts on personnel working nearby. Vibration impacts would not be significant. There would be no significant impacts from noise and vibration.

3.3.5.3 Pad 4 Alternative

Gun firing noise for the Pad 4 Alternative would be similar to the Pad 5 Alternative and would result in no significant impacts with protective measures in place to mitigate noise impacts on personnel working nearby. Vibration impacts would not be significant. There would be no significant impacts from noise and vibration.

3.3.5.4 Elevated Road Alternative

Gun firing noise for the Elevated Road Alternative would be similar to the Pad 5 Alternative and would result in no significant impacts with protective measures in place to mitigate noise impacts on personnel working nearby. Vibration impacts would not be significant. There would be no significant impacts from noise and vibration.

3.3.6 Protective Measures

Since no significant noise and vibration impacts would occur at off-base sensitive receptors, mitigation measures are not warranted. However, because high noise levels may be generated (i.e., ≥140 dBP) during firing around the launch site, protective measures that are already implemented for current activities and missions at WFF as part of standard operating procedures, such as specified personal protective equipment and allowed personnel locations during each operation, would continue to be implemented. These measures ensure that installation personnel and the public are not exposed to hazardous noise levels.

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3.4 Air Quality

Air quality in a given location is described by the ambient concentration of specific pollutants of concern in the atmosphere. A region's air quality is influenced by many factors including the type and amount of pollutants emitted into the atmosphere from various sources, the size and topography of the air basin, and the prevailing meteorological conditions.

Criteria Pollutants

Six air pollutants are regulated by the U.S. Environmental Protection Agency (USEPA) with the National Ambient Air Quality Standards (NAAQS) in compliance with the Clean Air Act because of the risks they create for human health and welfare when present in excessive amounts in the environment. These pollutants, known as "criteria pollutants," are ground-level ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), and particulate matter (that is, small particles suspended in the air; two types are included: particulate matter less than 10 micrometers in size [PM_{10}] and particulate matter less than 2.5 micrometers in size [$PM_{2.5}$]).

Areas where concentration levels are below the NAAQS for a criteria pollutant are designated as being in "attainment" per the Clean Air Act. Areas where a criteria pollutant level equals or exceeds the NAAQS are designated as being in "nonattainment." Where insufficient data exist to determine an area's attainment status, it is designated as either unclassifiable or in attainment.

The Clean Air Act as amended in 1990 requires federal agencies to ensure that their actions conform to the appropriate State Implementation Plan in a NAAQS nonattainment area. The State Implementation Plan provides for implementation, maintenance, and enforcement of the NAAQS; it includes emission limitations and control measures to attain and maintain the NAAQS. Conformity to a State Implementation Plan, as defined in the Clean Air Act, means conformity to a State Implementation Plan's purpose of reducing the severity and number of violations of the NAAQS to achieve attainment of the standards. The federal agency responsible for a Proposed Action is required to determine if its Proposed Action within a nonattainment area conforms to the applicable State Implementation Plan.

Hazardous Air Pollutants

In addition to the criteria pollutants discussed above, non-criteria toxic pollutants, called hazardous air pollutants, are also regulated under the Clean Air Act. USEPA has identified a total of 188 hazardous air pollutants that are known or suspected to cause health effects in small doses. Hazardous air pollutants are emitted by a wide range of man-made and naturally occurring sources including combustion mobile and stationary sources. However, unlike the NAAQS for criteria pollutants, federal ambient air quality standards do not exist for non-criteria pollutants.

Greenhouse Gases

Greenhouse gases are compounds that contribute to the greenhouse effect. The greenhouse effect is a natural phenomenon where gases trap heat within the surface-troposphere (lowest portion of the earth's atmosphere) system, causing heating at the surface of the earth. The primary long-lived greenhouse gases directly emitted by human activities are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

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The USEPA Administrator has recognized potential risks to public health or welfare and signed an endangerment finding regarding greenhouse gases under Section 202(a) of the Clean Air Act (USEPA 2009), which finds that the current and projected concentrations of the above primary greenhouse gases in the atmosphere threaten the public health and welfare of current and future generations. To estimate global warming potential, all greenhouse gases are expressed relative to a reference gas, carbon dioxide, which is assigned a global warming potential equal to 1. All six greenhouse gases are multiplied by their global warming potential and the results are added to determine the total CO_2 equivalent emissions.

The Council on Environmental Quality has provided draft guidance on the consideration of greenhouse gas effects on climate change in NEPA documents (Council on Environmental Quality 2010).

3.4.1 Affected Environment

The region of influence for the air quality analysis is the Northeastern Virginia Intrastate air quality control region (defined in 40 C.F.R. § 81.144). This air quality control region, which includes Accomack County, is designated as in attainment/unclassifiable for all criteria pollutants. Because the region is in attainment, the Clean Air Act General Conformity Rule (40 C.F.R. Parts 51 and 93) does not apply and will not be addressed in the impact analysis.

WFF is not a major source for any criteria or hazardous air pollutants. Because WFF's annual emissions levels do not exceed the Title V of the Clean Air Act major source threshold of 100 tons (907,185 kilograms) per year of any criteria pollutant, WFF is regulated as a synthetic minor source (i.e., a source with annual emissions capped under the major source threshold) for air pollutants. WFF maintains two synthetic minor air permits, one for Main Base and a combined one for Mainland and Wallops Island. The most recent on-base actual annual emissions is summarized in Table 3.4-1. The table also includes the emissions of nitrogen oxides (NOx) and volatile organic compounds (VOC), which are ozone precursors.

Table 3.4-1: Wallops Main Base and Mainland/Island 2012 Annual Emissions Statement

Total Emissions tons/year (metric tons/year)						
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	Pb
Mainland/ Wallops Island						
1.87 (1.70)	0.38 (0.34)	0.15 (0.14)	Not Available	1.62 (1.47)	0.05 (0.045)	0.00 (0.00)
Main Base						
0.259 (0.235)	1.447 (1.313)	2.095 (1.901)	Not Available	3.220 (2.921)	0.149 (0.135)	0.00 (0.00)

Notes: SO_2 = sulfur dioxide, CO = carbon monoxide, PM_{10} = particulate matter less than 10 micrometers in size, $PM_{2.5}$ = particulate matter less than 2.5 micrometers in size, NO_x = nitrogen oxides, VOC = volatile organic compounds, and Pb = lead.

Source: Virginia Department of Environmental Quality 2013

Greenhouse Gas Emissions

In accordance with the USEPA final rule on mandatory reporting of greenhouse gases, WFF provides annual estimates of facility-wide total greenhouse gas emissions. Between 2009 and

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2012, the annual emissions at Wallops Mainland/Island ranged between 856 and 1,660 tons (777 and 1,512 metric tons) of carbon dioxide equivalents (Virginia Department of Environmental Quality 2013). These emissions are well below the USEPA reporting threshold of 25,000 metric tons for carbon dioxide equivalents.

3.4.2 Environmental Consequences

3.4.2.1 No Action Alternative

Under the No Action Alternative, there would be no testing of HVPs using the powder gun or railgun. Therefore, there would be no additional impacts on air quality beyond those already analyzed by existing environmental planning documentation. There would be no impact on air quality due to implementation of the No Action Alternative.

3.4.2.2 Pad 5 Alternative (Preferred Alternative)

Construction Emissions

The installation of the powder gun and railgun would require a limited amount of construction consisting of grading, placing gravel as a base for facilities not on concrete, trenching to install underground utilities, driving pilings, and placing prefabricated shelters and the EM railgun's pulsed power system on the pilings (see Section 3.8.2.2). The emissions generated from construction activities, including emissions from construction equipment and from fugitive dust, would not be significant. An erosion and sediment control plan in accordance with the Virginia Erosion and Sediment Control regulations (9 Virginia Code 25-840) would be developed during project planning and carried out during construction to minimize fugitive dust.

Operational Emissions

The testing of the powder gun would use small quantities of propellant – a MK99 formulation – to fire projectiles. The primary constituent is cyclotrimethylenetrinitramine, also known as RDX. The propellant would be almost completely expended – more than 99.99 percent – during firing and would not add measurably to current emissions. Fugitive air emissions from the powder gun using MK99 propellant are summarized in Table 3.4-2. Most emissions would be compounds or elements, such as carbon monoxide, nitrogen, and water that are naturally found in air.

The EM railgun does not require the use of a propellant. Firing of railgun projectiles generates small quantities of aluminum oxide (Al_2O_3) in the immediate vicinity of firing caused by the abrasion of aluminum components. The quantity and form of aluminum oxide that would be emitted is not considered toxic and would not require any additional safety measures.

The power used for railgun firing would be drawn from the local grid resulting in no new combustion sources at WFF.

Based on annual number of shots and limited emissions associated with them, testing of HVPs with the powder gun and EM railgun would have no significant impacts on air quality under the Pad 5 Alternative.

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Table 3.4-2: MK99 Annual Emissions from Powder Gun Shots

Compound	Pound/Shot	Tons /Year
Criteria Pollutants		
Carbon monoxide (CO)	33.38	4.17
Nitrogen dioxide (NO_2)	<0.000001	0.00
Greenhouse Gases		
Carbon dioxide (CO_2)	4.83	0.60
Methane (CH_4)	0.005	0.00
Other Constituents		
Nitrogen (N_2)	21.37	2.67
Water (H_2O)	8.97	1.12
H_2 (Hydrogen)	1.30	0.16
Hydrogen cyanide (HCN)	0.07	0.01
Nitric oxide (NO)	0.006	0.00
Cyanide (CN)	0.00009	0.00
Source: NASA 2008.		

Because the gun firing would occur in an open field causing minor fugitive emissions that cannot be practicably controlled like a conventional stationary source with an exhaust stack or a vent, no pre-construction air permit is required for the proposed gun launch site.

Greenhouse Gas Emissions

Greenhouse gas emissions from construction and operations would be minimal and would not add substantively to WFF's greenhouse gas emissions, which are well below the reporting threshold of 25,000 metric tons for carbon dioxide equivalents.

3.4.2.3 Pad 4 Alternative

The testing performed under the Pad 4 Alternative would be identical to that under the Pad 5 Alternative, except testing would be located about 1,020 feet (310 meters) south of Pad 5. The difference in location would have no impact on air quality, as the preparation of Pad 4 for testing would involve construction activities similar to those required for Pad 5. Based on the maximum proposed annual number of shots (250) and limited emissions (Table 3.4-2) associated with them, testing of HVPs with the powder gun and EM railgun would have no significant impacts on air quality under the Pad 4 Alternative.

3.4.2.4 Elevated Road Alternative

The testing performed under the Elevated Road Alternative would be identical to that under the Pad 5 Alternative, except testing would be located about 280 feet (85 meters) north of the Pad 5. The difference in location would have negligible impacts on air quality, as preparation of the elevated road for testing would require slightly more grading and paving than Pad 5. Based on the maximum proposed annual number of shots (250) and limited emissions (Table 3.4-2) associated with them, testing of HVPs with the powder gun and EM railgun would have no significant impacts on air quality under the Elevated Road Alternative.

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3.5 Socioeconomics

Socioeconomics address the social and economic aspects of the human environment, and encompass population, housing, employment, personal income, and economic activity. Socioeconomics for this EA focus on the general features of the local economy of Chincoteague, Virginia as the town that could be affected by facility construction and fluctuations in visiting personnel under the Proposed Action, and on maritime transport, recreational boating, and commercial and recreational fishing as the socioeconomic activities that could be affected by the proposed gun testing.

3.5.1 Affected Environment

Wallops Island is a 6.5-square mile (16.8-square kilometer) island off the coast of the Eastern Shore of Virginia and is located within Accomack County, Virginia. The region of influence for socioeconomics is Accomack County, which includes Chincoteague Island and the proposed firing area. This socioeconomic analysis includes data for Chincoteague and Accomack County; data for the Commonwealth of Virginia is provided as a general comparison.

3.5.1.1 Population

WFF and Wallops Island are located in a rural area with no major urban centers. Year-round densities of neighboring areas are low. The unincorporated community of Assawoman, approximately 3.3 miles (5.3 kilometers) to the northwest of Wallops Island (measured from Pad 5), is the closest residential community to Wallops Island. Rural villages near the Wallops Island are Atlantic, 3.8 miles (6.1 kilometers) northwest of the facility (measured from Pad 5); Temperanceville, 5.0 miles (8.0 kilometers) northwest; and Mappsville, 5.4 miles (8.7 kilometers) west. In 2010, each of these villages had a population of fewer than 1,000 people (U.S. Census Bureau 2013, DP-1 Profile of General Population and Housing Characteristics 2010).

Chincoteague, Virginia is the closest incorporated town to Wallops Island and is the largest, most densely-populated community in the area with a 2010 population of 2,941. As shown in Table 3.5-1, Chincoteague accounted for approximately 8.9 percent of the county population in 2010. The population of Chincoteague and Accomack County experienced decreases in population of 31.9 and 13.4 percent, respectively, between 2000 and 2010. By comparison, the population of the Commonwealth of Virginia saw an increase of 13.0 percent.

Area populations fluctuate seasonally. During the summer months, the population increases due to tourism and vacationers who visit the beaches of Assateague Island and the Chincoteague Wildlife Refuge; daily populations often triple during the summer months. Chincoteague's population increases to over 15,000 during the summer months (Town of Chincoteague 2010). Special events can draw large crowds. Recent attendance estimates range from 35,000 to 50,000 for the Chincoteague Volunteer Fire Department's carnival and pony penning/auction, which occurs annually on the last Wednesday, Thursday and Friday in July.

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Table 3.5-1: Population 2000-2010

Geographic Area	2000 Population	2010 Population	Percent Change (2000 to 2010)
Chincoteague	4,317	2,941	-31.9
Accomack County	38,305	33,164	-13.4
Commonwealth of Virginia	7,078,515	8,001,024	13.0
Sources: U.S. Census Bureau 2013, DP-1 Profile of General Demographic Characteristics 2000; DP-1 Profile of General Population and Housing Characteristics 2010.			

3.5.1.2 Employment and Income

Total employment in Accomack County was approximately 12,700 jobs in the fourth quarter (October-December) of 2012, as shown in Table 3.5-2. The industries that employed the most people in the county were manufacturing (24.1 percent), government (22.3 percent), retail trade (10.7 percent), accommodation and food services (9.0 percent), and health care and social assistance (9.0 percent).

The U.S. Census Bureau 2011 American Community Survey provides five-year estimates of employment by industry. As presented in Table 3.5-3, the largest industry in Chincoteague with respect to employment between 2007 and 2011 was arts, entertainment, and recreation, and accommodation and food services. The second largest industry in Chincoteague was educational services, and health care and social assistance, which was also the largest industry in both the county and the state. The third largest industry in Chincoteague was professional, scientific, and management, and administrative and waste management services. In Accomack County, the second and third largest industries in 2007-2011 were retail trade and manufacturing.

Unemployment rates in Accomack County increased dramatically over the last five years, as shown in Table 3.5-4, increasing by more than one-third from 2008 to 2012. The unemployment rates for Virginia nearly doubled over the same time period. The 2012 unemployment rate for Accomack County was higher than the rate for Virginia. The comparable 2012 unadjusted unemployment rate was 8.1 percent for the nation.

As summarized in Table 3.5-5, total personal income in Accomack County increased by 11.0 percent from 2007 to 2011. Per capita income in Virginia grew by 6.6 percent over the same time period.

The median household income for Chincoteague in 2011 was $34,625, in inflation-adjusted dollars (U.S. Census Bureau 2013, DP03, Selected Economic Characteristics, 2011 American Community Survey 5-year Estimates). For Accomack County, the median household income was $41,595. For both Chincoteague and the county, the median household incomes were substantially lower than that for Virginia, which reported a median household income of $63,302.

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Table 3.5-2: Accomack County Employment by Industry 4th Quarter 2012

Industry	Accomack County	Commonwealth of Virginia
Agriculture, Forestry, Fishing and Hunting	186	12,289
Mining, Quarrying, and Oil and Gas Extraction	0	8,505
Utilities	*	10,545
Construction	440	177,605
Manufacturing	3,056	230,928
Wholesale Trade	241	111,430
Retail Trade	1,358	418,231
Transportation and Warehousing	130	99,845
Information	72	70,994
Finance and Insurance	166	127,687
Real Estate and Rental and Leasing	127	51,726
Professional, Scientific, and Technical Services	890	397,451
Management of Companies and Enterprises	96	75,979
Administrative and Support and Waste Management	290	209,356
Education Services	*	63,628
Health Care and Social Assistance	1,138	396,739
Arts, Entertainment, and Recreation	39	43,216
Accommodation and Food Services	1,144	311,560
Other Services (except Public Administration)	378	130,713
Government Total	2,823	701,634
Federal Government	633	175,744
State Government	401	147,351
Local Government	1,789	378,539
Unclassified	0	6,692
TOTAL	12,659	3,656,752

Note: * indicates non-disclosable data.

Source: Virginia Employment Commission 2013a, 2013b.

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Table 3.5-3: Percent Employment by Industry 2007-2011

Industry	Chincoteague	Accomack County	Commonwealth of Virginia
Agriculture, Forestry, Fishing and Hunting, and Mining	4.7	5.7	1.1
Arts, Entertainment, and Recreation, and Accommodation and Food Service	25.2	9.4	8.1
Construction	4.8	8.1	7.1
Educational Services, and Health Care and Social Assistance	21.3	21.0	20.8
Finance and Insurance, and Real Estate and Rental and Leasing	6.7	3.8	6.6
Information	0.0	1.5	2.4
Manufacturing	3.8	11.5	7.9
Other Services, except Public	5.0	3.2	5.2
Professional, Scientific, and Management, and Administrative and Waste Management Services	13.2	6.8	14.4
Public Administration	8.5	7.3	9.2
Retail Trade	3.4	12.5	10.9
Transportation and Warehousing, and	2.0	3.3	4.2
Wholesale Trade	1.3	5.8	2.1
Sources: U.S. Census Bureau 2013, DP03, Selected Economic Characteristics, 2011 American Community Survey 5-year Estimates.			

Table 3.5-4: Unemployment Rates 2008-2012

Geographic Area	2008	2009	2010	2011	2012	Percent Change (2008-2012)
Accomack County	5.0	6.7	7.1	7.3	6.9	38.0
Commonwealth of Virginia	4.0	6.9	7.1	6.4	5.9	47.5
United States	5.8	9.3	9.6	8.9	8.1	39.7
Note: Unemployment rates not seasonally adjusted. Source: Virginia Employment Commission, 2013a.						

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Table 3.5-5: Per Capita Income 2007-2011

Geographic Area	2007 Per Capita Income	2011 Per Capita Income	Percent Increase 2007-2011
Accomack County	30,048	33,368	11.0
Commonwealth of Virginia	43,261	46,107	6.6
Note: Per capita incomes not adjusted for inflation. Sources: U.S. Department of Commerce 2013a, CA1-3, Personal Income, Per Capita Personal Income, and Population.			

3.5.1.3 Housing

In 2010, the number of housing units in Accomack County totaled 21,002 and housing units in Chincoteague totaled 4,517, or about 21.5 percent of the county total, as shown in Table 3.5-6. Approximately 34.3 percent of the housing units in Accomack County and 68.6 percent of the housing units in Chincoteague were vacant. The comparable vacancy rate for Virginia was 9.2 percent. The Eastern Shore is a popular vacation destination and the high vacancy rates in Accomack County reflect the high number of second or vacation homes in the area.

Table 3.5-6: Housing Units 2010

Geographic Area	Total Housing Units	Occupied Units	Vacant Units	Vacancy Rate
Atlantic	419	357	62	14.8
Chincoteague	4,517	1,417	3,100	68.6
Mappsville	167	135	32	19.2
Temperanceville	167	148	19	11.4
Accomack County	21,002	13,798	7,204	34.3
Commonwealth of Virginia	3,364,939	3,056,058	308,881	9.2
Source: U.S. Census Bureau 2013, DP-1 Profile of General Population and Housing Characteristics.				

Navy housing areas are located adjacent to the WFF Main Base. Navy Gateway Inns and Suites, also adjacent to Main Base, provides hotel accommodations for active duty personnel, reservists, retirees, non-appropriated fund or DoD civilians, and sponsored guests (Department of Defense Lodging 2013). The Town of Chincoteague has at least 18 hotels/motels and the remainder of Accomack County has at least another six that could accommodate individuals working at Wallops Island on a temporary basis (Navy 2013).

3.5.1.4 Maritime Transport and Recreational Boating

Commercial, recreational, and military maritime traffic all use the waters off the coast of Virginia, one of the busiest areas in the world for maritime traffic. The lower Chesapeake Bay is home to the Port of Virginia in Norfolk, Virginia, the third busiest port facility on the East Coast (Virginia Port Authority 2013). In 2012, the port handled 2,866 vessel calls, an average of about eight per day. Numerous small harbors are located throughout Accomack County, which are

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used primarily for commercial or recreational fishing and boating. The triangle-shaped Wallops Island Approach Zone is located at the mouth of Chincoteague Inlet and is designed to encourage boaters to exercise caution while traversing the inlet.

The Wallops Island shoreline is a popular location for local fishermen who fish from boats in the nearshore environment. Recreational transportation activities offshore consist of game and sport fishing, charter boat fishing, sport diving, water skiing, swimming, dolphin and whale watching, sailing, and power cruising. In 2012, the number of recreation boats registered in Virginia was 239,878, approximately 2.0 percent of the recreational boats registered in the nation (U.S. Department of Homeland Security 2013).

The U.S. Department of Commerce (2011) reported the number of establishments, number of employees, and payroll for the transport, support, and marine operations industries in Virginia in 2008. Table 3.5-7 summarizes these data. For industries for which data were available, marinas employed more people than any other industry in this sector, employing approximately 964 people at 119 establishments in Virginia. In 2008, the deep sea freight transportation industry had the highest annual payroll in the state, totaling about $32.5 million.

Table 3.5-7: Virginia Transport, Support, and Marine Operations Industries 2008

Industry	Establishments (number)	Employees (number)	Payroll (thousand dollars)
Coastal and Great Lakes Freight Transportation	10	ND	ND
Deep Sea Freight Transportation	18	409	32,473
Deep Sea Passenger Transportation	2	ND	ND
Marinas	119	964	24,326
Marine Cargo Handling	12	ND	ND
Navigational Services to Shipping	23	375	21,014
Port and Harbor Operations	8	ND	ND
Ship and Boat Building	59	ND	ND
Note: ND indicates these data are confidential and thus cannot be disclosed. Source: U.S. Department of Commerce 2011.			

3.5.1.5 Commercial and Recreational Fishing

Commercial Fishing – Landings

The National Marine Fisheries Service (NMFS) collects landings data from several sources, including state-mandated fishery or mollusk trip-tickets; landing weigh-out reports provided by seafood dealers; federal logbooks of fishery catch and effort; shipboard and portside interviews; and biological sampling of catches (U.S. Department of Commerce, 2013b). These data are incorporated into the NMFS Fisheries Statistics and Economics Division commercial landings databases. The term landing is defined by NMFS as the number or weight of fish caught, kept, and brought to shore. Three caveats are relevant to the interpretation of the landings data:

- Landing data do not indicate the location of capture; fish landed in Virginia by Virginia fisherman could have been taken offshore of another state, but landed in Virginia.

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- Data report only non-confidential landing statistics; whenever confidential landings occur, they have been combined with other landings and usually reported as unclassified. Total landings by state include confidential data and are accurate, but landings reported by individual species may be misleading.
- All of the estimates of value presented in the section are based on ex-vessel value, or the price the fishermen are paid for their catch at the point of landing; this value increases by several orders of magnitude as the fish are sold up the chain from the dealers to restaurants, grocery stores, etc. and later to the public.

As shown in Table 3.5-8, between 2007 and 2011, the commercial landings of food and baitfish in Virginia, measured by weight, averaged about 469 million pounds (213 million kilograms). Commercial landings were variable over the five years. Landings dipped to a low of less than 423 million pounds (192 million kilograms) in 2008, but recovered to a peak in 2010, when approximately 510 million pounds (231 million kilograms) of finfish and shellfish were landed.

Table 3.5-8: Virginia Commercial Landings 2007-2011

Year	Pounds Landed	Kilograms Landed	Value (dollars)
2007	491,848,988	223,102,701	137,992,873
2008	422,594,753	191,688,980	146,611,091
2009	426,282,450	193,361,719	152,021,704
2010	509,841,262	231,263,996	183,893,909
2011	494,028,366	224,091,267	191,664,734
5-year Average	468,919,164	212,701,733	162,436,862
Source: U.S. Department of Commerce 2013b.			

Chincoteague is one of six major ports in Virginia where large, ocean-going fishing vessels unload their catches (McCay and Cieri 2000). Also in Accomack County, south of Wallops Island, Wachapreague is an active commercial fishing port. Current landings data are not available. In 1998, 900,910 pounds (408,653 kilograms) of food and bait fish were landed in Chincoteague and 173,012 pounds (78,478 kilograms) were landed in Wachapreague; 1.1 percent and 0.2 percent, respectively, of the total landings in Virginia in that year (McCay and Cieri 2000).

The dollar values of the landings averaged more than $162 million over the five-year period. Total values ranged from a low of about $138 million in 2007 and climbed steadily to a high approaching $192 million in 2011 (Tables 3.5-8 and 3.5-9). In each of the five years, over two-thirds of the commercial value for the Virginia marine fishery was shellfish, primarily sea scallop, blue crab, and northern quahog clam (U.S. Department of Commerce 2013b). Sea scallops alone represented 42.0 percent of the commercial value of the fishery over the five-year period. Among finfish, menhaden, Atlantic croaker, summer flounder, and striped bass dominated commercial landings measured by value. These four species comprised approximately 25.1 percent of the commercial value of the fishery, with menhaden alone representing 16.9 percent.

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Table 3.5-9: Value of Virginia Commercial Landings 2007-2011

Year	Finfish		Shellfish		Total
	Dollars	% of Total	Dollars	% of Total	Dollars
2007	45,658,583	33.1	92,334,290	66.9	137,992,873
2008	40,465,676	27.6	106,145,415	72.4	146,611,091
2009	47,350,739	31.1	104,670,965	68.9	152,021,704
2010	55,809,821	30.3	128,084,088	69.7	183,893,909
2011	58,677,051	30.6	132,987,683	69.4	191,664,734
5-year Average	49,592,374	30.5	112,844,488	69.5	162,436,862
Source: U.S. Department of Commerce 2013b.					

Commercial Fishing – Economy

In 2009, the seafood industry generated 19,064 jobs in Virginia (U.S. Department of Commerce 2011). Virginia's seafood industry generated approximately $1.74 billion in sales, $482 million in income, and $722 million in value added in 2009. Table 3.5-10 summarizes the employment impacts of the seafood industry in Virginia for 2009. The sector that generated the greatest employment impacts in Virginia was the retail sector with nearly one-half of the total seafood industry jobs and over one-third of the income. The harvest sector generated approximately 19,000 jobs and $482 million in income, or about 22.0 percent of the seafood industry jobs and 18.1 percent of the industry income.

Table 3.5-10: Employment Impacts of Virginia's Seafood Industry 2009

Employment Sector	Jobs		Income	
	Number	Percent	Thousand Dollars	Percent
Total Impacts	19,064	100.0	482,440	100.0
Commercial Harvesters	4,199	22.0	87,158	18.1
Seafood Processors and Dealers	1,402	7.4	48,265	10.0
Importers	3,083	16.2	135,914	28.2
Seafood Wholesalers and Distributors	1,020	5.4	43,196	9.0
Retail	9,361	49.1	167,907	34.8
Source: U.S. Department of Commerce 2011.				

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Recreational Fishing – Landings

The Marine Recreational Fishery Statistics Survey, conducted by the NMFS, provides estimates of fishing effort, catch, and participation by recreational anglers in the marine waters of the United States by state. There are no data available by port for recreational fisheries. Table 3.5-11 presents the recreational fishery landings for Virginia state waters – i.e., the inshore saltwater and brackish water bodies combined with the state territorial sea, a zone extending seaward 3 nautical miles from shore.

Table 3.5-11: Virginia Recreational Landings in State Waters 2007-2011

Year	Fish Landed	Pounds Landed	Kilograms Landed
2007	37,030,273	15,240,023	6,912,829
2008	32,592,604	13,052,512	5,920,580
2009	25,875,387	10,319,854	4,681,055
2010	19,991,234	7,010,594	3,179,985
2011	21,024,497	6,878,873	3,120,236
5-year Average	27,302,799	10,500,371	4,762,937
Source: U.S. Department of Commerce 2013c.			

Marine recreational landings for Virginia state waters averaged approximately 27.3 million fish and 10.5 million pounds (4.8 million kilograms) during the five years from 2007 through 2011. Measured both by number of fish and by weight, recreational landings declined during the period. The peak annual recreational landings figure was over 37.0 million fish and over 15.2 million pounds (6.9 million kilograms) in 2007. Landings were at a low in 2011, at about 21.0 million fish and 6.9 million pounds (3.1 million kilograms).

For the 2007-2011 period, the most commonly caught species (in numbers of fish) in Virginia marine waters were Atlantic croaker, spot, summer flounder, and black sea bass, together comprising approximately 80.1 percent of the fish landed (U.S. Department of Commerce 2013c). The largest harvests by weight were Atlantic croaker, spot, striped bass, and summer flounder, totaling nearly 75.8 percent of the landings between 2007 and 2011. Atlantic croaker alone represented 45.6 percent of the total landings by number of fish and 36.5 percent by weight.

Recreational Fishing – Effort and Economy

From 2007 through 2011, an average of about 3.1 million fishing trips were taken each year by individual marine recreational anglers fishing in the state waters along the coast of Virginia, as shown in Table 3.5-12. These angler trips contribute to the local economy through purchases of boats, bait, and tackle and from fees for fishing piers, jetties, charter boats, and boat rentals. After peaking at nearly 3.5 million trips in 2008, overall the number of angler trips declined during the subsequent years.

The average estimated number of participants in recreational fishing in marine fishing areas in Virginia, including both state waters and federal waters, was approximately 873,000 persons. About 8.5 percent of the total participants were residents of non-coastal counties in Virginia –

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i.e., counties within the state but not in the defined coastal zone – and 35.3 percent of the participants were from other states or countries.

Table 3.5-12: Virginia Recreational Effort and Participation 2007-2011

Year	Angler Trips in State Waters	Participants in State and Federal Waters				
		Non-Coastal Number	Percent of Total	Out-of-State Number	Percent of Total	Total Number
2007	3,434,632	75,930	9.1	296,858	35.5	836,063
2008	3,455,006	89,325	10.0	337,831	37.9	891,349
2009	3,008,625	87,013	9.6	305,362	33.7	907,422
2010	2,552,365	62,883	7.5	279,313	33.3	838,265
2011	2,840,404	55,645	6.2	320,447	35.9	892,347
5-year Average	3,058,206	74,159	8.5	307,962	35.3	873,089
Source: U.S. Department of Commerce 2013c.						

The U.S. Department of Commerce (2011) reported the economic impacts for 2009 of recreational fishing activities in Virginia. The economic impacts were generated by expenditures on recreational fishing trips taken by anglers – private or rental boat, for-hire boat, or shore-based trips (e.g., fishing from a pier or a beach) – and expenditures on durable equipment. In 2009, 5,167 jobs were generated by recreational fishing activities in Virginia, with 1,906 (36.9 percent) of those jobs generated by expenditures on recreational fishing trips. Total fishing trip and durable equipment expenditures in Virginia in 2009 were approximately $623.5 million.

The Marine Recreational Fishery Statistics Survey provides estimates of effort by recreational anglers in the marine waters by county. Table 3.5-13 presents the angler trips for Virginia state waters and the federal exclusive economic zone – i.e., a zone extending seaward from the state territorial sea 200 nautical miles from shore – combined. The average estimated number of angler trips in marine fishing areas for Accomack County, including both state waters and federal waters, was approximately 376,000 trips. About 84 percent of the total trips were angler trips on boats and 16 percent were from shore. For each year from 2007 through 2011, the number of angler trips in marine fishing areas for Accomack County peaked during July and August, which accounted for an average of 37 percent of the annual trips over the five years (Dolinger Few 2013).

Organized fishing tournaments, targeting a single species or multiple species, are popular along the Virginia coast. Fishing tournaments occur throughout the year, but most are held in June, July, and August.

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Table 3.5-13: Accomack County Angler Trips 2007-2011

Year	Boat	Shore	Total
2007	318,379	38,279	356,659
2008	265,663	156,719	422,382
2009	374,994	25,600	400,594
2010	270,243	19,457	289,700
2011	355,423	55,438	410,861
5-year Average	316,941	59,099	376,039
Source: Dolinger Few 2013.			

3.5.1.6 Environmental Justice

Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, dated 11 February 1994, requires that federal agencies take appropriate and necessary steps, to the greatest extent practicable and permitted by law, to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations. The general purposes of the EO are to 1) focus the attention of federal agencies on the human health and environmental conditions in minority communities and low-income communities with the goal of achieving environmental justice; 2) foster nondiscrimination in federal programs that substantially affect human health or the environment; and 3) give minority communities and low-income communities greater opportunities for public participation in and access to, public information on matters relating to human health and the environment. Environmental justice mandates that no minority or low-income population group shall bear a disproportionate share of potential adverse environmental impacts resulting from a major federal action. EO 12898 directs federal agencies to develop environmental justice strategies. NASA has developed an Environmental Justice Implementation Plan and WFF an Environmental Justice Plan to comply with EO 12898.

Minority and Low-Income Populations

This section identifies minority or low-income populations that could be affected by the Proposed Action. For the purpose of this evaluation, minority refers to people who identified themselves in the Census as Black or African American, Asian, or Pacific Islander, American Indian or Alaskan Native, other non-White races, or as being of Hispanic or Latino origin. Persons of Hispanic and Latino origin may be of any race (Executive Office of the President 1997). The Council on Environmental Quality identifies these groups as minority populations when either 1) the minority population of the affected area exceeds 50 percent or 2) the minority population percentage in the affected area is meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis. While not defined by the Council on Environmental Quality, the term “meaningfully greater” has been interpreted to mean 20 percent greater than the geographic region of comparison (most often the state of which the affected area is part). The geographical unit for comparison in this analysis is the Commonwealth of Virginia.

The U.S. Census Bureau determines poverty status by using a set of dollar-value thresholds that vary by family size and composition (U.S. Census Bureau 2013, Glossary). If a family’s total

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income is less than the dollar value of the appropriate threshold, then that family and every individual in it are considered to be in poverty. Similarly, if an unrelated individual's total income is less than the appropriate threshold, then that individual is considered to be in poverty. The poverty thresholds do not vary geographically. They are updated annually to allow for changes in the cost of living (inflation factor) using the Consumer Price Index.

For the analysis of environmental justice, the study area encompasses the population in the four Accomack County census tracts that surround Wallops Island: Census Tracts 901, 902, 903, and 904.

In the Census, Hispanic origin is viewed as the heritage, nationality group, lineage, or country of birth of the person or the person's parents or ancestors before their arrival in the United States. People who identify their origin as Spanish, Hispanic, or Latino may be of any race. Consequently, for this analysis the minority population was compiled using the sum of the Hispanic population (of any race) plus the non-Hispanic populations of Black or African Americans, Native Americans and Alaskan Natives, Asians, Hawaiian and Pacific Islanders, some other race, and two or more races – i.e., White non-Hispanic populations are excluded from the minority count. For environmental justice analysis, the minority population is the aggregation of all minority persons.

Census data on the 2010 racial and ethnic composition of the study area are summarized in Table 3.5-14. The percentage of minorities in Census Tract 902 and Census Tract 904 were the highest in the study area. Census Tract 904 exceeds the rates for Accomack County and Virginia. As the total minority population in Census Tract 904 exceeds 50 percent and is meaningfully greater than the minority population of Virginia, it is a minority community according to the Council on Environmental Quality definition.

Table 3.5-14: Percentage Race and Ethnicity 2010

Geographic Area	Hispanic or Latino Origin	Not Hispanic or Latino Origin						Total Minority
		Black/ African American	American Indian/ Alaska Native	Asian	Native Hawaiian/ Other Pacific Islander	Other Race	Two or More Races	
Census Tract 901	1.7	0.7	0.3	0.6	0.0	0.1	2.7	6.0
Census Tract 902	2.9	30.8	0.4	0.6	0.2	0.1	1.7	36.7
Census Tract 903	6.5	18.9	0.1	0.4	0.1	0.4	2.1	28.5
Census Tract 904	23.8	37.0	0.2	0.4	0.1	0.2	0.9	62.6
Accomack County	8.6	27.9	0.3	0.5	0.1	0.1	1.3	38.9
Commonwealth of Virginia	7.9	19.0	0.3	5.5	0.1	0.2	2.3	35.2

Notes: Numbers may not total exactly due to rounding.
Source: U.S. Census Bureau 2013, DP-1 Profile of General Population and Housing Characteristics 2010.

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Table 3.5-15 presents the 2007-2011 American Community Survey five-year estimates for families and individuals in the study area whose annual income in the past 12 months was below the poverty level. The percentage of low-income families in Census Tract 903 is by far the highest in the study area. With the exception of Census Tract 903, the tracts have percentages of low-income families lower than in Accomack County overall. However, the study area census tracts, with the exception of Census Tract 904, and Accomack County have higher percentages of low income families than Virginia. Census Tract 903 has a higher percentage of low-income individuals than in Accomack County. All four census tracts have higher percentages of low-income individuals than Virginia. The low-income populations in the four census tracts—Census Tracts 901, 902, 903, and 904 – are meaningfully greater (20 percent greater) than the low-income population of Virginia; therefore, environmental justice will be assessed for low-income populations in these census tracts.

Table 3.5-15: Percentage Below Poverty Level 2007-2011

Geographic Area	Families Below Poverty Level	Individuals Below Poverty Level
Census Tract 901	8.9	18.4
Census Tract 902	8.1	17.0
Census Tract 903	18.3	21.4
Census Tract 904	7.4	13.2
Accomack County	10.5	18.7
Commonwealth of Virginia	7.5	10.7
Source: U.S. Census Bureau 2013, DP03, Selected Economic Characteristics, 2011 American Community Survey 5-year Estimates.		

3.5.1.7 Protection of Children

EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, was signed on 21 April 1997. Because the scientific community recognized that children may suffer disproportionately from environmental health and safety risks, each federal agency is directed to identify and assess such risks, and consequently to ensure that its policies, programs, activities, and standards address effects on children. Children may suffer disproportionately more environmental health and safety risks than adults because of various factors: children's neurological, digestive, immunological, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults; children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves; and children's size and weight may diminish the protection they receive from standard safety features. "Environmental health and safety risks" are defined as "risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest." Covered regulatory actions that are affected by this EO are those substantive actions that concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children.

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Children Under 18 Populations

This Section identifies populations under the age of 18 in the study area. As shown in Table 3.5-16, in 2010, Census Tracts 903 and 904 had a higher percentage of the population under 18 than Accomack County. Although Census Tract 904 had a greater percentage of the population under 18 than Virginia, it is not meaningfully greater.

No schools, daycare centers, or camps are located near Pad 5 on Wallops Island. A private campground, Chincoteague Bay Trails End Campground, is located 7.3 miles (11.7 kilometers) to the north of Pad 5, in Horntown. A daycare center, Emma's World Daycare, is located 5.2 miles (8.4 kilometers) northwest of Pad 5 and approximately 1,500 feet (460 meters) from the fence line at the Main Base. The closest schools are Arcadia High School, located approximately 6.7 miles (10.7 kilometers) northwest of Pad 5 in Oak Hall, and Kegotank Elementary School, located 5.2 miles (8.4 kilometers) to the west in Mappsville.

Table 3.5-16: Percentage Children 2010

Geographic Area	Percentage Under Age 18
Census Tract 901	15.4
Census Tract 902	20.0
Census Tract 903	22.3
Census Tract 904	24.5
Accomack County	20.9
Commonwealth of Virginia	23.2
Source: U.S. Census Bureau 2013, DP-1 Profile of General Population and Housing Characteristics 2010.	

3.5.2 Environmental Consequences

The primary focuses for the socioeconomic analysis are related to the short-term influx of personnel that would arrive during construction/demolition activities and during HVP tests, and to the activation of R-6604A, the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet, and W-386 during tests (Figure 1-3).

3.5.2.1 No Action Alternative

Under the No Action Alternative, there would be no testing of HVPs using the powder gun or railgun and operational missions and activities would remain at current levels. All operational missions and activities under the No Action Alternative have been covered by previous NEPA documents; therefore, there would be no impact to population, employment and income, housing, maritime transport and recreational boating, commercial and recreational fishing, or environmental justice.

3.5.2.2 Pad 5 Alternative (Preferred Alternative)

Construction and HVP and EM railgun testing activities may benefit the local economies. Construction activities may increase employment opportunities for the construction workforce

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and increase revenues for local businesses and government generated from construction activities and workers. However, any increase would be temporary, lasting only as long as the construction. Construction on the powder gun and railgun sites would occur over approximately six months.

HVP tests would occur year-round at WFF. A test using the powder gun would require a minimum of 8 to 11 personnel, depending on the test objectives. A test using the railgun would require a minimum of 12 to 15 personnel. The HVP/EM railgun program personnel would be at WFF for about five days per test event. While at WFF, the personnel would stay in Navy lodging at the facility, when available, or in motels in the Town of Chincoteague, where they would purchase food, supplies, and lodging. The Town of Chincoteague has an adequate supply of restaurants and lodging accommodations to meet the anticipated needs of the program personnel.

Table 3.5-17 shows the estimates for lodging, meals, and incidentals, based on the fiscal year 2014 per diem rates for Wallops Island, over the five years of the proposed program, assuming 10 personnel per test event and all personnel stay in Chincoteague. As the actual number of personnel would vary between test events and over the duration of the program, and as some personnel likely would stay in Navy lodging during some test events, the values shown in the table are intended only to illustrate the approximate scale of the expenditures in the local economy.

Table 3.5-17: Estimated Lodging, Meals, and Incidental Expenses by Year for 10 Personnel

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Test Events	10	10.4	15	15	25
Days in Chincoteague	50	52	75	75	125
Lodging ($)	47,750	49,660	71,625	71,625	119,375
Meals and Incidentals ($)	28,000	29,120	42,000	42,000	70,000
Total Expenses ($)	75,750	78,780	113,625	113,625	189,375
Source: U.S. General Services Administration 2014.					

As discussed in Section 3.2.2.2, the firing of HVPs would increase activation of portions or the entirety of the Atlantic Ocean Danger Zone around Wallops Island and Chincoteague Inlet. The flight safety plans, developed by the WFF Range Safety Officer for each HVP test, would establish a hazard area and, as needed, a caution area for each projectile. To support HVP testing, WFF would restrict vessel movements near Wallops Island for several hours and, if required, would stop vessel movement through Chincoteague Inlet typically for 30 to 60 minutes per projectile firing. Based on a median value of 45 minutes per firing, vessel movements through the inlet could be restricted approximately 80 hours annually in the first and second years, approximately 110 hours annually in the third and fourth years, and approximately 190 hours annually in the fifth year. WFF may allow passage through the hazard area and through Chincoteague Inlet during gaps between firings, providing the gaps are of sufficient duration to allow safe transit across the area.

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The following factors would contribute to minimizing the effects of increased activation of the danger zone on maritime transport and recreational boating, and on commercial and recreational fishing:

- NASA works with the public and adjusts the azimuth of the firing to avoid major boating corridors and fishing areas.
- Information on the time and duration of each test would be made available in advance through flyers and notices to mariners over maritime frequency radio and on the WFF website. Boaters and fishermen in the area are familiar with WFF's range restrictions and are aware that they might need to shift the timing and location of their activities.
- Gun firing would be intermittent and would include long periods during which vessels may be allowed to pass under controlled conditions through the hazard area and through Chincoteague Inlet.
- Activation of only parts of the danger zone would allow vessels to move freely in and commercial and sports fishermen to relocate to the unrestricted part, outside the hazard area and caution area.
- The Navy generally would schedule testing to occur on weekdays, whereas pleasure boating and recreational fishing are predominantly weekend activities, and would avoid scheduling testing during organized fishing tournaments.

Significant impacts to environmental justice populations would occur if there were increased, disproportionately high, and/or adverse risks for any minority or low-income populations. The environmental justice analysis focuses on noise impacts associated with the Proposed Action's gun firing since they have the potential to disproportionately affect the minority and low-income populations identified above.

In order to analyze the potential for disproportionate impacts to environmental justice populations, the estimated population within noise contours greater than 115 dB was analyzed. As discussed in Section 3.3.2, based on Army guidelines, a predicted sound level of 115 dB is considered to have a low risk of noise complaints, 115-130 dB has a medium risk, 130-140 dB has a high risk, and over 140 dB there is a risk of physiological damage to unprotected human ears and structural damage claims.

Based on the peak blast noise levels from powder gun firing, predicted using the BNOISE2 model, noise contour areas at or greater than 115 dBP are mainly within WFF. In only one scenario, shown in Figure 3.3-1, the 115 dBP contour crosses the most southern part of Assateague Island National Seashore/Chincoteague National Wildlife Refuge. The 115-130 dBP noise level area would not affect the minority population in Census Tract 904 or the low-income populations in Census Tracts 901, 902, 903, and 904. The predicted railgun peak noise, including the extent of the 115 dBP noise contour, is lower than powder gun noise. Therefore, railgun firing likewise is unlikely to affect the minority population or the low-income populations in the environmental justice study area.

Implementation of the Pad 5 Alternative would comply fully with EO 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations, and EO 13045, Protection of Children from Environmental Health Risks and Safety Risks. The alternative would have no disproportionately high and adverse human health or environmental effects on minority

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populations and low-income populations, and would not pose disproportionate environmental health or safety risks to children.

Based on the annual number of shots and the preceding analysis, testing of HVPs with the powder gun and EM railgun would have no significant socioeconomic impacts under the Pad 5 Alternative.

3.5.2.3 Pad 4 Alternative

The testing performed under the Pad 4 Alternative would be identical to those under the Pad 5 Alternative, except testing would be located about 1,020 feet (310 meters) south of Pad 5. The difference in location would have no impact on socioeconomic conditions, as the benefits to the local economies and the need to activate the Atlantic Ocean danger zone around Wallops Island and Chincoteague Inlet would be identical. Therefore, testing of HVPs with the powder gun and EM railgun would have no significant socioeconomic impacts under the Pad 4 Alternative.

3.5.2.4 Elevated Road Alternative

The testing performed under the Elevated Road Alternative would be identical to those under the Pad 5 Alternative, except testing would be located about 280 feet (85 meters) north of the Pad 5. The difference in location would have no impact on socioeconomic conditions, as the benefits to the local economies and the need to activate the Atlantic Ocean danger zone around Wallops Island and Chincoteague Inlet would be identical. Therefore, testing of HVPs with the powder gun and EM railgun would have no significant socioeconomics impacts under the Elevated Road Alternative.

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3.6 Cultural Resources

Cultural resources include prehistoric or historic sites, buildings, structures, objects, or other physical evidence of human activity that are considered important to a culture or community for scientific, traditional, or religious reasons.

Section 106 of the National Historic Preservation Act of 1966, as amended, and as implemented by 36 C.F.R. § 800, requires federal agencies to consider the effects of their actions on historic properties before undertaking a project. A historic property is defined as any cultural resource that is included in, or eligible for inclusion in, the National Register of Historic Places (hereafter, National Register). For actions that may impact historic properties, federal agencies are required to initiate consultation with the State Historic Preservation Officer (SHPO) informing them of the planned action and requesting their submittal of any comments or concerns. The Navy is consulting with the Virginia Department of Historic Resources, the designated SHPO for Virginia, to identify and mitigate, if necessary, impacts on historic resources that may result from the implementation of the Proposed Action.

3.6.1 Areas of Potential Effects (APEs)

The Proposed Action evaluated in this EA has the potential to directly and indirectly affect historic properties protected under Section 106. With regard to potential direct effects, installation of the guns would involve ground-disturbing activities that may affect archaeological resources if any are present within the disturbance footprint. During the operation phase, the firing of the guns would cause expended materials – sabots, pusher plates, and armatures – to fall into the waters off WFF, potentially affecting underwater shipwrecks if any are present within the impact area. With regard to indirect effects, the operation of the guns would generate noise that may detract from the setting of nearby historic properties; additionally, noise vibrations above a certain threshold may affect the structural integrity of architectural resources.

Based on the character of the potential direct and indirect effects of the Proposed Action on historic properties, two areas of potential effects (APEs) were defined: a Landside APE and a Waterside APE (Figure 3.6-1). The Landside APE includes land within the 115 dBP contour as shown in Figure 3.3-1. The 115 dBP contour was selected because, as shown in Table 3.3-1, this is the level above which the risk of noise complaints is considered medium as opposed to low. The 115 dBP contour additionally encompasses the disturbance footprints of the guns and the 134 dBP level above which some damage may occur to high-risk buildings (i.e., buildings with poorly fitted loose window glass and/or walls already under stress through structural settling, deterioration, age, or earlier damage, see Table 3.3-2)/ Note that Figure 3.6-1 shows the 130 dBP contour because the 134 dBP contour was not modeled for this EA; land outside the 130 dBP contour is also outside the smaller 134 dBP contour. Therefore, the Landside APE comprises all land areas within which direct and indirect effects might occur.

The Waterside APE includes the sabot petal impact area and the pusher plate and armature impact area as shown in Figure 2-4. These are the areas where debris from the projectiles would fall and might potentially hit submerged shipwrecks. While projectiles would eventually hit the water within the offshore firing area (see Figure 2-4), the size and depth of this area make the risk of damage to a wreck so low as to be negligible.

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3.6.2 Historic Properties within the APEs

3.6.2.1 Historic Architectural Resources

A comprehensive architectural survey and National Register eligibility evaluation of WFF was conducted in 2004 (NASA 2004). The study consisted of a reconnaissance level architectural survey of 124 buildings, structures, and objects at WFF built before 1956, as well as a historic context of the facility. In consultation with the Virginia SHPO, it was determined that there are no National Register-eligible historic districts within WFF and that two of the 124 resources surveyed were eligible for listing in the National Register (NASA 2004). A supplemental historic context study and comprehensive architectural survey of 76 buildings and structures with dates of construction between 1956 and 1965 were completed for WFF in 2011 (NASA 2011). In consultation with the Virginia SHPO, it was determined that there are no eligible historic districts within WFF and that the 76 buildings and structures evaluated in the report are not individually eligible for listing on the National Register.

The only resources eligible for listing on the National Register are a Coast Guard Station (Department of Historic Resources #01-0027-0100) and associated tower (Department of Historic Resources #001-0027-0101) located on the inland side of Wallops Island. U.S. Coast Guard stations on Wallops Island date to 1883. Following the destruction of a station in a hurricane in 1933, the Wallops Beach Lifesaving Station and the associated steel frame observation tower were completed in 1936 and remained in operation until the station's decommissioning in 1947. The 2004 architectural survey concluded that the Station is eligible for listing on the National Register and the Virginia Landmarks Register, and that the associated tower is a contributing structure of the station. The Virginia SHPO subsequently concurred with this finding (NASA 2011). These resources are located just inside the Landside APE and well outside the 130 dBP and, therefore, the 134 dBP, noise contours.

3.6.2.2 Archaeological Resources

Eight archaeological sites have been identified at WFF. None is within or near the ground-disturbance area associated with this Proposed Action.

In 2003 WFF completed a Cultural Resources Assessment. The assessment included background research and field reconnaissance involving assessing land forms for their archaeological potential. The study established a predictive model for understanding the archaeological potential at WFF, with areas of high, moderate, and low potential. Areas that contain moderate and high archaeological sensitivity were found to be located for the most part along the fringes of WFF. Prior ground disturbances limit the archaeological potential of many parts of WFF. Causes of these disturbances include past erosion by the wind and sea on Wallops Island, as well as construction, demolition, and landscaping for mission-driven improvements in all parts of the facility. The sites being considered for the proposed powder gun and EM rail gun are within areas mapped as having low potential for unknown archaeological resources (Appendix E of the *Final Site-Wide Environmental Assessment, Wallops Flight Facility* [NASA 2005]).

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Areas of Potential Effects

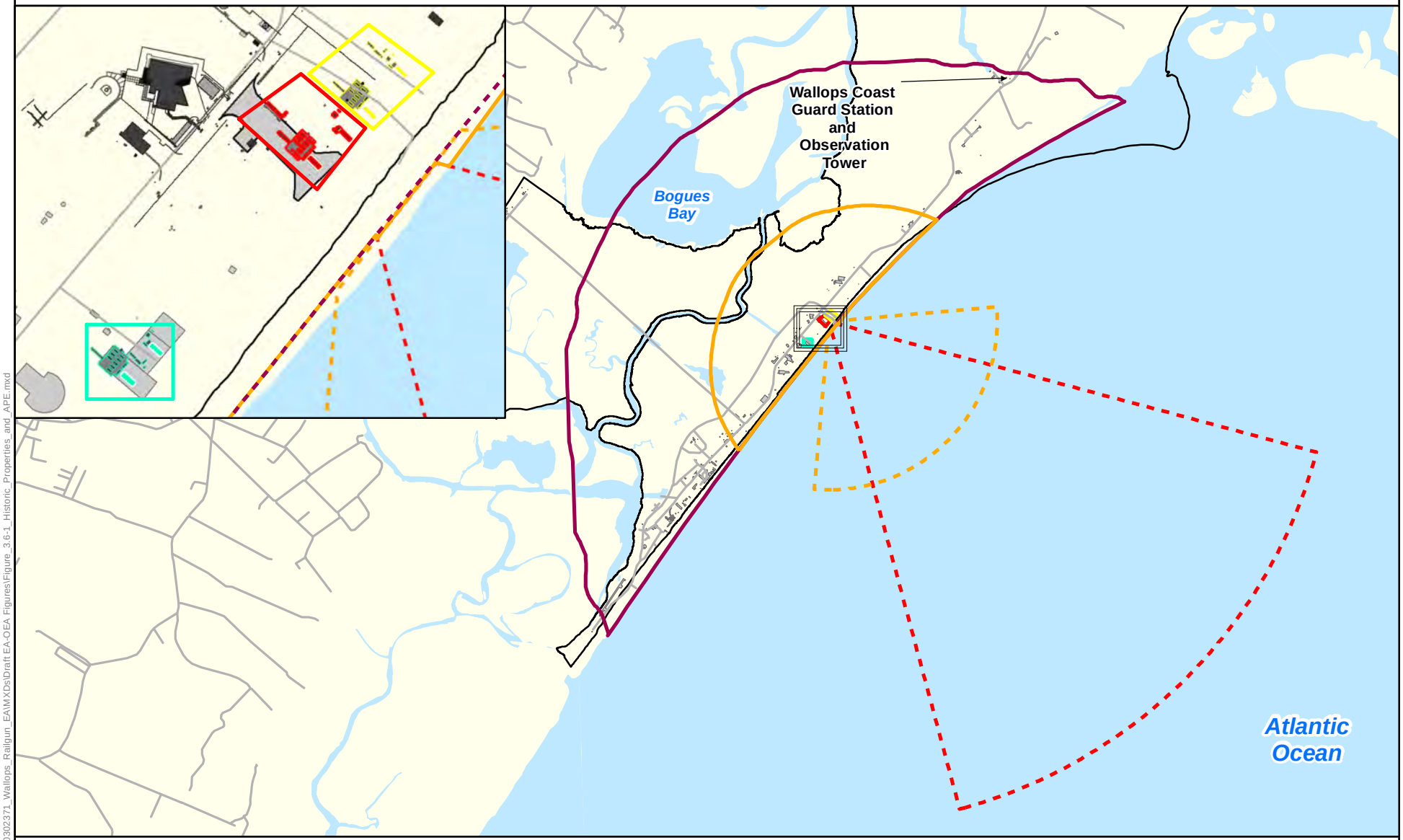

Figure 3.6-1

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3.6.2.3 Submerged Resources

Based on a review of data from the National Oceanographic and Atmospheric Administration's Automated Wreck and Obstruction Information System (NOAA 2014), there are no documented shipwrecks within the Waterside APE.

3.6.3 Environmental Consequences

3.6.3.1 No Action Alternative

Under the No Action Alternative, there would be no change to current conditions. This would have no effect on National Register-eligible resources under Section 106 and no impact to cultural resources under NEPA.

3.6.3.2 Pad 5 Alternative (Preferred Alternative)

Landside APE

Architectural Resources

Installation of the 5" powder gun and the EM railgun under the Preferred Alternative has no potential to directly affect the National Register-eligible Coast Guard Station and associated tower, which are located about 2 miles (3.2 kilometers) from the Pad 5 site.

Operation of the guns is not anticipated to affect these resources either. The resources are located just inside the 115 dBP contour. Noise levels at or above 115 dBP have medium potential to generate noise complaints (Table 3.3-1). However, the Coast Guard Station and associated tower are uninhabited structures that are not open to the public. Occasionally elevated noise levels would not affect the characteristics that make these resources eligible for the National Register. As can be seen on Figure 3.6-1, the resources are also outside the 130 dBP contour and are therefore well outside the 134 dBP contour, which is the threshold at which potential indirect effects from air-borne vibrations become possible for especially fragile structures. Effects from ground-borne vibration are not anticipated either, as these become less important than air-borne vibrations beyond 500 feet for the type of detonation than would occur under the Proposed Action (Siskind 1989). As noted above, the Coast Guard Station and associated tower are located about 2 miles (3.2 kilometers) from the Pad 5 site.

Based on the above, the Preferred Alternative would result in no effects to historic architectural properties within the Landside APE under Section 106 and no impacts under NEPA.

Archaeological Resources

The only ground-disturbing activities under the Preferred Alternative would occur within an area mapped as low-probability for unknown archaeological resources. In case of inadvertent discovery of archaeological artifacts during construction, the NASA WFF Historic Preservation Officer would be notified. In cooperation with the Navy, the NASA Historic Preservation Officer would consult with the Virginia SHPO to assess the significance of the newly discovered resource, the potential effects on it, and appropriate mitigation measures (if necessary) to preserve its integrity.

Based on the above, the Preferred Alternative would result in no effects to historic archaeological properties within the Landside APE under Section 106 and no impacts on cultural

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resources under NEPA. The Virginia SHPO concurred with the determination that the Preferred Alternative would have no effects on historic properties and no impact on cultural resources under NEPA (Appendix C).

Waterside APE

As noted in Section 3.6.2.3, based on data from the Automated Wreck and Obstruction Information System (NOAA 2014), there are no shipwrecks within the Waterside APE. It is possible that unknown or undocumented submerged resources are present. However, such resources, if any are present, would be few and widely scattered. While it is possible that expended materials such as sabots, pusher plates, and armatures could hit a shipwreck of cultural interest, the likelihood of such a strike is very small. Additionally, the velocity of the expended materials would rapidly decrease upon contact with the water and as they travel through the water column, making substantial damage unlikely, even in the case of a direct strike.

On this basis, the risk of adverse effect to submerged resources may be considered negligible. Thus, the Preferred Alternative would result in no effect to resources under Section 106 and no impact on cultural resources under NEPA. The Virginia SHPO concurred that the effects of the proposed action on submerged resources would be negligible (Appendix C).

3.6.3.3 Pad 4 Alternative

Under the Pad 4 Alternative, the 5" powder gun and the EM rail gun would be installed on a site located about 1,020 feet (310 meters) to the south of the Pad 2 site, farther away from the National Register-eligible Coast Guard Station and associated tower than under the Preferred Alternative. Operations would be the same as under the Preferred Alternative. The Pad 4 site, like the Pad 5 site, is within an area mapped as having low archaeological potential.

Therefore, the analyses presented in Section 3.6.3.2 for the Preferred Alternative also apply to the Pad 4 Alternative. For the reasons stated in Section 3.6.3.2, the Pad 4 Alternative would have no effect on historic properties under Section 106 and no impact on cultural resources under NEPA. The Virginia SHPO concurred with the determination that the Pad 4 Alternative would have no effects on historic properties and no impact on cultural resources under NEPA (Appendix C).

3.6.3.4 Elevated Road Alternative

Under the Elevated Road Alternative, the 5" powder gun and the EM rail gun would be installed on a site located about 280 feet (85 meters) north of the Pad 5 site. While this would be slightly closer to the National Register-eligible Coast Guard Station and associated tower than under the Preferred Alternative, the distance remains sufficient to prevent any direct impacts from the construction or any indirect impacts from operation of the guns. The Coast Guard Station and associated tower are located a little under 2 miles (3.2 kilometers) feet from the Elevated Road site, outside the 130 dBP and 134 dBP contours, as well as beyond the 500 feet beyond which ground-borne vibrations become less important than air-borne ones. Operations would be the same as under the Preferred Alternative. The Elevated Road site, like the Pad 5 site, is within an area mapped as having low archaeological potential.

Therefore, the analyses presented in Section 3.6.3.2 for the Preferred Alternative also apply to the Elevated Road Alternative. For the reasons stated in Section 3.6.3.2, the Elevated Road Alternative would have no effect on historic properties under Section 106 and no impact on

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cultural resources under NEPA. The Virginia SHPO concurred with the determination that the Elevated Road Alternative would have no effects on historic properties and no impact on cultural resources under NEPA (Appendix C).

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3.7 Health and Safety

3.7.1 Affected Environment

3.7.1.1 Hazardous Materials, Toxic Substances, and Hazardous Waste

Hazardous materials, toxic substances, and hazardous waste used on WFF are regulated by the USEPA and the Virginia Department of Environmental Quality under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Toxic Substances Control Act, and the Clean Air Act. Construction activities and project operations can generate hazardous waste, and construction sites can generate hazardous materials or waste or disturb past hazardous waste sites.

The WFF *Integrated Contingency Plan* serves as the facility's primary guidance document for the prevention and management of oil, hazardous material, and hazardous waste releases (NASA 2013c). The guidance in the plan minimizes hazards to human health and the environment from any accidental release of oil or hazardous substance to the air, soil, surface water, storm water, or sanitary sewer system at WFF. WFF Mainland/Wallops Island has its own USEPA hazardous waste generator number (VA7800020888) and is classified as a large quantity generator, meaning that it can generate more than 2,205 pounds (1,000 kilograms) of hazardous waste per month. Typical Wallops Island hazardous waste generated includes rags containing lead or petroleum byproducts, crushed fluorescent bulbs, acetic acid, jet fuel from maintenance activities, chemicals associated with tank cleaning, paint, and paint thinners (NASA 2014).

NASA's Environmental Office carries out the WFF Environmental Compliance and Restoration Program and is responsible for the planning, implementation, and oversight of past site activities to ensure the protection of human health and the environment. Beginning in 1988, a series of facility-wide surveys, assessments, and inspections of existing and past hazardous materials and waste sites performed by NASA under the oversight of USEPA and the Virginia Department of Environmental Quality identified 25 Areas of Concern that may pose a risk to human health or the environment. NASA has coordinated activities at these 25 Areas of Concern with USEPA and the Virginia Department of Environmental Quality and has taken actions to address potential risks, on a priority basis, under the appropriate environmental and regulatory programs. Actions conducted at the Areas of Concern include supplemental investigations, sampling programs, removals, product recovery, remedial investigations, feasibility studies, remediation, and closeout (NASA 2014).

3.7.1.2 Health and Safety

The WFF Safety Office plans, develops, and provides functional management of policies and procedures for safety and establishes and approves safety precautions for the protection of the public, NASA personnel, contractors, and civilians. The Safety Office is divided into the Ground Safety and Flight Safety Groups. Ground safety considers potential hazards associated with operations and maintenance activities (e.g., fueling, handling, assembly, and checkout for all prelaunch activities), occupational hazards, and facility security and emergency planning and operations including fire, crash, and rescue. Flight safety considers the risks from potentially hazardous operations such as flight operations, flight trajectory and dispersion,

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and launch failures. All ground and flight safety processes are guided by the *Range Safety Manual for Goddard Space Flight Center/Wallops Flight Facility* (NASA 2008a). Additionally, the *Wallops Flight Facility Wallops Range User Handbook* summarizes policies, procedures, facilities, and services (NASA 2013a).

The Ground Safety Group plans, develops, and implements facility programs and controls for the safety of personnel, protection of property, and reliable operations of facilities. Day-to-day institutional operations and maintenance activities conducted at WFF are performed in accordance with applicable NASA institutional safety and mission assurance programs and controls. Safety controls are established to minimize the potential hazards associated with institutional and workplace activities.

WFF requires all range users to submit formal documentation pertaining to their proposed operations for safety review. Mission-specific Ground Safety Plans addressing all potential ground hazards related to a given mission are prepared by WFF's Ground Safety Group in accordance with the Range Safety Manual (NASA 2008a). The Ground Safety Plan outlines operational management procedures for minimizing risks to human health and the environment. The Ground Safety Plan specifically addresses hazardous materials handling; explosive safety; personal protective equipment; health and safety monitoring; training; and operational security, controls, and procedures.

Risks to human health and safety from flight hazards must be thoroughly assessed, addressed, and managed by the Flight Safety Plan (NASA 2008a). WFF coordinates all operations with the Federal Aviation Authority, Navy, U.S. Coast Guard, and other organizations as required in order to clear potential hazard areas. If necessary, Notices to Mariners and Notices to Airmen are published at least 24 hours prior to an operation. NASA and the U.S. Coast Guard have a Memorandum of Agreement for the U.S. Coast Guard to provide security support for exercises occurring from WFF and in the Virginia Cape Ranges in accordance with 33 C.F.R. § 334.130.

All personnel involved with scientific research programs and facilities follow appropriate safety protocols, including Occupational Safety and Health Administration regulations and training requirements. Activities comply with all applicable federal and state, NASA, WFF, DoD, and Navy occupational safety and environmental regulations.

Procedures for the powder gun and EM railgun would include standard elements such as a risk hazard analysis, safety precautions, and step-by-step procedures. Testing would comply with Naval Ordnance Safety and Security Activity Instruction 8023.11 (Naval Ordnance Safety and Security Activity 2004). Relevant NSWCDD operating procedures for EM railgun operation, such as *Procedures for Operating the Electromagnetic Launch Facility* (CGE-0800-011-10), would also be followed. NASA safety protocols contained in NASA *Procedural Requirements for Occupational Safety and Health* (NASA 2012) and *General Safety Program Requirements* (NASA 2008b) would also be followed. The SCSC Commanding Officer would be the final approval authority for the safety plan and function as the Operations Safety Supervisor.

There are two fire stations at WFF, one on Main Base and one on Wallops Island. Each is manned 24 hours a day by fully trained firefighters and emergency medical technicians. The stations support all normal aircraft activities and generally provide support including hazardous materials, water supply, rescue, and emergency medical service operations to WFF. The Emergency Operations Center is manned at all times and serves as the communications and

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alarm center for all WFF emergency services (NASA 2005). There is also a fully equipped first aid and emergency treatment facility at WFF.

3.7.2 Environmental Consequences

3.7.2.1 No Action Alternative

Under the No Action Alternative, operational missions and activities would remain at current levels and there would be no testing of the powder gun or railgun as described in the Proposed Action. There would be no impact on health and safety or waste management and hazardous materials under the No Action Alternative.

3.7.2.2 Pad 5 Alternative (Preferred Alternative)

Hazardous Materials, Toxic Substances, and Hazardous Waste

No historical or active hazardous material or hazardous waste release sites or abandoned underground storage tank sites have been found within the footprint of the Pad 5 Alternative site shown on Figure 2-7 (NASA 2014).

The testing of the powder gun would involve the use of propellants. Although the majority of the HVPs tested would be inert, some high-explosive variant and kinetic energy dispensing variant projectiles would be tested, particularly as the program moves forward (Table 2-1). An MK99 formulation would be used as a propellant for the powder gun. The primary MK99 constituent is cyclotrimethylenetrinitramine, also known as RDX. The propellant would be almost completely expended – more than 99.99 percent – during firing and would therefore not add measurably to current emissions (see Air Quality, Section 3.4).

SCSC would coordinate and arrange for the disposal of all scrap, hazardous material and trash generated by the Proposed Action (Navy SCSC 2013). An approved hazardous materials storage cabinet would be located in an equipment container next to the gun. Hazardous materials that could be used during testing include gun cleaners (5 gallons [18.9 liters]), mineral spirits (5 gallons [18.9 liters]), hydraulic fluid (<50 gallons [<1890 liters]), grease/moly B (2 gallons [7.6 liters]), and break free (2 gallons [7.6 liters]). Safety Data Sheets for hazardous materials required to conduct this operation would be provided to WFF. In accordance with the WFF Integrated Contingency Plan (NASA 2013c), hydraulic fluid spills shall be contained, recovered, and placed in appropriate container. Contaminated rags shall be placed into an approved receptacle.

Based on the standard operating procedures that would be followed to ensure safe handling of materials and considering ongoing current activities at WFF, there would be no significant impacts on waste management and hazardous materials under the Pad 5 Alternative.

Health and Safety

The testing of the powder gun and railgun involves the use of explosives and EM energy. Activities would comply with all applicable federal, state, NASA, WFF, DoD, and Navy occupational safety and environmental regulations to ensure protection of the public and WFF/NSWCDD personnel. A significant impact would be considered to occur if there is a likelihood of injuries or illnesses to personnel resulting from the Proposed Action.

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Project-specific safety documentation prepared at NASA/WFF and reviewed by the NSWCDD representative would be followed during testing (NASA 2013b). On-site safety support would be provided by NASA/WFF representatives for both ground and flight safety (NASA 2013b). The appropriate health and safety-related documents would be developed for the project including Mission Operations Directive; Ground Safety Plan; Flight Safety Plan; and documentation that all reviews and associated actions are satisfactorily closed. Approval from the Suborbital and Special Orbital Projects Directorate (Code 800) would also be obtained prior to testing.

To operate the powder gun and railgun, NSWCDD would provide trained gun crews and Safety Standard Operating Procedures for all gun operations, ammunition handling, and control of activities inside explosive safety arcs (Navy SCSC 2013).

According to the Navy (OPNAVINST 5100.23G), activities shall consider personnel at risk if exposed to impact or impulse noises of 140 dB peak noise. The Occupational Safety and Health General Industry Standard, 29 C.F.R. 1910.95 also specifies that impulse or impact noise should not exceed 140 dB without adequate hearing protection devices.

Noise generated by powder gun and railgun firing are described in Section 3.3. A noise attenuation study was performed to determine whether the envelopes (insulated metal panels and wall systems) of the nearby occupied buildings (V-3, V-10, V-20,and V-21 as shown in Figure 2-6) are sufficient to reduce sound pressure levels associated with firing to 140dB or lower (EI Group, 2014). The study found that the building skins provide transmission loss values so that the maximum peak noise would range between 110 to 125 dB at Building V-3 and between 92 to 117 dB at Buildings V-10, 20, and 21. At no time would the 140 dB level be exceeded, allowing personnel to remain in the buildings without hearing protection during firing.

Standard operating procedures would be followed for each EM railgun operation. These procedures identify and incorporate safe operating parameters with respect to hazards of electromagnetic radiation to personnel, hazards of electromagnetic radiation to ordnance, hazards of electromagnetic radiation to fuel, and electromagnetic interference with electronic equipment. Specific NSWCDD policies for EM emissions control can be found in "*Control of Electromagnetic Emissions with Respect to Energetic Operations within NSWCDL*" (NSWCDD Instruction 5104.3). SCSC would provide reference material such as SCSC instructions that cover safety and hazardous weather. There are no fuel storage areas close to Pad 5 and therefore implementation of a safety fan for hazards of electromagnetic radiation to fuel is not required.

To estimate permissible hazards of electromagnetic radiation to personnel EM exposure, the rate at which energy is absorbed in body tissues, called the specific absorption rate, is generally used. The specific absorption rate varies based on distance from the source. The International Commission on Non-Ionizing Radiation Protection has guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields up to 300 GHz (International Commission on Non-Ionizing Radiation Protection 1998). Exposure restrictions to EM energy are based on short-term, immediate health effects, including stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure to EM fields (International Commission on Non-Ionizing Radiation Protection 1998). For electromagnetic fields, the energy level falls rapidly as the distance from the source increases (proportional to the square of the distance). For example, a doubling of the distance from the source results in exposure to one-fourth of the original field.

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A minimum separation distance of 80 feet (24 meters) from the EM railgun was calculated for personnel present during railgun operation based on the International Commission on Non-Ionizing Radiation Protection guidelines (International Commission on Non-Ionizing Radiation Protection 1998) and the strength of the radiated field from a railgun shot (Balchin 2007). At this distance, EM energy exposure levels would be below exposure limits and would be insufficient to cause adverse effects on health, even under repeated or long-term exposure conditions. In addition, personnel in the immediate vicinity of the railgun during testing would be in trailers, vans, or shelters to provide additional protection.

The Pad 5 alternative is within the NASA rocket launching Pad 0A 10,000-foot (3,048-meter) hazard arc. The WFF safety protocol for launches from these pads is to clear the entire island about 3 to 4 hours ahead of launch time. All personnel in the Navy buildings on Wallops Island are vacated, except for a skeleton security force at each building, which remains under cover during a launch.

In previous testing, aluminum sabots were measured to land approximately 665 to 1435 feet (203 to 437 meters) from the firing point. When the projectile is fired, the sabots would hit the water at distances conservatively delimited as from a minimum of 600 feet (183 meters) to a maximum of 1 nautical mile from the gun in the direction of the target. The pusher plate and armature would fall into nearshore waters hits the water a minimum of 600 feet (183 meters) to a maximum of 3 nautical miles away from the gun in the direction of fire. The nearshore area would be kept clear of vessels during testing.

Based on the standard operating procedures that would be followed to ensure safe operation of the powder gun, EM railgun, and associated HVPs, there would be no significant impacts on health and safety under the Pad 5 Alternative.

3.7.2.3 Pad 4 Alternative

Under the Pad 4 Alternative, the Proposed Action would be identical to the Pad 5 Alternative, except that it would be located about 1,020 feet (310 meters) south of the Pad 5 Alternative. This distance places the Pad 4 Alternative within NASA's rocket launching Pad 0B 10,000-foot (3,048-meter) hazard arc, in contrast to the Pad 5 Alternative which is outside of the Pad 0B hazard arc. Both alternatives are within the NASA rocket launching Pad 0A 10,000-foot (3,048-meter) hazard arc. The WFF safety protocol for launches from these pads is to clear the entire island about 3 to 4 hours ahead of launch time. All personnel in the Navy buildings on Wallops Island are vacated, except for a skeleton security force at each building, which remains under cover during a launch.

Activities would continue to be conducted in accordance with federal and state regulations, stringent DoD and NASA policies, and carefully-conceived management controls and SOPs. No historical or active release sites or abandoned underground storage tank sites have been found within the footprint of the Pad 4 Alternative site shown on Figure 2-11 (NASA 2014).

Based on the standard operating procedures that would be followed to ensure safe operation of the powder gun, EM railgun, and associated HVPs, there would be no significant impacts on health and safety or waste management and hazardous materials under the Pad 4 Alternative.

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3.7.2.4 Elevated Road Alternative

Under the Elevated Road Alternative, the Proposed Action would be identical to the Pad 5 Alternative, except that it would be located about 280 feet (85 meters) north of the Pad 5 Alternative. Both alternatives are outside the Pad 0B 10,000-foot (3,048-meter) hazard arc, but within the Pad 0A 10,000-foot (3,048-meter) hazard arc. The WFF safety protocol for launches from these pads is to clear the entire island about 3 to 4 hours ahead of launch time. All personnel in the Navy buildings on Wallops Island are vacated, except for a skeleton security force at each building, which remains under cover during a launch.

No historical or active release sites or abandoned underground storage tank sites have been found within the footprint of the Elevated Road Alternative site shown on Figure 2-12 (NASA 2014).

Based on the standard operating procedures that would be followed to ensure safe operation of the powder gun, EM railgun, and associated HVPs, there would be no significant impacts on health and safety or waste management and hazardous materials under the Elevated Road Alternative.

3.7.3 Protective Measures

Standard Operating Procedures serve the primary purpose of providing for safety and mission success, and are implemented regardless of their secondary benefits. They often include protective measures. In contrast, mitigation measures would be implemented entirely for the purpose of reducing environmental impacts resulting from the Proposed Action. Because standard operating procedures are crucial to safety and mission success, they would not be modified as a way to further reduce effects on environmental resources. Based on these procedures, no mitigation measures would be required for safety and health resources.

In order to minimize potential impacts, the Navy and NASA would ensure through Standard Operating Procedures that:

- All activities proposed under the Proposed Action would strictly adhere to all Navy and NASA health, safety, and environmental protocols.
- All activities proposed would strictly adhere to all safety zones – i.e., danger zones, hazard arcs, and Airfield Safety Zones (R-6604A/B and W-386).
- Members of the public and personnel not involved in a test would be excluded from testing areas, warning areas, and the affected portion of the Virginia Capes Operating Area prior to and during tests.
- The WFF Range Safety Officer would ensure that the Wallops Range safety policy, criteria, and procedures are not violated during operations and the WFF Operations Safety Supervisor would ensure that the ground safety plan is implemented.

Protective measures would be implemented, continually assessed to determine effectiveness, and revised as needed to increase their effectiveness.

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3.8 Geomorphology, Soils, and Sediments

3.8.1 Affected Environment

3.8.1.1 Geology

WFF is located within the Atlantic Coastal Plain Physiographic Province. This area is underlain by approximately 7,000 feet (2,134 meters) of sediment, lying above crystalline basement rock. The sedimentary section ranges in age from Cretaceous to Quaternary and consists of a thick sequence of terrestrial, continental deposits overlain by a much thinner sequence of marine sediments. These sediments are generally unconsolidated and consist of clay, silt, sand, and gravel. The uppermost stratigraphic deposit at WFF is the Yorktown Formation which was deposited during the Pliocene epoch of the Tertiary Period. The Yorktown Formation generally consists of fine to coarse, glauconite quartz sand, which is greenish gray, clayey, silty, and in part, shelly. The Yorktown Formation occurs at depths of 60 to 140 feet (18 to 43 meters) in Accomack County (NASA 2008).

3.8.1.2 Topography

The topography at WFF is typical of the Mid-Atlantic coastal region, generally low-lying with elevations ranging from sea level to 50 feet (15 meters) above mean sea level. The three major landforms found at WFF are mainland, tidal marsh, and barrier island.

Wallops Island is a barrier island approximately 7 miles (11 kilometers) long and 0.5 mile (0.8 kilometer) wide. It is separated from Main Base and Wallops Mainland by numerous inlets, marshes, bays, creeks, and tidal estuaries. The island is bordered by Chincoteague Inlet to the north, Assawoman Island to the south, the Atlantic Ocean to the east, and marshland to the west. The sandy portion of Wallops Island has an elevation of about 7 feet (2 meters) above mean sea level, although most of the island is less than 10 feet (3 meters) above mean sea level (NASA 2008).

Topographic conditions at each of the three alternative sites are similar: they are located along the Atlantic Ocean between the east side of Island Road and the beach. The sites are relatively flat overall, with elevations ranging between 4 and 6 feet (1.2 to 2 meters) above mean sea level. A portion of the Elevated Road site rises to a height of about 11 feet (3.4 meters) above mean sea level along an approximately 400-foot (122-meter) long paved ridge that is embanked on either side.

All three alternative sites are located approximately 200 feet (61 meters) from the rock seawall/primary dune that separates the sites from the beach. The seawall/dune was constructed by mounding large rocks, adding sand, and planting beach grass. Following storm damage, the dune was restored and the beach extended as part of a beach nourishment effort at Wallops Island that was evaluated in a 2010 programmatic EIS (NASA 2010) and implemented beginning in spring and summer 2012 (NASA 2013). Prior to the beach nourishment project, the beach fronting the SCSC area had been severely eroded such that only the seawall/dune separated the pad from the ocean. In total, the nourishment project added approximately 3,199,000 cubic yards (2,446,000 cubic meters) of sand to 3.6 miles (5.8 kilometers) of beaches along the Atlantic shoreline of Wallops Island (see Figure 3.10-1) (NASA 2010). In addition, the project included the repair of the stone seawall at selected locations, extensive dune restoration, and the

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installation of other erosion control measures. The sand used to replenish the beach was dredged from an offshore shoal approximately 12 miles (19 kilometers) east of the Proposed Action area (NASA 2010). Hurricane Sandy in late October 2012 damaged the seawall/dune and swept away part of the newly-restored beach. There are plans to replenish the beach with 800,000 cubic yards (611,643 cubic meters) of sand in 2014, and the seawall/dune has been repaired (NASA 2013). Currently the beach extends for approximately 110 feet (34 meters) from the seawall/dune to the water.

3.8.1.3 Soils

The predominant soil types on Wallops Island are presented in Table 3.8-1. Generally, the predominant soils are high in sand content, resulting in a highly leached condition, an acidic pH, and low natural fertility (United States Department of Agriculture, Natural Resource Conservation Service 2014). Soils underlying the alternative sites are illustrated in Figure 3.8-1, Alternative Site Soils. Pad 5, Pad 4, and the Elevated Road site are all underlain by Assateague fine sand, Comacca fine sand, and Fisherman Comacca complex soils. A portion of the Elevated Road site is also underlain by Udorthent and Udipsamment soils. Select properties of soils on the proposed sites are presented in Table 3.8-2.

Table 3.8-1: Wallops Island Soils

Soil Type	Symbol	Typical Slopes	Location	Description
Assateague fine sand	AtD	2-35%	Wallops Island – eastern portion	Gently to steeply sloping, very deep, excessively drained. This soil is rarely flooded.
Beaches	BeB	1-5%	Wallops Island – eastern portion	Moderately sloping.
Comacca fine sand	CaA	0-2%	Wallops Island – central and western portions in depressions and on flats associated with dunes and marshes	Nearly level, very deep, very poorly drained.
Chincoteague silt loam	ChA	0-1%	Wallops Island – eastern portion	Nearly level, very deep, very poorly drained hydric soils.
Fisherman Assateague fine sands complex	FmD	0-35%	Wallops Island – southern end	Nearly level to steep, very deep, moderately well-drained to excessively drained.
Fisherman Comacca fine sands complex	FrB	0-6%	Wallops Island – depressions and areas associated with dunes and salt marshes	Very poorly to moderately well-drained.
Udorthents and Udipsamments	UpD	0-35%	Wallops Island – east of Chincoteague silt loam	Nearly level to steep, very deep, and range from well-drained to somewhat poorly drained.
Source: United States Department of Agriculture, Natural Resource Conservation Service 2014.				

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Alternative Site Soils

Soils:

- Pad 4 Alternative
- Pad 5 Alternative
- Elevated Road Alternative
- ChA – Chincoteague silt loam
- UpD – Udorthents and Udipsamments
- CaA – Comacca fine sand
- FrB – Fisherman Comacca fine sands complex
- AtD – Assateague fine sand
- BeB – Beaches

0 240 480
Feet

0 75 150
Meters

N

Sources: USGS 2013, NASA 2013, and NASA 2013b

Figure 3.8-1

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Table 3.8-2: Select Properties of Site Soils

Soil Type	Soil Characteristics				
	Hydric	Prime Farmland	Shallow excavations of five to six feet	Erosion (water)	Erosion (wind)
Assateague Fine Sand (AtD)	No	No	Very limited	Moderately low	Highly susceptible
Comacca fine sand (CaA)	Yes	No	Very limited	Moderately low	Low susceptibility
Fisherman-Comacca Complex (FrB)	Yes	No	Very limited	Moderately low	Highly susceptible
Udorthent and Udipsamment Soils (UpD)	No	No	Very limited	Not rated	Not rated
Source: United States Department of Agriculture, Natural Resource Conservation Service 2014.					

3.8.1.4 Floodplains

Floodplains are lowland areas located adjacent to bodies of water in which the ordinary high water level fluctuates on an annual basis. Functioning floodplains provide critical protection for surrounding communities because of their ability to dissipate energy and water from flooding. Development in one portion of a floodplain has the potential to intensify the impacts from flooding in other areas of the floodplain.

Floodplains are frequently discussed in terms of the 100-year flood and 500-year flood. The 100-year flood, or base flood, is a flood having a 1 percent chance of occurring in any given year. The 500-year floodplain designates the area having a 0.2 percent chance of being inundated in any given year. EO 11988, *Floodplain Management*, prohibits federal agencies from funding construction in the 100-year floodplain unless there are no practicable alternatives.

Flood Insurance Rate Maps produced by the Federal Emergency Management Agency indicate that Wallops Island is located entirely within the 100-year floodplain (Federal Emergency Management Agency 2014).

3.8.1.5 Bathymetry

The bathymetry of waters underlying the firing ranges associated with the railgun site alternatives is illustrated in Figure 3.8-2, Firing Area Bathymetry.

The nearshore environment south of Chincoteague Inlet and east of Wallops Island is a relatively featureless basin known as the Chincoteague Bight. This area covers approximately 86 square nautical miles and extends roughly 7 nautical miles offshore. The seafloor is generally devoid of shoals and sand bars and slopes gently from the shoreline to a depth of approximately 12 meters at the limit of state jurisdictional waters, 3 nautical miles offshore (NASA 2010).

As illustrated in Figure 3.8-2, the sabot petal impact area overlies nearshore waters that range from less than one meter to approximately six meters deep. Water depths within the pusher plate and armature impact area vary from less than one meter to approximately 10 meters.

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Ocean depths underlying the firing area vary from about 10 meters in nearshore waters to over 3,100 meters at its eastern limit, as shown in Figure 3.8-2. The central portion of the firing area overlies the continental shelf break, continental slope and continental rise. The firing area is also underlain by the Washington and Norfolk Canyons. Both canyons originate near the edge of the continental shelf and are distinguishable through the continental slope and continental rise.

3.8.1.6 Sediments

Bottom sediments found on the continental margin of the Virginia Capes OPAREA and surrounding areas are derived from four primary sources: rivers, glaciers, erosion of onshore and submarine outcrops of older rocks, and decomposed organic matter (Tucholke 1987, as cited in Navy 2008). Deposition of sediments by modern rivers onto the continental shelf between Cape Hatteras and Cape Cod is minimal and is limited primarily to nearshore regions and estuaries (Hollister 1973, as cited in Navy 2008). Relict sediments deposited on the continental shelf by receding glaciers consist mainly of onshore sediments eroded by ancient rivers and carbonate detritus. The high-energy current and tidal systems of the region also transport sediments off of the shelves into deeper waters (Riggs et al. 1998, as cited in Navy 2008). The continental shelves of the western North Atlantic are considered to be sediment-starved because of the lack of sediment inputs.

Bottom sediments found on the continental margin of the Mid-Atlantic Bight are well sorted by grain size with sands and localized areas of gravelly sand distributed over the continental shelf and finer grained silts and clays transported shoreward by tidal currents into the estuaries or seaward by turbidity currents onto the continental slope and rise (Hollister 1973; Tucholke 1987, as cited in Navy 2008). Shelf sands in the Mid-Atlantic Bight consist mostly of quartz and feldspar. Sediments found on the continental slope and rise consist mostly of resuspended and reworked fine-grained sediments from the continental shelf that are transported seaward by bottom currents, as well as detritus derived from biological sources (Hollister 1973; Tucholke 1987, as cited in Navy 2008).

3.8.2 Environmental Consequences

3.8.2.1 No Action Alternative

The implementation of the No Action Alternative would have no effect on geomorphological resources at WFF because there would be no change in existing conditions. Operational missions and activities covered by previous NEPA documents would continue. There would be no impact on geological resources, topography, soils, floodplains, bathymetry, or sediments under the No Action Alternative.

3.8.2.2 Pad 5 Alternative (Preferred Alternative)

Geological Resources

Construction of the proposed powder gun and EM railgun facility would require the installation of multiple pilings to support control and equipment structures and elevate them to a height of 11 feet (3.4 meters) above ground level to prevent flooding of the structures during high-water events. Because the proposed facility is still in the early stages of design, the exact number of pilings is not yet known, but preliminary construction drawings indicate that the pilings would be embedded to a minimum depth of 15 feet (5 meters). In comparison, the pilings supporting the

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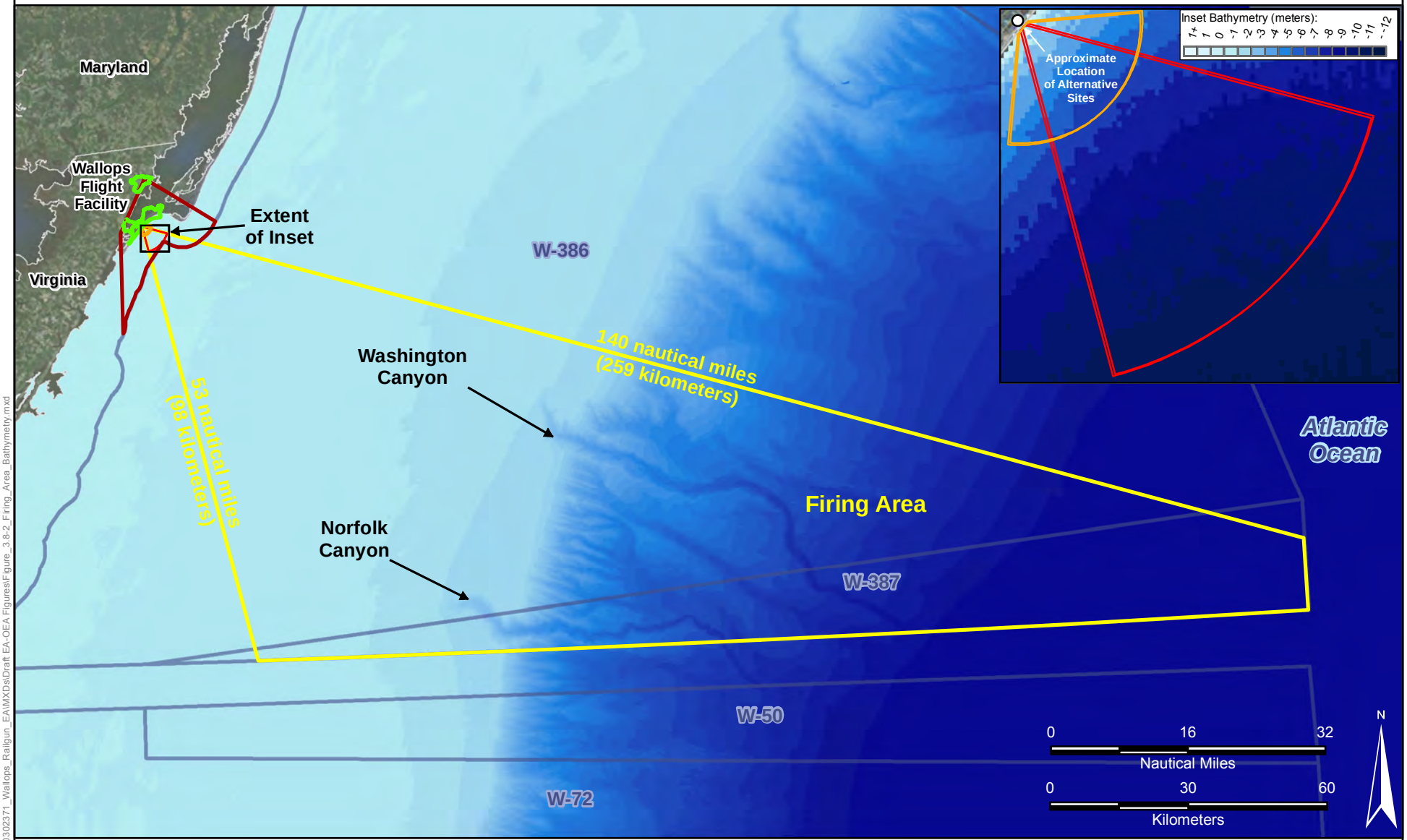
Firing Area Bathymetry



Nearshore Action Area - Sabot Petal Impact Area

Nearshore Action Area – Pusher Plate and Armature Impact Area

R-6604A/B Restricted Area

Virginia Capes Range Complex Warning Areas

Firing Area

Wallops Flight Facility

Source: NASA 2013 and NOAA 2013

Bathymetry (meters): -19.0 + -45.9 - -20 -82.9 - -46 -150.9 - -83 -257.9 - -151 -384.9 - -258 -517.9 - -385 -652.9 - -518 -783.9 - -653 -907.9 - -784 -1,022.9 - -908 -1,127.9 - -1,023 -1,225.9 - -1,128 -1,320.9 - -1,226 -1,411.9 - -1,321 -1,501.9 - -1,412 -1,590.9 - -1,502 -1,679.9 - -1,591 -1,768.9 - -1,680 -1,852.9 - -1,769 -1,933.9 - -1,853 -2,013.9 - -1,934 -2,092.9 - -2,014 -2,172.9 - -2,093 -2,251.9 - -2,173 -2,324.9 - -2,252 -2,405.9 - -2,325 -2,496.9 - -2,406 -2,582.9 - -2,497 -2,671.9 - -2,583 -2,764.9 - -2,672 -2,953 - -2,765

Figure 3.8-2

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existing concrete pad at Pad 5 were installed to a depth of up to 90 feet (27 meters). From a geological perspective, 15 feet (5 meters) would be a relatively shallow depth. No effects on geological resources would result from the long-term operation of the powder gun and EM railgun facility. Thus, the implementation of the Pad 5 Alternative would have no significant impacts on geological resources at WFF.

Topography

The construction of the proposed facility would involve minor grading but would not substantially alter existing topographic features on or in the vicinity of Pad 5. The site and its surrounding area would remain relatively flat. Therefore, the Preferred Alternative would have no significant impacts on topography.

Soils

The implementation of the Preferred Alternative would require the installation of buried utilities involving trenching approximately 600 linear feet (183 meters) at a minimum depth of 40 inches (102 centimeters) and an estimated 500 linear feet (152 meters) of directional boring. The installation of utilities would occur in both paved and unpaved areas of the site. Pad 5 includes paved areas covering approximately 41,000 square feet (3,809 square meters) of the 86,791-square foot (8,063 square-meter) site.

The trenching would disturb about 889 cubic yards (680 cubic meters) of earth, the majority of which would be used to backfill the trenches once the utilities are installed. Any excess earth would be disposed of in accordance with applicable Navy, NASA, federal, state, and local regulations and procedures.

The potential for erosion and runoff of earth removed from the trenches, which would likely be temporarily stockpiled along the length of the trenches until needed as backfill, would be minimal. The depth of excavations to install utilities supporting the Proposed Action would be similar to other existing buried utilities at and in the vicinity of the project site. Excavated areas would be returned to their previous condition (paved or vegetated, as applicable) after the trenches are backfilled. Directional boring to install underground utilities would have no above-ground effects on soils.

An 18-inch- (46-centimeter-) thick base course of aggregate stone would be laid in an approximately 36,000-square-foot (3,345-square-meter) area north of and adjacent to Pad 5 to accommodate the development of the proposed facility. Although the addition of the gravel would compact the underlying soils and somewhat reduce permeability in that portion of the site, stormwater would still percolate and disperse through the gravel, rather than run off in sheet flows. Based on conceptual drawings of the proposed facilities, the amount of new impervious surface that would result from the construction of some of the new facilities on the graveled area would be minimal when compared to the overall size of that area.

The aggregate base course described above would likely be laid prior to the construction of the powder gun and EM railgun support facilities in the vacant, unpaved area north of and adjacent to the existing concrete pad. This would eliminate the potential for soil erosion from construction vehicles and equipment operating in that area. The relatively small footprints of the facilities that would be built in the vacant area would minimize the potential for construction-related erosion.

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Best management practices would also be implemented as applicable to further minimize erosion from wind and water during construction activities.

Because the construction of the project would disturb more than 10,000 square feet (929 square meters) of land, the construction contractor would be required to prepare an erosion and sediment control plan in accordance with the Virginia Erosion and Sediment Control Regulations (4 Virginia Code [VAC] 50-30). If, as the design of the project is finalized, it is determined that an acre or more of land would be disturbed during the construction of the proposed facility, the construction contractor also would be required to obtain a General Permit for Discharges of Stormwater from Construction Activities in accordance with 9 VAC 25-880. Acquisition of the permit would require the preparation of a stormwater pollution prevention plan. Compliance with the requirements set forth in the erosion and sediment control plan, the General Permit and the stormwater pollution prevention plan would minimize impacts resulting from construction-related soil erosion and stormwater runoff.

Soils underlying the Pad 5 site would not excessively corrode concrete or steel structures embedded in them. The soils are not considered prime farmland and are previously-disturbed. The operation of the proposed facility would have no potential to disturb soils.

Based on the use of best management practices, the Pad 5 Alternative would have no significant impacts on soils.

Floodplains

Based on Flood Insurance Rate Maps (Federal Emergency Management Agency 2014), all facility construction and infrastructure improvements would take place within the 100-year and 500-year floodplains. As outlined in Chapter 2, the only practicable alternative is to construct the facilities and operate the guns within the floodplain. Because Wallops Island is the location for NAVSEA's SCSC, including the mission-essential SPY-1 radar, no practicable alternatives to development in the floodplain exist. The Navy and NASA would ensure that the Proposed Action complies with EO 11988, Floodplain Management, and 14 C.F.R. 1216.2 (NASA Regulations on Floodplain and Wetland Management) to the maximum extent possible. Because the Proposed Action would involve federally funded and authorized construction in the 100-year floodplain, this EA also serves as the Navy's and NASA's means for facilitating public review as required by EO 11988.

Because access to Wallops Island is controlled and only authorized personnel are allowed on the facility, public education regarding flood hazards (e.g., marking flood heights on buildings) is not applicable. However, flood elevations are marked on some Wallops Island facilities to inform NASA, Navy, and visiting personnel. Other flood control measures that would be implemented include locating water-sensitive equipment, supplies, chemicals, etc. above the flood level (approximately 11 feet [3.4 meters] above mean sea level), and moving hazardous waste outside of the floodplain when substantial storms are imminent.

The functionality of the floodplain on Wallops Island, provided both by the wetlands on the island and the area of the island itself, would not be substantially reduced due to the presence of existing or proposed facilities because the footprint of the facilities would not cover a substantial area of the island and most of the new structures would be on pilings, which displace little water. For these reasons, the implementation of the Preferred Alternative would have no significant impacts on floodplains at WFF.

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Bathymetry

During firings of the powder gun and EM railgun, non-explosive parts would detach from each projectile and fall into the waters off Wallops Island. Each projectile fired from the gun would include four sabot petals and a titanium pusher plate for the powder gun and an armature for the railgun. The thin, lightweight sabot petals (currently made of aluminum and possibly to be made of carbon composite materials as the technology advances) typically fall from projectiles at least 600 feet (183 meters) away, placing them in the waters of the nearshore area. Pusher plates and armatures generally would fall off farther, hitting the water from at least 600 feet (183 meters) to 3 nautical miles away from the firing point in the direction of fire.

The sabots, pusher plates, and armatures would descend through the water and sink into sediment or come to rest on hard bottom. With an average of 100 to 250 projectiles a year deposited over a large firing range, the amount of expended materials on the ocean bottom is not considered significant.

The Preferred Alternative would have no significant impacts on bathymetry.

Sediments

Sabots, pusher plates, and armatures separating from the projectiles would sink into sediments or rest on top of hard bottom on the ocean floor. The probability of any expended material's landing on one another would be less than one in a million, resulting in no accumulation of material in any one area. In the context of the large area covered by the firing range, the small number of projectiles tested, and natural events causing localized sediment disturbance, the Preferred Alternative would not cause excessive sediment disturbance nor create excessive turbidity. The Preferred Alternative would have no significant impacts on sediments in the target area.

3.8.2.3 Pad 4 Alternative

Geological Resources

The construction of the proposed powder and railgun facility at Pad 4 would be similar to the description for the Preferred Alternative. An as-yet undetermined number of pilings to elevate control and equipment structures would be embedded at an approximate depth of 15 feet (5 meters) at the site. From a geological point of view, this would be a relatively shallow depth, and the pilings would not penetrate beyond the layer of sediment underlying Wallops Island. The operation of the powder gun and railgun would have no potential to affect geological resources. Therefore, the implementation of the Proposed Action at Pad 4 would have no significant impacts on geological resources at WFF.

Topography

The implementation of the Proposed Action at Pad 4 would have no significant impacts on topography because no existing topographic features on or in the vicinity of Pad 4 would be altered as part of the construction or operation of the powder gun and EM railgun.

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Soils

The construction of the proposed facility at Pad 4 would involve similar amounts of trenching, excavation, directional boring, and aggregate stone to be laid as described for the Preferred Alternative. Concrete or steel structures embedded in soils underlying the Pad 4 site would not be excessively corroded by those soils. The soils are previously-disturbed and are not considered prime farmland. The operation of the proposed facility would have no potential to disturb soils.

Pad 4 includes paved areas measuring approximately 35,000 square feet (3,252 square meters) of the 77,720 square-foot (7,220 square-meter) site. As described for the Pad 5 Alternative and for similar reasons, the construction contractor would be required to prepare a sediment and erosion control plan. If it is determined that the project would disturb one acre or more of land, the construction contractor would also obtain a General Permit for Discharges of Stormwater from Construction Activities and prepare a stormwater pollution prevention plan. Adherence to the requirements of the erosion and sediment control plan, the General Permit and the stormwater pollution prevention plan would minimize construction-related impacts on soils. Thus, as described for the Pad 5 Alternative, the implementation of the Proposed Action at Pad 4 using best management practices would have no significant impacts on soils.

Floodplains

Impacts on floodplains resulting from the implementation of the Proposed Action at Pad 4 would be similar to those described for the Pad 5 Alternative. There would be no significant impacts on floodplains.

Bathymetry

Projectiles fired from Pad 4 would affect the same area as described for the Preferred Alternative. There would be no significant impacts on bathymetry.

Sediments

The implementation of the Proposed Action at Pad 4 would affect the same area as described for the Pad 5 Alternative. There would be no significant impacts on sediments.

3.8.2.4 Elevated Road Alternative

Geological Resources

For the same reasons as described for the Pad 5 and Pad 4 Alternatives, the implementation of the Proposed Action at the Elevated Road site would have no significant impacts on geological resources.

Topography

The implementation of the Proposed Action at the Elevated Road site would have no significant impacts on topography at the elevated road site. No existing topographic features on or in the vicinity of the site would be altered as part of the construction or operation of the powder gun and EM railgun and there would be no significant impacts on topography.

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Soils

Impacts on soils at the Elevated Road site would be similar to those described for the Pad 5 and Pad 4 Alternatives. Pavement atop the ridge on the Elevated Road site encompasses approximately 17,825 square feet (1,656 square meters) of the 78,389 square-foot (7,282 square-meter) site.

As with the other action alternatives, the construction contractor would be required to prepare and erosion and sediment control plan. Coverage under the General Permit for Discharges of Stormwater from Construction Activities would be obtained if it is determined that the project would disturb more than one acre or more of land, and a stormwater pollution prevention plan would be prepared. Compliance with the requirements of the erosion and sediment control plan, General Permit and stormwater pollution prevention plan would minimize construction-related impacts on soils. Therefore, through the application of best management practices, there would be no significant impacts on soils.

Floodplains

Floodplain impacts resulting from the implementation of the Proposed Action at the Elevated Road site would be similar to those described for the Pad 5 and Pad 4 Alternatives. There would be no significant impacts on floodplains.

Bathymetry

The construction and operation of the proposed rail and powder guns at the Elevated Road site would have no significant impacts on bathymetry, for the same reasons as described under the Preferred Alternative.

Sediments

For the same reasons as described under the Preferred Alternative, the implementation of the Proposed Action at the Elevated Road site would have no significant impacts on sediments.

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3.9 Water Resources

Water resources for this EA refer to surface and subsurface waters, and marine waters that exist in and around WFF. The Clean Water Act of 1972 (33 U.S.C. § 1251) is the primary federal law that protects the nation's waters, including lakes, rivers, aquifers, and coastal areas. The primary objective of the act is to restore and maintain the integrity of the nation's waters.

3.9.1 Affected Environment

3.9.1.1 Surface Waters

WFF is located in the Eastern Lower Delmarva and Chincoteague watersheds (NASA 2008). The western portion of Wallops Island north of Route 803 is part of the Chincoteague watershed drainage. The portion of Wallops Island south of Route 803 and along the eastern edge of the island is part of the Eastern Lower Delmarva watershed drainage.

Surface water on Wallops Island flows through numerous tidal tributaries that subsequently flow to the Atlantic Ocean. The northern boundary of Wallops Island is formed by Chincoteague Inlet, and its western side is bounded by a series of water bodies which separate the island from the Mainland. No natural perennial streams or ponds exist on the island; however, intermittent water bodies may form after storms or in response to other physical forces such as tides. No wild or scenic rivers are located on or adjacent to WFF. Therefore, the Wild and Scenic Rivers Act of 1968 (16 U.S.C. § 1271-1287) does not apply and will not be discussed further.

Surface water features in the vicinity of the alternative sites include tidal creeks and their associated tributaries, ponds, and the Atlantic Ocean. The Atlantic Ocean lies to the east. Surface waters in the vicinity are saline to brackish, and are influenced by the tides (NASA 2008).

The Virginia Department of Environmental Quality has designated the surface waters in the vicinity of WFF as Class I – Open Ocean and Class II – Estuarine Waters. Surface waters in Virginia must meet the water quality criteria specified in 9 VAC 25-260-50. This set of criteria establishes limits for minimum dissolved oxygen concentrations, pH, and maximum temperature for the different surface water classifications in Virginia. In addition, Virginia surface waters must meet the surface water criteria specified in 9 VAC 26-260-140. This set of criteria provides numerical limits for various potentially toxic parameters. For the Class I and II waters in the vicinity of WFF, the saltwater numerical criterion is applied. Both sets of standards are used by the Commonwealth of Virginia to protect and maintain surface water quality.

3.9.1.2 Marine Waters

In the project area in winter, the water column is vertically well-mixed, whereas in the summer months, the offshore waters are vertically stratified, with notable differences in temperature between surface waters and those at greater depths (NASA 2013a). During most of the year, there is a clear gradient of increasing sea surface temperature from north to south in the Virginia Capes OPAREA; this trend is less obvious in summer when the variation in surface water temperatures is smallest (Navy 2008). Water temperatures in the Virginia Capes OPAREA reach a minimum in winter with a well-defined thermal convergence of cold, northern waters and warm Gulf Stream waters off of Cape Hatteras. The effects of the Gulf Stream are most noticeable in the southern portion of the Virginia Capes OPAREA where seasonal sea surface

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temperature ranges from a low of approximately 70° Fahrenheit in winter to 88° Fahrenheit in summer (21° to 31° Celsius). Just north of Cape Hatteras, the Gulf Stream separates from the coast, and waters on the continental shelf near the mouth of Chesapeake Bay undergo a much wider seasonal cycle, ranging in temperature between 46° and 79° Fahrenheit (8° and 26° Celsius) (Navy 2008).

Salinity over the southern Hatteras-Cape Cod Shelf ranges between 30 and 35 practical salinity units throughout most of the year (Navy 2009). Increases in salinity over the shelf are often associated with persistent southerly upwelling-favorable winds (i.e., winds out of the south). Saltwater intrusions typically initiate rapidly and persist for only a short period of time. Intrusions also may result from Gulf Stream meanders and warm-core eddies (Navy 2009).

The Gulf Stream flows northward along the U.S. southeast coast and is the dominant surface current in the Virginia Capes OPAREA. In addition to the Gulf Stream, currents originating from the outflow of both the Chesapeake Bay and Delaware Bay influence the surface circulation in the OPAREA (Navy 2008). The Chesapeake Bay plume flows seaward from the mouth of the bay and then turns south to form a coastal jet that can extend as far as Cape Hatteras. Similarly, the Delaware Coastal Current initiates in Delaware Bay and flows southward along the Delmarva Peninsula before being entrained into the Chesapeake Bay plume.

On average, surface currents over the Florida-Hatteras Shelf move slowly to the northeast, and surface currents over the Hatteras-Cape Cod Shelf move to the southwest until a confluence of the two water masses occurs just north of Cape Hatteras (Navy 2009; Pickard and Emery 1982). However, reversals in the direction of flow over the shelves have been observed and tend to coincide with changes in the direction of the prevailing winds and low river discharge (Navy 2009).

3.9.1.3 Stormwater Drainage

Wallops Island has storm drains that divert stormwater flow to several individual discharge locations (NASA 2009). The northern portion of Wallops Island drains by overland flow to Bogues Bay and Chincoteague Inlet via Sloop Gut and Ballast Narrows. The central portion of the island drains primarily to the west toward Bogues Bay. Cross-culverts under Island Road drain stormwater collected by culverts and ditches. Flap gates have been installed west of Island Road to release stormwater to Bogues Bay via Hog Creek.

Stormwater discharges associated with industrial activities must be permitted under the Clean Water Action National Pollutant Discharge Elimination System (33 U.S.C. § 1342). The Virginia Department of Environmental Quality is authorized to carry out National Pollutant Discharge Elimination System permitting under the Virginia Pollutant Discharge Elimination System as administered under 9 VAC 25-151. There are three permitted stormwater outfalls located on Wallops Island that require monitoring for flow, pH, total suspended solids, and total petroleum hydrocarbons under the conditions of the permits.

Pad 5 is located at the northern end of Drainage Area DA-307, which comprises 36.9 acres (14.9 hectares). Stormwater draining from DA-307 discharges at outfall WI-1 into the marshlands along the west side of Wallops Island and ultimately into Cat Creek (NASA 2013b). Monitoring of WI-1 is not required under the permit. NASA maintains a WFF-wide stormwater pollution prevention plan (NASA 2013b) to ensure that its operations have minimal impact on stormwater quality.

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The Virginia Stormwater Management Act (§ 62.1-44.15:24 et seq.) and implementing regulations (9 VAC 25-870), administered by the Virginia Department of Environmental Quality, require that construction and land development activities incorporate measures to protect aquatic resources from the effects of increased volume, frequency, and peak rate of stormwater runoff and from increased non-point source pollution carried by stormwater runoff. The program also requires that land-disturbing activities of 1 acre (0.4 hectare) or greater obtain a General Permit for Discharges of Stormwater from Construction Activities and develop a stormwater pollution prevention plan prior to construction.

3.9.1.4 Groundwater

Four major aquifers underlie the Eastern Shore of Virginia: the Columbia aquifer and the three aquifers comprising the Yorktown-Eastover aquifer system (Richardson 1994). The Columbia aquifer is the uppermost aquifer, comprising saturated, chiefly sandy, surficial sediments. The aquifer is unconfined throughout the Eastern Shore. The Yorktown-Eastover aquifer system is a multi-aquifer unit consisting of alternating sand and clay-silt units that form three distinct aquifers; the upper, middle, and lower Yorktown-Eastover aquifers. The three Yorktown-Eastover aquifers generally are present throughout the Eastern Shore.

The Columbia and Yorktown-Eastover multi-aquifer system is designated and protected by the USEPA as a sole-source aquifer (USEPA 2013). A sole source aquifer is a drinking water supply located in an area with few or no alternative sources to the groundwater resource, and where if contamination occurred, the use of an alternative source would be extremely expensive. The designation protects an area's groundwater resource by requiring the USEPA to review any proposed projects within the designated area that are receiving federal financial assistance, to ensure they do not endanger the water source.

3.9.2 Environmental Consequences

3.9.2.1 No Action Alternative

Under the No Action Alternative, testing of the HVPs and railgun would not take place and there would be no change in existing conditions. There would be no impact on water resources including surface water, marine waters, stormwater drainage, and groundwater.

3.9.2.2 Pad 5 Alternative (Preferred Alternative)

The Pad 5 Alternative would require the installation of buried utilities and construction of the powder gun and EM railgun support facilities, described in Section 3.8.2.2. The potential for runoff of earth to surface waters during trenching activities would be minimal.

Pad 5 comprises 1.99 acres (0.81 hectares), of which 0.94 acres (0.38 hectares) are paved. If, as the design of the project is finalized, it is determined that one acre or more of land would be disturbed during construction of the project, the construction contractor would obtain a General Permit and would prepare a stormwater pollution prevention plan as required by the Virginia Stormwater Management Act.

Best management practices would be followed during the construction of the powder gun and EM railgun support facilities to minimize erosion. The amount of new impervious surface that would result from the construction of some of the new facilities would be approximately 3,400 square feet (0.08 acre) and is considered negligible when compared to the overall size of the

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area. The addition of the new impervious surface would have a negligible effect on water resources.

Operations at Pad 5 would not generate any runoff that would impact surface water, marine waters, stormwater, or groundwater. Therefore, the Pad 5 Alternative would have no significant impacts on water resources.

3.9.2.3 Pad 4 Alternative

The environmental consequences of the Pad 4 Alternative would be similar to the Pad 5 Alternative and would involve similar amounts of trenching, excavation, directional boring, and impervious surface. The potential for runoff of earth to surface waters during trenching activities would be minimal.

Pad 4 comprises 1.78 acres (0.72 hectares), of which 0.80 acres (0.32 hectares) are paved. As required by the Virginia Stormwater Management Act, the construction contractor would obtain a General Permit and would prepare a stormwater pollution prevention plan prior to construction if it is determined that the project would disturb one acre or more of land.

Best management practices would be followed during the construction of the powder gun and EM railgun support facilities to minimize erosion. The amount of new impervious surface that would result from the construction of some of the new facilities would be approximately 1,179 square feet (0.03 acre) and is considered negligible when compared to the overall size of the area.

Operations at Pad 4 would not generate any runoff that would impact surface water, marine waters, stormwater, or groundwater. Therefore, the Pad 4 Alternative would have no significant impacts on water resources.

3.9.2.4 Elevated Road Alternative

The environmental consequences of the Elevated Road Alternative would be similar to the Pad 5 Alternative and would involve similar amounts of trenching, excavation, and directional boring.

The Elevated Road comprises 1.80 acres (0.73 hectares), of which 0.41 acres (0.17 hectares) are paved. Prior to construction, the construction contractor would obtain a General Permit and prepare a stormwater pollution prevention plan if it is determined that the project would disturb one acre or more of land.

Best management practices would be followed during the construction of the powder gun and EM railgun support facilities to minimize erosion. The potential for runoff of earth to surface waters during trenching activities would be minimal.

The amount of new impervious surface that would result from the construction of some of the new facilities would be approximately 7,633 square feet (0.18 acre), slightly more than the Pad 5 or 4 Alternatives. The amount of new surface is considered negligible when compared to the overall size of the area.

Operations at the Elevated Road would not generate any runoff that would impact surface water, marine waters, stormwater, or groundwater. Therefore, the Elevated Road Alternative would have no significant impacts on water resources.

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3.10 Terrestrial Biological Resources

3.10.1 Affected Environment

A variety of terrestrial plants and animals are found at WFF. Representative vegetation, invertebrate, amphibian, reptile, bird, and mammal species found at Wallops Island are discussed below.

3.10.1.1 Vegetation

Vegetative communities found on Wallops Island include beaches, maritime grassland, maritime scrub, maritime woodland, maritime forest, wetlands, interdune ponds, and managed/maintained areas as summarized in Table 3.10-1 and shown in Figure 3.10-1 (NASA 2008). The proposed project area includes managed/maintained areas and beaches.

Table 3.10-1: Vegetative Communities at Wallops Island

Vegetative Community	Size	
	Acres	Hectares
Managed/maintained	240	97
Beach	74	30
Maritime grassland	79	32
Maritime scrub	186	75
Maritime woodland	36	15
Maritime forest	45	18
Wetlands (estuarine emergent)	2,514	1,017
Source: NASA 2008.		

Managed/maintained vegetation on Wallops Island consists mainly of meadows, lawn, and open roadside. Species found in the meadows include bushy bluestem (*Andropogon glomeratus*), little bluestem (*Schizachyrium scoparium*), thoroughwort and boneset (*Eupatorium* spp.), and goldenrods (*Solidago* spp.) (NASA 2008). Man-made ponds on Wallops Island are dominated by widgeon grass (*Ruppia maritima*) and duck weed (*Lemna minor*) (NASA 2008).

Beach habitat at Wallops Island consists of upper beaches and overwash flats. Overwash flats are areas above the high tide line that are occasionally flooded by storm surges and high spring tides. These areas have sparse vegetation, with species such as American searocket (*Cakile edentula*) and seabeach orach (*Atriplex arenaria*) (NASA 2008). Beach habitat is also being expanded through the shoreline restoration effort that began in 2010 and is scheduled to continue for 50 years.

Maritime grasslands occur on the foredunes and secondary dunes of Wallops Island. Vegetation in these areas includes American beachgrass (*Ammophila breviligulata*), saltmeadow cordgrass (*Spartina patens*), beach panic grass (*Panicum amarum*), and seaside goldenrod (*Solidago sempervirens*). The northern end of Wallops Island contains some areas of relatively pristine maritime grasslands (NASA 2008).

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3.10.1.2 Wetlands

The wetlands at WFF are part of an extensive network of wetlands within Accomack County. Non-tidal wetlands occur inland on Wallops Island in depressional areas, and tidal marsh wetlands occur on the western edge of the island. As shown in Figure 3.10-2, wetlands are present in the vicinity of the proposed project area.

Primary tidal and non-tidal wetlands at WFF have been identified by the National Wetlands Inventory and delineated using aerial imagery (USFWS 2014). Three major systems make up 3,940 acres (9,736 hectares) of wetlands at WFF. These systems include marine, estuarine, and palustrine wetlands. These wetlands are further categorized by types of vegetation dominant within them, common types at WFF include: emergent wetlands, scrub-shrub wetlands, and forested wetlands.

Common vegetation found in wetlands at WFF include salt meadow hay (*Spartina patens*), salt grass (*Distichlis spicata*), common reed (*Phragmites australis*), and greenbrier (*Smilax rotundifolia*).

Wetlands at WFF provide vital ecosystem services. Tidal and non-tidal wetland functions include water quality control, stream flow maintenance, shoreline stabilization, nutrient recycling, fish and wildlife habitat, sediment and particulate retention, and conservation of biodiversity. These wetlands and marshes also function as both breeding grounds and nurseries for wildlife.

3.10.1.3 Invertebrates

Common invertebrates found at WFF include the salt marsh grasshopper (*Orchelium fidicinium*), plant hoppers (*Prokelisia* spp.), salt marsh mosquitoes (*Ochlerotatus* spp.), greenhead flies (*Tabanus nigrovittatus*), and various wasps, parasitic flies, spiders, mites, and fiddler crabs (*Uca spp.*) (NASA 2008).

3.10.1.4 Reptiles and Amphibians

Reptiles and amphibians found at WFF include Fowler's toad (*Anaxyrus fowleri*), green treefrog (*Hyla cinerea*), eastern ratsnake (*Pantherophis alleghaniensis*), eastern hognose snake (*Heterodon platirhinos*), fence lizard (*Sceloporus undulates*), eastern box turtle (*Terrapene carolina*), and northern diamond-backed terrapin (*Malaclemys terrapin*) (NASA 2008).

3.10.1.5 Birds

WFF is home to a wide variety of bird species. A large number of migratory birds have been documented at WFF due to its location within the Atlantic Flyway, which is a major migration route for migratory birds along the Atlantic coast. Millions of migratory birds, including waterfowl, shorebirds, and songbirds, use the Atlantic flyway to travel between their summer breeding grounds and winter feeding grounds.

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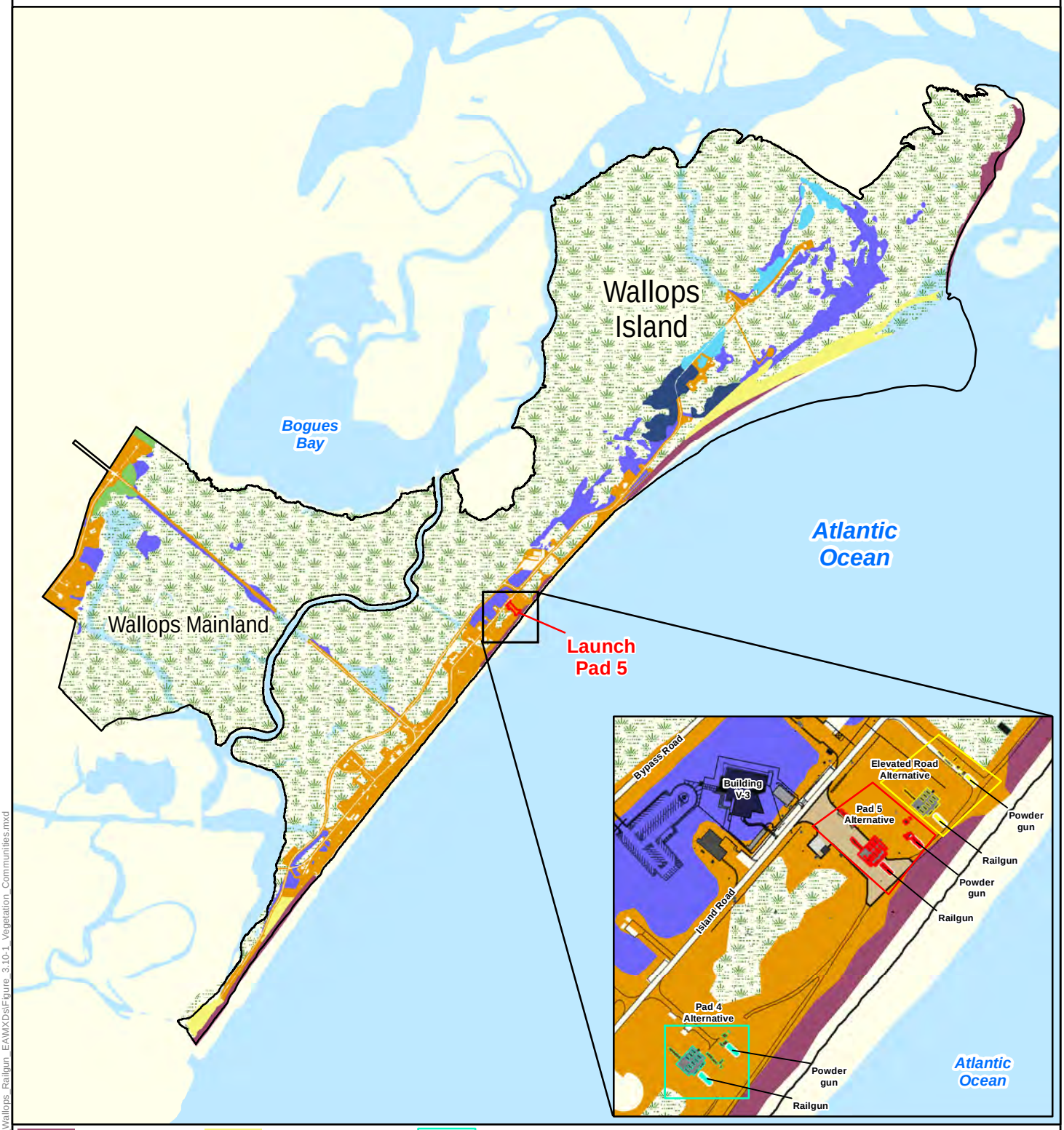
Vegetation Communities at Wallops Island



Source: NASA 2013

Figure 3.10-1

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EA\MXDs\Figure_3.10-1_Vegetation_Communities.mxd

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Wetlands

Sources: NASA 2013 and NASA 2013b

Figure 3.10-2

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Many waterfowl species are found at WFF because of the abundance of wetlands and surface water in the area. Waterfowl that occur at WFF include loons (*Gavia* spp.), Canada goose (*Branta canadensis*), snow goose (*Chen caerulescens*), gadwall (*Anas strepera*), American blackduck (*Anas rubripes*), blue-winged teal (*Anas discors*), bufflehead (*Bucephala albeola*), common goldeneye (*Bucep angula*), canvasback (*Aythya valisineria*), scaup (*Aythya* spp.), and mergansers (*Mergus* spp.). These waterfowl commonly overwinter in areas around WFF.

The marshes and shorelines at WFF also provide habitat for a variety of shorebirds and wading birds including least sandpiper (*Calidris minutilla*), short-billed dowitcher (*Limnodromus griseus*), least tern (*Sterna antillarum*), great-black-backed gull (*Larus marinus*), American oystercatcher (*Haematopus palliatus*), willet (*Catoptrophorus semipalmatus*), glossy ibis (*Plegadis falcinellus*), ring-billed gull (*Larus delawarensis*), double-crested cormorant (*Phalacrocorax auritus*), horned grebe (*Podiceps auritus*), great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), and green heron (*Butorides striatus*) (NASA 2008).

Songbirds found at WFF include saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*), swamp sparrow (*Melospiza Georgiana*), common yellowthroat (*Geothlypis trichas*), white-eyed vireo (*Vireo griseus*), ruby-crowned kinglet (*Regulus calendula*), and white-breasted nuthatch (*Sitta canadensis*).

Raptor species found at WFF include turkey vulture (*Cathartes aura*), black vulture (*Coragyps atratus*), sharp-shinned hawk (*Accipiter striatus*), red-tailed hawk (*Buteo jamaicensis*), Cooper's hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), barn owl (*Tyto alba*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and peregrine falcon (*Falco peregrinus*) (NASA 2008). These species are found mainly in the marsh areas to the west of Wallops Island.

3.10.1.6 Mammals

The only large mammal that occurs at WFF is the white-tailed deer (*Odocoileus virginianus*). Other mammals found on WFF include the red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), eastern grey squirrel (*Sciurus carolinesis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), river otter (*Lontra canadensis*) and eastern cottontail (*Sylvilagus floridanus*) (NASA 2008).

3.10.2 Environmental Consequences

3.10.2.1 No Action Alternative

Under the No Action Alternative, operational missions and activities would remain at current levels and there would be no testing of the powder gun or railgun. There would be no impact on terrestrial biological resources.

3.10.2.2 Pad 5 Alternative (Preferred Alternative)

Potential impacts on terrestrial biological resources associated with the Proposed Action include direct impacts such as disturbances associated with construction (noise, presence of people), noise associated with firing, exposure to magnetic fields, and lighting if night testing is required.

The Pad 5 site is mainly concrete and disturbed soils with limited vegetation and does not contain habitat to attract animals. There are no wetlands present on the Pad 5 site. Disturbances

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during site construction, such as noise and the presence of people, would result in negligible impacts on biological resources, as the site and surroundings are developed and the habitat present is of low value. The seawall/dune provides physical separation between the site and the beach, which would further minimize impacts.

No vegetation or animals would be in the line of fire. A visual survey for animals in the immediate vicinity of the testing would be performed prior to firing and testing would be delayed until the area is cleared if any animal were sighted.

The latent strength of the earth's magnetic field is 0.52 Gauss along the mid-Atlantic coast (Maus et al. 2010). The magnetic field produced by the railgun during firing is predicted to fall below this level within 120 feet (37 meters) of the gun. Because there is limited habitat in this area (primarily concrete pad), vegetation and wildlife would not be exposed to elevated electromagnetic fields.

The duration of the powder gun and railgun tests is extremely short (about 8 milliseconds), so that the likelihood of a bird's flying in front of the railgun and being hit by a projectile at the precise moment of firing is negligible, particularly as the noise associated with firing activities is likely to keep animals away.

The beach area in front of Pad 5 is part of the shoreline restoration project. Wildlife is slowly returning to the restored shoreline area, and utilization of this area may increase in the future. Sabots, armatures, and pusher plates break off after railgun firing. Safety footprints have been calculated and would be applied during testing. Expended sabots, armatures, and pusher plates would hit the water at distances from a minimum of 600 feet (183 meters) to a maximum of 3 nautical miles from the gun in the direction of the target, placing them in the waters of the nearshore area, resulting in no onshore impacts to plants or animals from expended munitions components.

Noise generated during firing could potentially disturb animals in the area. Noise levels in the immediate vicinity of the line of fire would reach up to 150 dBP (Section 3.3; Figures 3.3-1 to 3.3-5), and drop rapidly with distance from the firing point. Animals in the line of fire may be temporarily disturbed by firing, but resident wildlife in the vicinity of WFF is frequently exposed to loud noise associated with activities, some at much higher levels (e.g., rocket launches) than would be generated by the Proposed Action. Transient wildlife, such as migratory shorebirds, may be less habituated to noise and may be startled. Effects would be temporary and only a limited number of projectiles would be fired each day. Noise would not affect vegetation.

Most testing would occur during the day. If night testing is required, lighting would be used. Lighting may disturb individual animals, which may relocate to unlit areas of WFF during testing.

Noise and light associated with testing may startle animals away from the area and interrupt foraging. However, disturbances would be intermittent and would not affect animals at the population level.

Emissions from firing would consist of low levels of compounds or elements, such as CO, nitrogen, and water that are naturally found in air. There would be negligible deposition and no significant impacts to soil and water resources used by wildlife. Testing activities under the Pad 5 Alternative would have no significant impacts on WFF's terrestrial biological resources.

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3.10.2.3 Pad 4 Alternative

Pad 4 is also a former rocket launch pad, located close to Pad 5. Impacts from this alternative would be almost identical to the preferred alternative, as it would be located about 1,020 feet (310 meters) southwest of the Pad 5 Alternative. There are some wetlands in the northwest area of the site, but based on the current conceptual layout, wetland impacts would be avoided.

Testing activities under the Pad 4 Alternative would be similar to those under the Pad 5 Alternative and would have no significant impacts on WFF's terrestrial biological resources.

3.10.2.4 Elevated Road Alternative

The Elevated Road site would utilize an old road and an adjacent area where gravel would be placed. Impacts from this alternative would be similar to the Pad 5 Alternative, except testing would be located about 280 feet (85 meters) north of the Pad 5. There is a small wetland area in the southwest area of the site, but that area would not be disturbed.

Testing activities under the Elevated Road Alternative would be similar to those under the Pad 5 Alternative and would have no significant impacts on WFF's terrestrial biological resources.

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3.11 Aquatic Biological Resources

This section discusses aquatic biological resources in the nearshore (within 3 nautical miles) of WFF. Protected species and habitats, including sea turtles, marine mammals, and EFH are described in Section 3.12. Offshore aquatic biological resources are covered in the AFTT FEIS/OEIS (Navy 2013), which evaluates the impacts from at-sea training and testing activities and is incorporated by reference in this EA.

3.11.1 Affected Environment

3.11.1.1 Aquatic Vegetation

The Virginia Institute of Marine Science has been mapping submerged aquatic vegetation in the Chesapeake Bay and Delmarva Peninsula Bays since the 1970s using aerial photo-interpretation and ground surveys. Eel grass (*Zostera marina*) and widgeon grass (*Ruppia maritima*) are the dominant submerged aquatic vegetation species in the Delmarva Peninsula bays that can be found in waters near WFF (Orth et al. 2013). Submerged aquatic vegetation beds are present in the waters north of the Mainland, near the mouth of Little Mosquito Creek, and further east in the waters of Chincoteague Bay, but none are located in the waterways on or adjacent to WFF near the Proposed Action area (Orth et al. 2013).

3.11.1.2 Plankton

Plankton refers to organisms that passively float or weakly swim in water. While planktonic organisms may have some locomotory ability, they generally do not have enough power to counteract major ocean currents or turbulence. The majority of planktonic organisms are, at most, less than an inch (2.5 centimeters) in size. Plankton are found in freshwater and saltwater ecosystems.

Zooplankton, or animal plankton, provides the intermediate link between primary producers, such as phytoplankton (plant plankton), and secondary consumers, such as macroinvertebrates and fish. Zooplankton can include organisms that spend their entire life as plankton, such as copepods, cladocerans, and rotifers or those that spend only a portion of their life as plankton, such as the larvae of benthic invertebrates, benthic chordates, and certain fish.

3.11.1.3 Macroinvertebrates

Most major invertebrate groups are found in nearshore sandy areas including mollusks (e.g., clams and whelks), crustaceans (e.g., crabs, shrimp, and amphipods), and polychaetes (marine worms). Commercially important invertebrates such as the sea scallop (*Plactopecten magellanicus*) and blue crab (*Callinectes sapidus*) are seasonally abundant in Virginia (see Section 3.5.1.5). Other species of decapod crustaceans, stomatopod crustaceans, and cephalopods are also found in the nearshore area.

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3.11.1.4 Fish

The structure of fish communities depends on abiotic (physical) factors, such as salinity, temperature, and dissolved oxygen, and biotic (biological) factors such as food availability, competition, predation, and habitat requirements. Common fish in the waters near WFF include the Atlantic croaker (*Micropogonias undulates*), sandbar shark (*Carcharhinus plumbeus*), sand shark (*Carcharisa taurus*), northern pipefish (*Syngnathus fuscus*), dusky pipefish (*Syngnathus floridae*), bay anchovy (*Anchoa mitchilli*), smooth dogfish (*Mustelus canis*), smooth butterfly ray (*Gymnura micrura*), bluefish (*Pomatomidae saltatrix*), spot *(Leiostomus xanthurus*), and summer flounder (*Paralichthys dentatus*) (NASA 2008).

Fish species composition in the Virginia Capes OPAREA is diverse since numerous species, including commercially and recreationally important species, migrate seasonally through this region (Navy 2009). There is significant overlap of cold-temperate and warm-temperate species and dramatic seasonal shifts in their distribution. Warm-water species such as bluefish and weakfish (*Cynoscion regalis*) enter the region as temperatures rise in the spring and summer, while cold-water species such as Atlantic cod (*Gadus morhua*), Atlantic herring (*Clupea harengus*), and American shad (*Alosa sapidissima*) migrate north. Similarly, as fall approaches, warm-water species may migrate offshore toward deep waters and then move southward, while cold-water species move south into the Mid-Atlantic Bight areas.

3.11.2 Environmental Consequences

3.11.2.1 No Action Alternative

Under the No Action Alternative, operational missions and activities would remain at current levels and there would be no testing of the powder gun or railgun. There would be no impact on aquatic biological resources.

3.11.2.2 Pad 5 Alternative (Preferred Alternative)

Potential impacts on biological resources associated with the Proposed Action consist of direct impacts on aquatic life and indirect impacts on sediment and water quality.

It is possible that expended military materials such as sabots, pusher plates, and armatures could strike fish or other aquatic life. However, the velocity of these materials would rapidly decrease upon contact with the water and as they travel through the water column. Consequently, most fish and aquatic life would have ample time to detect and avoid expended material falling through the water column. Military expended materials hitting the water could result in an extremely unlikely strike of an individual fish, or more likely in a short-term and local displacement of fish in the water column. However, these behavioral reactions are not expected to result in significant changes to an individual's fitness or species recruitment, and are not expected to result in population-level impacts. The overall number of military expended material under this alternative would result in an increase in the strike risk; however, it would not rise to the level of being a concern.

Sabots, armatures, and pusher plates break off after railgun firing and may land in the nearshore area. Projectiles fired by the powder gun and railgun would sink to the bottom of the seafloor. Most military expended materials that settle on soft bottom habitats, while not damaging the actual substrate, would inhibit the substrate's ability to function as a habitat by covering it with a

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hard surface. This would effectively alter the substrate from a soft surface to a hard structure and, therefore, would alter the habitat to be more suitable for organisms more commonly found associated with hard bottom environments. However, when HVP firing would be at the highest level, with an average of 250 projectiles fired annually, accumulated sabots on the seafloor would impact only 0.0017 percent of the total sabot petal impact area. Pusher plates would impact 0.0000075 percent and armatures would impact 0.000064 percent of the pusher plate and armature impact area. Expended materials that settle in the shallower, more dynamic environments of the continental shelf would likely be eventually covered over by sediments due to currents and other coastal processes or encrusted by organisms. The firing of an average of 250 shots a year would have a negligible impact on soft and hard substrates and the biological resources associated with them.

The AFTT FEIS/OEIS (Navy 2013) examined the potential impact of a worst-case scenario of usage of military expended material and found that it would impact only a small percentage of the total Virginia Capes OPAREA seafloor (Navy 2013). The firing of up to an average of 250 shots a year (the level in the 5th program year) would have a negligible impact on soft and hard substrates and the biological resources associated with them.

Indirect impacts that could influence aquatic biological resources include change to water or sediment quality from the introduction of military expended materials into the ocean. The military expended materials associated with powder and railgun testing would be limited to up to 250 projectiles a year, including up to 50 live projectiles, which would be widely dispersed in space and time.

Chemical, physical, or biological changes to water or sediment quality would not be detectable and would remain below or within existing conditions or designated uses, as described in detail in the AFTT FEIS/OEIS (Navy 2013). This conclusion is based on the following:

- Many components of expended materials are inert or corrode slowly
- The alloys used in expended materials do not contain metals with high toxicities and metal corrosion is a slow process that allows for dilution
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign; and
- Potential areas of negative impacts would be limited to small zones immediately adjacent to the expended materials.

Therefore, potential water and sediment quality impacts would be insignificant.

Testing of HVPs and the railgun under the Pad 5 Alternative would have no significant impacts on WFF's nearshore aquatic biological resources.

3.11.2.3 Pad 4 Alternative

The nearshore impacts of the Proposed Action from Pad 4 would be identical to that of Pad 5, as there would only be a slight difference in the firing location. Firing activities under the Pad 4 Alternative would have no significant impacts on WFF's nearshore aquatic biological resources.

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3.11.2.4 Elevated Road Alternative

The nearshore impacts of the Proposed Action from the Elevated Road Alternative would be identical to that of Pad 5, as there would only be a slight difference in the firing location. Firing activities under the Elevated Road Alternative would have no significant impacts on WFF's nearshore aquatic biological resources.

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3.12 Protected Species

A wide range of plants and animals are found at or offshore of WFF. Specific laws and regulations applicable to biological resources are discussed in Section 3.12.1. Section 3.12.2 discusses protected plant and animal species found at or within the nearshore area of Wallops Island and Section 3.12.3 covers environmental impacts with and without mitigation measures. Mitigation measures are discussed in Appendix B.

3.12.1 Laws and Regulations

This section describes laws to protect biological resources relevant to the Proposed Action.

3.12.1.1 Endangered Species Act

The Endangered Species Act (ESA) of 1973 (16 U.S.C. § 1531 et seq.; 50 C.F.R. § 17, Subpart I, and 50 C.F.R. § 402) and subsequent amendments provide for the conservation of threatened and endangered species of animals and plants, and the habitats in which they are found. The ESA prohibits jeopardizing endangered and threatened species or adversely modifying critical habitats essential to their survival without specific authorization from the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) depending on the species and the area within which it occurs. A species is considered “endangered” if it is in danger of extinction throughout all or a significant portion of its range, and “threatened” if it is likely to become endangered in the foreseeable future.

Section 7(a)(2) of the ESA requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. Federal agencies are required to consult with USFWS or NMFS if an action may affect a listed species.

The Virginia Endangered Species Act gives the Virginia Department of Game and Inland Fisheries regulatory authority over federally or state listed fish or wildlife species in Virginia. NASA coordinates with the Virginia Department of Game and Inland Fisheries and Virginia Department of Conservation and Recreation to ensure protection and monitoring of state-listed species at WFF.

3.12.1.2 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §§ 1361-1421h) establishes a federal responsibility to conserve marine mammals, with management vested in the NMFS for whales, dolphins, porpoises, seals, and sea lions. USFWS is responsible for all other marine mammals (i.e., manatees, dugongs, polar bears, sea otters, and walruses). NMFS maintains jurisdiction of the majority of marine mammal species found worldwide.

The act prohibits the "taking" of marine mammals in the United States or on the high seas, subject only to limited exceptions. The term “take,” as defined in Section 3 (16 U.S.C. § 1362) of the MMPA, means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” “Harassment” was further defined in the 1994 amendments to the MMPA, which provided two levels of “harassment” – Level A (potential injury) and Level B (potential disturbance).

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The National Defense Authorization Act of fiscal year 2004 (Public Law 108-136) amended the definition of harassment as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government, consistent with Section 104(c)(3) [16 U.S.C. § 1374 (c)(3)]. For military readiness activities the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"), or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 U.S.C. § 1362 (18)(B)(i)(ii)].

3.12.1.3 Magnuson-Stevens Fishery Conservation and Management Act

The Fishery Conservation and Management Act of 1976 (later changed to the Magnuson Fishery Conservation and Management Act in 1980), established a 200-nautical mile fishery conservation zone in United States waters and a regional network of fishery management councils. The Fishery Management Councils are composed of federal and state officials, including USFWS, which oversee fishing activities within the fishery management zone. In 1996, the Magnuson Fishery Conservation and Management Act was reauthorized and amended as the Magnuson-Stevens Fishery Conservation and Management Act, also known as the Sustainable Fisheries Act. The Magnuson-Stevens Fishery Conservation and Management Act mandated numerous changes to the existing legislation designed to prevent overfishing, rebuild depleted fish stocks, minimize by-catch, enhance research, improve monitoring, and protect fish habitat.

One of the most significant mandates in the Magnuson-Stevens Fishery Conservation and Management Act is the Essential Fish Habitat (EFH) provision, which provides the means to conserve fish habitat. The EFH mandate requires that the regional Fishery Management Councils, through federal fishery management plans, describe and identify EFH for each federally managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitats.

Congress defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. § 1802[10]). The term "fish" is defined in the Magnuson-Stevens Fishery Conservation and Management Act as "finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds." The regulations for implementing EFH clarify that "waters" include all aquatic areas and their biological, chemical, and physical properties, while "substrate" includes the associated biological communities that make these areas suitable fish habitats (C.F.R. § 50:600.10). Habitats used at any time during a species' life cycle (i.e., during at least one of its life stages) must be accounted for when describing and identifying EFH. In addition to EFH designations, areas called habitat areas of particular concern, which are a subset of designated EFH that is especially important ecologically to a species/life stage and/or is vulnerable to degradation, are also to be designated to provide additional focus for conservation efforts (50 C.F.R. § 600.805-

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600.815). Categorization as habitat areas of particular concern does not confer additional protection or restriction to designated areas.

Authority to implement the Magnuson-Stevens Fishery Conservation and Management Act is given to the Secretary of Commerce and delegated to NMFS. The act requires that EFH be identified and described for each federally managed species. NMFS and regional fishery management councils determine the species distributions by life stage and characterize associated habitats, including habitat areas of particular concern. The Magnuson-Stevens Fishery Conservation and Management Act requires federal agencies to consult with NMFS on activities that may adversely affect EFH, or when NMFS independently learns of a federal activity that may adversely affect EFH. The act defines an adverse effect as "any impact which reduces quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 C.F.R. § 600.810).

NMFS concurred with the Navy's determination that the proposed action is not likely to adversely affect the EFH (Appendix B).

3.12.1.4 Other Regulations

Migratory Bird Treaty Act

Many bird species occurring at WFF are protected under the Migratory Bird Treaty Act. The Migratory Bird Treaty Act of 1918 established federal responsibilities for protecting nearly all migratory species of birds, eggs, and nests. Bird migration is defined as the periodic seasonal movement of birds from one geographic region to another, typically coinciding with available food supplies or breeding seasons. More than 1,000 species are protected under the Migratory Bird Treaty Act. Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. § 21), the USFWS promulgated a rule that permits the incidental take of migratory birds during military readiness activities necessary for national defense.

Bald and Golden Eagle Protection Act

The bald eagle (*Haliaeetus leucocephalus*) is further protected under the Bald and Golden Eagle Protection Act (16 U.S.C. §§ 668-668d), which prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles. Taking is described to include their parts, nests, or eggs, molesting or disturbing the birds.

3.12.2 Protected Species Found in Proposed Action Area

3.12.2.1 Animals and Plants

Federal and state protected animals and plants that may occur on or in nearshore areas off of Wallops Island are listed in Table 3.12-1. Figure 3.12-1 shows the known locations of protected species.

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Table 3.12-1: Federal ESA and State Listed Species Potentially Found near the Proposed Action Area

Common Name	Scientific Name	Federal Status	State Status
PLANTS			
Seabeach amaranth	*Amaranthus pumilus*	Threatened	Threatened
FISH			
Atlantic sturgeon	*Acipenser o. oxyrinchus*	Threatened/Endangered[1]	Tier II species of greatest conservation need
REPTILES			
Loggerhead sea turtle	*Caretta caretta*	Threatened[2]	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempi*	Endangered	Endangered
Atlantic green sea turtle	*Chelonia mydas*	Threatened[3]	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	Endangered
BIRDS			
Red knot	*Calidris canutus*	Proposed Threatened	Tier IV species of greatest conservation need
Piping plover	*Charadrius melodus*	Threatened	Threatened
Roseate tern	*Sterna d. dougallii*	Threatened	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Bald and Golden Eagle Protection Act	Delisted
Wilson's plover	*Charadrius wilsonia*	Not listed	Endangered
Peregrine falcon	*Falco peregrinus*	Delisted	Threatened
Gull-billed tern	*Gelochelidon nilotica*	Not listed	Threatened
MAMMALS			
Fin whale	*Balaenoptera physalus*	Endangered	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered	Endangered
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered

Notes: [1] Five distinct population segments (DPSs) may be present in the action area. Atlantic sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs are listed as endangered, while the Gulf of Maine DPS is listed as threatened (77 Federal Register 5880; 77 Federal Register 5914; both 6 February 2012).

[2] Nine DPSs of loggerhead turtles were determined in 2011 within the global population (76 C.F.R. 58868). The only DPS that occurs within the effect area of this EA—the Northwest Atlantic Ocean DPS—is listed as threatened.

[3] As a species, the green turtle is listed as threatened, but the Florida and Mexican Pacific coast nesting populations are listed as endangered. It is likely that any green turtles found at WFF are not from these populations.

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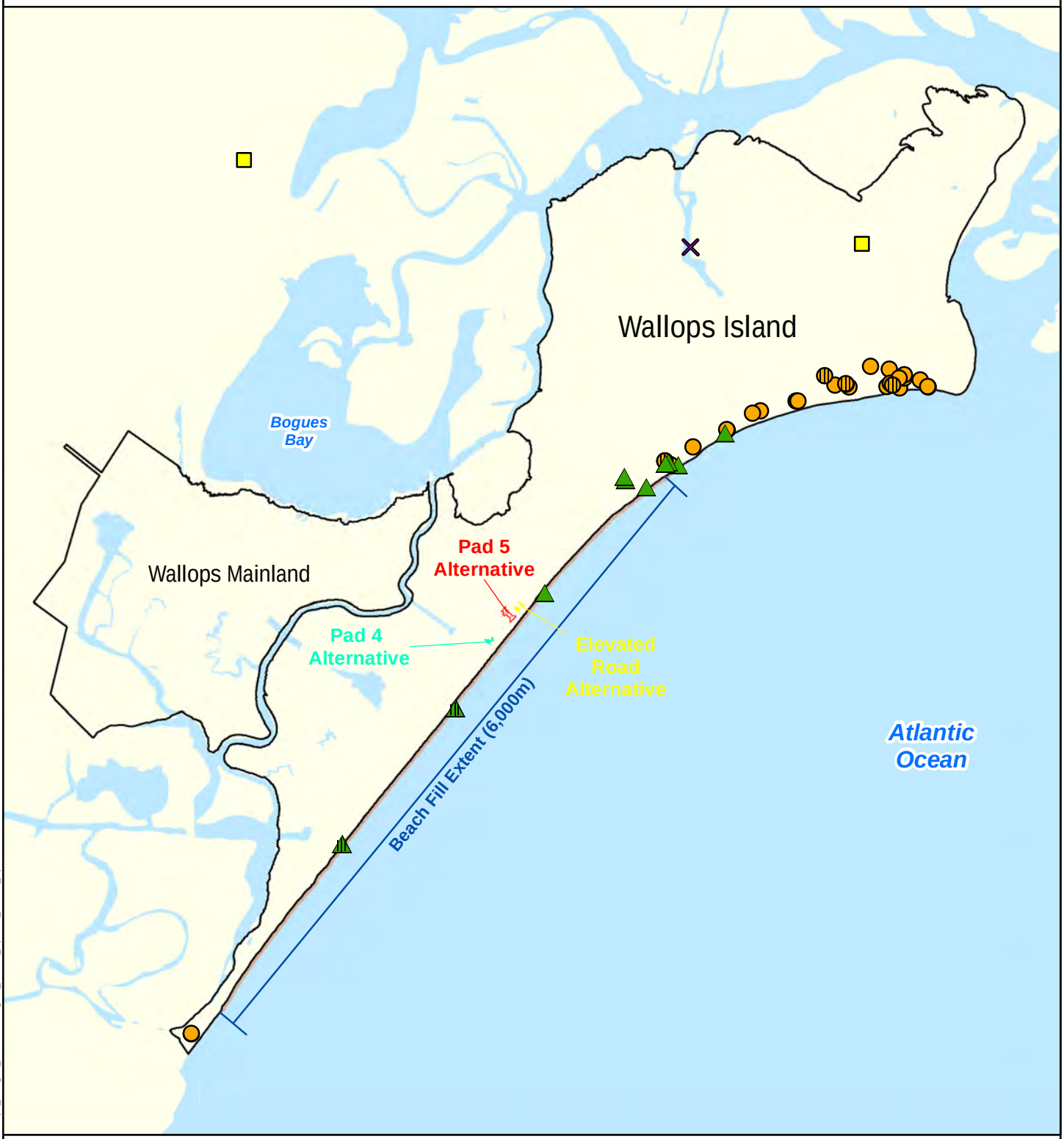
Special-Status Species on Wallops Island



Loggerhead Sea Turtle Nest (2013)
Loggerhead Sea Turtle Nest (2010-2012)
Piping Plover Nest (2013)
Piping Plover Nest (2010-2012)
Active Bald Eagle Nesting Site
Peregrine Falcon Nest Tower
Installation Boundaries

0 4,000 8,000
Feet
0 1,220 2,440
Meters
N

Sources: NASA 2010b, NASA 2011a, NASA 2012a, NASA 2013b, NASA 2013c.

Figure 3.12-1

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EA\MXDs\Figure_3.12-1_Special_Status_Species.mxd

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WFF administers a *Protected Species Monitoring Plan* (NASA 2013a) to manage threatened and endangered species in accordance with Section 7 of the ESA. This monitoring plan details a methodology to monitor protected species within the property boundaries of Wallops Island. Protected species covered by this plan include sea turtles, in particular the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea)*; birds, including the piping plover (*Charadrius melodus*) and red knot (*Calidris canutus*); and the plant seabeach amaranth (*Amaranthus pumilus*). Other species of interest surveyed include at a minimum Wilson's Plover (*Charadrius wilsonia*) (state endangered), American oystercatcher (*Haemotopus palliates*), and colonial nesting birds such as tern species (NASA 2013a). The marine mammal and sea turtle stranding program managed at WFF in cooperation with the Virginia Aquarium is also included in this plan. WFF confers with the USFWS and the Virginia Department of Game and Inland Fisheries to determine which other species will be surveyed and to confirm survey methods.

In 2011, the Virginia Department of Conservation and Recreation conducted an inventory of rare plant species and habitat in the northern portion of Wallops Island. This inventory found occurrences of Florida thoroughwort (*Eupatorium anomalum*) and Maritime Dune Woodland habitat in northern Wallops Island, approximately 2.8 miles (4.5 kilometers) northeast of Pad 5. Although Florida thoroughwort is not listed as threatened or endangered by Virginia or USFWS, it is considered rare in Virginia and globally (Van Alstine et al. 2012). In coordination with the Virginia Department of Conservation and Recreation, WFF created the Rare Species and Community Action Plan for Northern Wallops Island (NASA 2012b).

3.12.2.2 Essential Fish Habitat

NASA prepared an EFH assessment (NASA 2010a) in conjunction with the programmatic environmental impact statement for the WFF Shoreline Restoration and Infrastructure Protection Program (SRIPP). Likewise, the Navy prepared an EFH assessment (Navy 2012a) in conjunction with the AFTT FEIS/OEIS (Navy 2013). That EFH assessment reassesses the EFH analyses of Navy at-sea training and testing activities contained in various NEPA documents, including the Navy's EFH assessment for the Virginia Capes Range Complex, and consolidates those analyses into a single EFH assessment.

The Shoreline Restoration and Infrastructure Protection Program EFH assessment and the Atlantic Fleet Training and Testing EFH assessment describe in detail all managed species and life stages that could occur within the project area, inclusive of nearshore and offshore marine waters at WFF and within the proposed firing area. As such, the documents are incorporated by reference in this report.

3.12.3 Protected Species

3.12.3.1 Plants

Seabeach Amaranth

Seabeach amaranth is an annual plant that is federally and state listed as threatened. It occupies a narrow beach zone that lies at elevations from 0.7 to 5 feet (0.2 to 1.5 meters) above mean high tide. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season. Landward, seabeach amaranth does not occur more than

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approximately 3 feet (1 meter) above the beach elevation on the foredune, or anywhere behind it, except in overwash areas.

Seabeach amaranth has never been documented on Wallops Island, but has been found on nearby Assateague Island. Although this species is not found on Wallops Island, the necessary habitat is present. WFF currently performs annual surveys for this plant species to ensure no unintended impacts occur. There were no documented occurrences of seabeach amaranth at WFF as of 2013 (NASA 2013c). Beach re-establishment activities have restored the primary dune over what was once a seawall along Wallops Island. As this habitat stabilizes and becomes more established, natural recruitment of seabeach amaranth is possible.

3.12.3.2 Fish

Atlantic Sturgeon

There are five distinct population segments (DPSs) of Atlantic sturgeon. The New York Bight, Chesapeake Bay, South Atlantic, and Carolina DPSs are listed as endangered, while the Gulf of Maine DPS is listed as threatened (77 Federal Register 5880; 77 Federal Register 5914; February 6, 2012). The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida, and therefore sturgeon from any of the five DPSs may occur off Wallops Island.

The Atlantic sturgeon is a long-lived, estuarine dependent, anadromous fish that can grow up to approximately 14 feet (4 meters) in length and weigh up to 800 pounds (360 kilograms) (NMFS 2013a). They are similar in appearance to shortnose sturgeon but are distinguished by their larger size, smaller mouth, different snout shape, and scutes (scales). Though historically abundant, the slowly reproducing populations have been depleted due to overfishing, water pollution, and commercial bycatch (NMFS 2010).

Atlantic sturgeon range from Newfoundland to the Gulf of Mexico and are highly migratory. Adults migrate to natal rivers and spawn in flowing waters between the salt front and fall line. Spawning occurs in the spring and early summer and afterwards adults migrate into estuarine and marine waters where they spend the majority of their lives.

Atlantic sturgeon are benthic feeders and typically forage on benthic invertebrates (crustaceans, worms, mollusks, etc.). Atlantic sturgeon stay at the bottom and move into deeper waters (197 to 213 feet [60 to 65 meters]) when the temperature drops to between 37 to 46 degrees Fahrenheit (3 to 8 degrees Celsius). They disperse back into shallower waters as temperatures rise again. Limited tracking has shown that they can stay in the same area for months, although sub adults may move over large areas of the coast (Hager 2011).

Sub adults and adults live in coastal waters and estuaries when not spawning, generally in shallow (35 to 165 feet [10 to 50 meters]) inshore areas of the continental shelf where they feed (NMFS 2010). In a 2004 study using fisheries bycatch data, Atlantic sturgeon were found to be strongly associated with specific coastal areas, such as the mouths of Narragansett Bay and Chesapeake Bay and the inlets of the North Carolina Outer Banks. Most fish were caught within a narrow range of depths (30 to 160 feet [10 to 50 meters]) over gravel and sand, and to a lesser extent, silt and clay (Stein et al. 2004). Erickson et al. (2011) tracked Atlantic sturgeon using pop-up satellite archival tags. They found that mean-daily depths typically ranged from 16 to 115 feet (5 to 35 meters), with Atlantic sturgeon occupying deeper waters during winter and early

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spring (December to March) and shallower waters during late spring to early fall (May to September).

Atlantic sturgeon are expected to be present in the Proposed Action area. If present, Atlantic sturgeon are likely to use the project area as a migratory pathway/corridor to and from overwintering, foraging, and spawning grounds and would most likely be encountered in the fall and early spring – times of peak migration (NASA 2011b).

3.12.3.3 Sea Turtles

Loggerhead Sea Turtle

The loggerhead sea turtle is a federally and state listed threatened species. In 2009, a status review conducted for the loggerhead identified nine distinct population segments within the global population (Conant et al. 2009). In a September 2011 rulemaking, NMFS and USFWS listed five of these distinct population segments as endangered and kept four as threatened under the ESA, (NMFS and USFWS 2011). The Northwest Atlantic DPS is the only one that occurs entirely within the Proposed Action area. However, loggerheads from other distinct population segments may occur within the Proposed Action area.

The National Oceanic and Atmospheric Administration proposed critical habitat for the loggerhead turtle in July 2013 (National Oceanic and Atmospheric Administration 2013). One of the critical habitat areas is Atlantic Ocean Sargassum (LOGG-S-1), encompassing U.S. waters south of 40° N latitude in the Atlantic Ocean to the beginning of the Gulf of Mexico from the 10-meter depth contour to the outer boundary of the U.S. Exclusive Economic Zone, which includes all waters from New Jersey south to Florida inclusive of Virginia.

On average, adult loggerheads in the southeastern United States weigh 250 pounds (113 kilograms) and grow to a length of 3 feet (1 meter) (NMFS 2013a).

The diet of loggerhead turtles changes with age and size. Very little is known of the diet of oceanic juveniles, but they are thought to be primarily carnivorous, consuming mainly sea jellies and other invertebrates (NMFS and USFWS 2008). Between the ages of 7 to 12 years, juvenile loggerheads migrate to coastal waters (NMFS 2013a). Juvenile loggerhead turtles are omnivorous and feed on a wide variety of organisms inhabiting coastal waters. Although they may forage on pelagic (free swimming) crabs, mollusks, jellyfish, and vegetation captured at or near the surface, benthic (bottom dwelling) invertebrates, such as mollusks and crabs, comprise the majority of their diet (Dodd 1988; NMFS and USFWS 2008).

The waters off the Virginia and North Carolina coasts are important transitional habitat for juvenile sea turtles. Juvenile sea turtles along the U.S. Atlantic Coast exhibit seasonal foraging movements, migrating north along the coast in the early spring and south in the fall (Morreale and Standora 2005). Coastal waters of Virginia, particularly the Chesapeake Bay, serve as developmental habitat for juvenile loggerhead sea turtles and Kemp's ridley sea turtles, which take up residency during the summer months (Lutcavage and Musick 1985). The presence of juvenile sea turtles in Virginia coastal waters peaks from May through October. As waters cool

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in the fall, most sea turtles migrate out of the Chesapeake Bay and Virginia coastal waters to travel southward at least as far as Cape Hatteras, North Carolina to avoid cold stunning[2].

Along the U.S. coast loggerheads successfully nest from Texas to Virginia with major nesting concentrations from North Carolina to southwest Florida and the majority of nests – about 80 percent – occurring in six Florida counties (NMFS and USFWS 2008). In the southeastern United States, they mate from March to early June, and females lay eggs between late April and early September. Female sea turtles leave the ocean only to lay eggs. After leaving the beach as hatchlings, male sea turtles spend their entire lives in the ocean. Loggerheads, like most sea turtle species, nest only at night with the females emerging from the surf and crawling ashore (Nelson 1988). Female turtles come ashore individually and select an area to hollow out a pit with their back legs. Loggerheads deposit from 50 to 200 eggs. When the last egg is laid, the turtle covers the eggs with sand, tamps down the sand, flings more sand about with her flippers to erase signs of the nest, and then crawls back out to sea. Nesting takes between one and three hours.

After about two months the eggs hatch. After hatching, the hatchlings dig up through the sand and typically emerge as a group at the surface and orient seaward (Hopkins and Richardson 1984). A number of stragglers follow over the next few nights (Christens 1990). Hatchlings escaping from nests show an immediate and well-directed orientation toward the water, guided by light cues that include brightness, shape, and in some species, color (Witherington and Martin 1996).

The number of loggerhead nests, eggs, and eggs hatched, recorded at Wallops Island from 2010 to date is summarized in Table 3.12-2. In 2010, four loggerhead turtle nests and two false crawls (when a turtle attempts to nest, but returns to the water without laying eggs) were observed on Wallops Island between 15 June and 28 July (NASA 2010b). The four nests had an average hatch rate of 42 percent, with 226 out of 534 eggs hatching. In 2011 there were no loggerhead nests on Wallops Island (NASA 2011a). In 2012, two loggerhead nests and two false crawls were observed between 25 June and 12 July. One nest lost all eggs to a predator during the hatch window, while the second nest had 100 of 134 eggs hatching for a 75 percent hatch rate (NASA 2012a). In 2013, two loggerheads nested (NASA 2013c). In one nest 64 of 81 eggs hatched for a 79 percent hatch rate, while the other nest was placed closer to the intertidal line than the dune and had only a 3.5 percent (4 of 114 eggs) success rate (NASA 2013c). Locations where loggerhead sea turtle nests have been observed on Wallops Island in the last four years are shown on Figure 3.12-1.

Current threats to the species include incidental capture in fishing gear, direct harvest, disease, consumption of marine debris, and environmental contamination. Threats to nesting include loss or degradation of nesting habitat, beach armoring (hardening of the beach, removing suitable nesting substrate), artificial lighting (potentially disorienting nesting turtles and hatchlings), and non-native vegetation on beaches (NMFS 2013a).

[2] Cold stunning is the state that turtles enter when they are suddenly exposed to cold water of less than 50°F (less than 10 °C). In this circumstance, they may become lethargic and begin to float on the surface of the water, making them susceptible to predators, accidental boat strikes, and even death if water temperatures continue to drop (Witherington and Ehrhart, 1989).

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Table 3.12-2: Loggerhead Nests on Wallops Island

Year	Number of Nests	Number of Eggs	Number of Eggs Hatched
2010	4	534	226
2011	0	0	0
2012	2	134	100
2013	2	195	64
Source: NASA 2010b, 2011a, 2012a; 2013c.			

Kemp's Ridley Sea Turtle

Kemp's ridley sea turtles are federally and state listed as endangered. Adult Kemp's ridleys are considered the smallest of all sea turtles; growing to 28 inches (70 centimeters) long and weighing up to 100 pounds (45 kilograms) (NMFS, USFWS, and Secretary of Environment and Natural Resources, Mexico [SEMARNAT] 2010; NMFS 2013b). The carapace is round to somewhat heart-shaped and the coloration changes from grey-black in hatchlings to the lighter grey-olive top and cream-white or yellowish bottom of adults (NMFS, USFWS, and SEMARNAT 2010).

Kemp's ridleys range includes the United States. Atlantic seaboard from New England to Florida, and the Gulf of Mexico. Kemp's ridleys share a general life history pattern similar to other sea turtles, such as the loggerhead (NMFS, USFWS, and SEMARNAT 2010). Feeding grounds and developmental areas are found on the Atlantic and Gulf coasts of the United States.

Young Kemp's ridley hatchlings and small juveniles feed on the macroalgae *Sargassum* and associated floating species in habitats of the North Atlantic Ocean. Kemp's ridleys move as large juveniles and adults to benthic, nearshore feeding grounds along the United States Atlantic and Gulf coasts (Morreale and Standora 2005). Kemp's ridleys feed on crabs, fish, jellyfish, and mollusks. They are found in shallow marine waters from the coast to about the edge of the continental shelf (200 meters) (neritic zone) that typically contain muddy or sandy bottoms where their prey can be found.

Young Kemp's ridleys may forage during warmer months in the Chesapeake Bay area, generally heading southward out of Chesapeake Bay by early November (Lutcavage and Musick 1985). During the winter, Kemp's ridleys migrate south to warmer waters in Florida (Marquez 1994).

Primary nesting beaches are located in the western Gulf of Mexico from Mexico up to Texas (NMFS, USFWS, and SEMARNAT 2010). Kemp ridley's exhibit synchronized nesting where many females come ashore to nest along the same beach at the same time. Large groups are known to nest in the state of Tamaulipas, Mexico, where 95 percent of the worldwide nesting of Kemp's ridley turtles occurs. Occasional nests have been documented in North Carolina, South Carolina, and Gulf and Atlantic Coasts of Florida (NMFS 2013b). In 2012 a Kemp's ridley was recorded as nesting for the first time on the coast of Virginia (USFWS 2012). However, this individual nesting is considered an anomaly, and Kemp's ridley sea turtles are considered highly unlikely to nest at WFF.

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Kemp's ridley sea turtles have never been observed onshore at WFF (NASA 2008). However, turtles may occur offshore in relatively shallow waters (less than 160 feet [50 meters]) where habitat exists for prey species (NMFS 2013b).

Green Sea Turtle

Green sea turtles are federally and state listed as threatened. The green turtle is the largest hard-shelled sea turtle, with adults reaching a length of 3.3 feet (1 meter) and 300 to 350 pounds in weight (136 to 159 kilograms) (NMFS and USFWS 1991a; NMFS 2013c). The adult ranges in color from solid black to gray, yellow, green, and brown on top, while the bottom is yellowish white. The common name refers to the color of the green turtle's fat.

In U.S. Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Massachusetts, and are also found around the U.S. Virgin Islands and Puerto Rico (NMFS and USFWS 1991a; NMFS 2013c). Juvenile green turtles use estuaries along the Atlantic coast as summer developmental habitat (Epperly et al. 1995a, 1995b). Adults are predominantly tropical and are only occasionally found north of southern Florida.

Green turtles mainly nest from North Carolina south, with most of the primary nesting beaches occurring in a six-county area in east central and southeastern Florida (NMFS and USFWS 1991a). The only documented case of a green sea turtle laying a nest in Virginia occurred in 2005 on the southern part of Virginia Beach (Marine Turtle Newsletter 2006). Green turtles are considered extremely unlikely to nest on Wallops Island.

Green sea turtles have been directly observed in the waters off WFF (NASA 2008). These turtles are likely to inhabit the waters off WFF during the warmer months when seagrasses and algae are plentiful.

Leatherback Sea Turtle

The leatherback sea turtle is federally and state listed as endangered. It is the largest sea turtle, reaching up to 6.5 feet (1.8 meters) in length and weighing up to 2,000 pounds (907 kilograms). It is the only sea turtle that lacks a bony shell, with the carapace instead made up of thick, leathery, oil-saturated connective tissue overlaying loosely interlocking dermal bones. Leatherbacks are the most migratory and widest-ranging of all sea turtle species. Unlike other sea turtle species, leatherbacks are more dependent upon prey availability and reproductive requirements than upon temperature for determining their distribution, as they are able to regulate their internal temperature. As a consequence, leatherbacks geographically range from the tropics to temperate waters and within these areas are found from nearshore to mid-oceanic waters, including the waters of the continental shelf, edge, and slope.

Leatherbacks are commonly known as pelagic (open ocean) creatures but they also forage in coastal waters. Leatherbacks feed on soft bodied pelagic prey, such as jellyfish and sea squirts (NMFS 2013d), as they lack the strong jaws necessary to process hard-shelled prey.

Leatherbacks are occasionally observed in the Chesapeake Bay but do not appear to be regular inhabitants (Navy 2009). Aerial surveys off the Virginia coastline have documented leatherbacks congregating off the mouth of the Chesapeake Bay, especially from May to July, presumably to feed on abundant jellyfish (Navy 2009). Leatherback occurrences decrease in the fall, likely because prey abundance has decreased.

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Leatherback nesting in the western North Atlantic is restricted to coarse-grained beaches in subtropical and tropical latitudes (NMFS and USFWS 1991b). Along the Atlantic coast of the United States, leatherback turtles nest on beaches from southern Florida to Georgia, with occasional records from the Carolinas (Navy 2003). Leatherback nesting activity has not been reported in Virginia, although one leatherback emergence was documented in 1996 on the Assateague Island National Seashore in Maryland (Rabon et al. 2003). A potential egg chamber, but no eggs, was found. Therefore, Wallops Island is not considered a potential nesting location for leatherbacks.

Leatherbacks have never been sighted on WFF, but may occur in the waters offshore of Accomack County (NASA 2008).

Hawksbill Sea Turtle

The federally endangered hawksbill sea turtle (*Eretmochelys imbricata*) is named for its elongated head that tapers to a point. The head shape is well-suited for feeding on prey that is found in tight spaces; hawksbills are known to reach into crevices of coral reefs to retrieve sponges and other invertebrate prey organisms. Adults range between 25 to 35 inches (65 to 90 centimeters) in length and generally weigh 100 to 150 pounds (45 to 70 kilograms) (NMFS 2014a).

Hawksbills are found circumtropically, including in the Atlantic, Pacific, and Indian Oceans and associated water bodies. Hawksbills are highly migratory. Females nest on sandy beaches surrounding islands or mainland coasts in the tropics or subtropics. Hawksbills do not nest north of Florida in the continental United States, and there are no records of nesting in North Carolina or Virginia. Although hawksbills have been sighted as far north as Massachusetts, their occurrence north of Florida is extremely rare. Since 1979, only two hawksbill sea turtles have been documented in Virginia waters (Mansfield 2006). There have been no verified observations of hawksbill sea turtles, and hawksbills are extremely unlikely to occur in the waters off Wallops Island or nest on Wallops Island (NMFS 2007).

Like other sea turtles, this species uses different habitats during different life stages. Post-hatchlings are thought to occupy the pelagic environment, and some drift in mats of macroalgae (*Sargassum*). Movement to coastal areas occurs after several years, where feeding takes place in the benthic environment. Coral reefs are recognized as optimal habitat for juvenile, sub-adult, and adult hawksbill turtles likely because of the presence of sponges, a favored prey item that comprises as much as 95 percent of their diet (NMFS and USFWS 1993, Navy 2008).

The hawksbill sea turtle is unlikely to occur near WFF.

3.12.3.4 Birds

Piping Plover

Piping plovers are listed as threatened on the federal and state level. These small, beige and white shorebirds with a black band across their breast and forehead typically feed on invertebrates such as marine worms, beetles, fly larvae, crustaceans, and mollusks. Habitat generally consists of ocean beaches, and sand or algal flats in protected bays. Breeding occurs mainly on gently sloping foredunes or blow-out areas behind dunes.

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In late March or early April, after they have established territories and conducted courtship rituals, plover pairs form shallow depressions for nests where they lay their eggs in the sand. Nests can be found above the high tide line on coastal beaches, sandflats at the end of spits and barrier islands, gently sloping foredunes, blowout areas behind dunes, and over-wash areas between dunes. Nest site substrates may include a range of materials from fine grained sands up to shells and cobbles. Nests are typically found in areas with little or no vegetation; however, occasionally nests have been found under beach grass and other vegetation (NASA 2013a). In Virginia piping plovers nest in areas with wider beaches, greater access to mudflat habitats, lower relative amounts of vegetation on the beach margin, and fewer stable dunes (Wilson et al. 2007).

The piping plover is a common transient and summer resident of the upper Virginia barrier islands and is known to inhabit the coastal habitats of the nearby Chincoteague National Wildlife Refuge. Piping plovers are known to use the sandy beaches and tidal flats along the shore of Wallops Island.

From 1986 and 2005 there were two breeding pairs of piping plovers nesting on average each year on Wallops Island (Boettcher et al. 2007). Annually between 1996 and 2008, piping plovers were observed feeding on Wallops Island, although exact numbers were not recorded (NASA 2009). In 2008, two pairs of piping plovers began nesting attempts at the north end of Wallops Island but no eggs were laid. In 2009, three pairs nested successfully on the northern beaches (NASA 2009).

The number of piping plover nests, eggs laid, eggs hatched, and number of chicks fledged from 2010 to date is summarized in Table 3.12-3. In 2010, there were three nesting attempts, including one that successfully produced four chicks (NASA 2010b). In 2011, there were three documented piping plover nesting attempts on Wallops Island: two nests on the north end and one on the south end. Of the 12 eggs laid, 11 hatched and three chicks fledged (NASA 2011a). There were six piping plover nests on Wallops Island in 2012. Fourteen eggs hatched and three chicks successfully fledged from the 20 eggs laid (NASA 2012a). In 2013 there were four piping plover nests on Wallops Island with 12 eggs hatched and eight chicks fledged (NASA 2013c).

Table 3.12-3: Piping Plover Nests on Wallops Island

Year	Number of Nests	Number of Eggs	Number of Eggs Hatched	Number of Chicks Fledged
2010	3	12	7	4
2011	3	12	11	3
2012	6	20	14	3
2013	4	10+ (unknown number of eggs in one nest)	10	8
Source: NASA 2010b, 2011a, 2012a; 2013c.				

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Red Knot

The red knot, proposed for federal listing as threatened on September 30, 2013 (78 Federal Register 60023), is a medium-sized sandpiper and one of the longest-distance migrants known in the world. Red knots have a rusty red head and breast during the breeding season but are grey during the rest of the year. Red knots migrate more than 9,300 miles (15,000 kilometers) each spring and autumn. USFWS plans to publish a proposal to designate critical habitat for the red knot in the near future (78 Federal Register 60023).

The red knot feeds on small mussels and other mollusks for much of the year and horseshoe crab eggs during migration (USFWS 2005). Based on survey data, during the mid-1990s, 8,000 to 10,000 individuals migrated through the barrier islands of coastal Virginia. Surveys conducted in 2005 and 2006 recorded similar numbers. However, trends from migration surveys indicate strong declines along the Atlantic coast of the U.S. (Bart et al. 2013).

Red knots do not breed in the vicinity of Accomack County, although they appear regularly during spring migration on Wallops Island beaches, mostly during the second half of May (NASA 2010b, 2011a, 2012a). On May 8, 2009, a flock of approximately 1,300 individuals was observed on north Wallops Island and again in late May 2009, flocks of approximately 20 to 200 red knots were observed (NASA 2009). Survey data for 2010 indicate that approximately 900 birds were observed on the northern end of Wallops Island in May (NASA 2010b). Survey data for 2011 indicate that red knots began arriving on May 6 (three birds sighted), and the last bird seen was on July 19, with almost 1,200 birds counted during that period (NASA 2011a). In 2012, approximately 2,600 red knots were counted, with the first bird observed May 1 and the last observed June 1 (NASA 2012a). In 2013, about 2,400 red knots were counted on the recreational beach and the north curve of Wallops Island. The first bird was observed May 7 and the last was observed May 31 (NASA 2013c).

Wilson's Plover

Wilson's plover is considered endangered by the Virginia Department of Game and Inland Fisheries. It is a small- to medium-sized plover and is a coastal wader. Its range covers both the east and west coasts of the United States, with breeding populations along the Gulf Coast. Wilson's plover has been documented as occurring on south Wallops Island, and, although no nests have been documented on Wallops Island, they are historically known to nest with piping plovers (NASA 2008). Wilson's plover is included in protected species surveys at WFF (NASA 2013a).

Bald Eagle

The bald eagle was formerly on the federal endangered species list as endangered, but has recovered and was delisted in 2007. It was also delisted from the Virginia list of threatened and endangered species. Bald eagles are still protected under the Bald and Golden Eagle Protection Act. There is an active bald eagle nest on the northern end of Wallops Island, well away from all site alternatives, as shown on Figure 3.12-1 (NASA 2013b). Nesting activities typically begin in November and conclude in the summer when the young fledge.

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Peregrine Falcon

The peregrine falcon was formerly federally-listed as endangered, but was delisted in 1999 and is now considered recovered. It remains listed in Virginia as a threatened species. One man-made peregrine falcon nesting tower is located on Wallops Island, as shown on Figure 3.12-1, and has been historically utilized by a pair of falcons. Peregrine falcons are also known to occur on Wallops Island during migration (NASA 2008).

Gull-billed Tern

The gull-billed tern is state-listed as threatened. It is a medium-sized, black-capped, heavy-billed, and long-legged tern. It has a broad distribution, breeding in scattered localities in Europe, Asia, northwest Africa, Australia, and the Americas. In the United States it nests only in coastal colonies along the Atlantic and Gulf coasts. North American gull-billed terns winter along the Gulf Coast, Pacific coast of Mexico, and into Central and South America. Breeding and nesting takes place on sandy beaches in spring and summer. Gull-billed terns are considered uncommon summer residents along Virginia's Eastern Shore; uncommon transients on the coast south of Cape Henry; and rare in the Lower Chesapeake Bay. Breeding activity has been recorded on the coast of the Eastern Shore, but not on Wallops Island (Virginia Department of Game and Inland Fisheries 2012).

Roseate Tern

The roseate tern is primarily found on the northeastern coast of North America from Canada to Florida (USFWS 2011), but is a rare migrant along the U.S. coast south of New Jersey (Nisbet 1984). The northeast population, ranging from Canada to North Carolina, is listed as endangered; elsewhere, it is threatened. The roseate tern is about 14 to 17 *inches* (36 to 43 cm) long, with a wingspan of about 30 *inches* (76 cm). Outside of the breeding season, it has a black bill, black legs, white forehead and mostly white crown, with a long, deeply forked tail (USFWS 2011).

It is a specialist feeder eating almost exclusively small marine fish, mainly the American sand lance (*Ammodyte* sp.) that it captures by plunge-diving (USFWS 2011). It also may feed in shallow waters or may even steal food from other seabirds.

In Accomack County, roseate terns are a rare transient and summer visitor near the coast (Virginia Department of Game and Inland Fisheries 2013). Historically, roseate terns nested irregularly on Virginia's Eastern Shore, but there has been no definite record of breeding or nesting since 1927. There are no records of this bird on Wallops Island, although it may be sighted there in the future. Roseate terns are not specifically mentioned in the Protected Species Monitoring Plan (NASA 2013a) due to their low probability of occurrence. However, were a roseate tern observed during monitoring, the date, time, observer name, and place of encounter would be recorded and reported in the annual monitoring report.

3.12.3.5 Marine Mammals

Six marine mammal species have been identified in the waters around Virginia's eastern shore/Accomack County including the: fin whale, humpback whale, West Indian manatee, bottlenose dolphin (*Tursiops truncatus),* harbor seal *(Phoca vitulina),* and harbor porpoise (*Phocoena phocoena*). The common dolphin (*Delphinus delphis*) and gray seal (*Halichoerus grypus*) may also occur in the nearshore area and are also discussed here. The bottlenose dolphin, common dolphin, harbor seal, gray seal, and harbor porpoise are not listed under the

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ESA, but are protected under the MMPA. Although the West Indian manatee has been sighted in Virginia's coastal waters, it is not considered to occur in the area (USFWS 2014), as manatees occur primarily in Florida and southeastern Georgia (USFWS 2001). Between 1991 and 2012 there were a total of 112 Florida manatee sightings in Virginia (Cummings et al. in press), with the closest sighting to WFF 12 miles (19 kilometers) south near Metompkin Island. The manatee was not included on the USFWS list of species potentially found in the action area (Appendix A).

Bottlenose Dolphin

The Western North Atlantic Coastal stock of bottlenose dolphin is considered depleted under the MMPA (Marine Mammal Commission 2013). Bottlenose dolphins range in length from 6 to 12.5 feet (1.8 to 3.8 meters) and can weigh between 300 and 1,400 pounds (136 and 635 kilograms) (NMFS 2013e).

The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and United States east coast (Marine Mammal Commission 2013). Inshore bottlenose dolphins are smaller and lighter in color, and are commonly found in groups of 2 to 15 individuals (NMFS 2013e). Offshore individuals are larger, darker in color, have smaller flippers, and can be found in pods that contain several hundred dolphins. Coastal populations of bottlenose dolphins migrate into bays, estuaries, and river mouths while offshore populations inhabit oceanic waters along continental shelves. The primary habitat for the coastal morphotype of the bottlenose dolphin extends from New Jersey south to Florida during summer months and is found in waters less than 65 feet (20 meters) in depth; this includes estuarine and inshore waters (Waring et al. 2010). The bottlenose dolphin is likely to be found in nearshore waters off WFF.

Bottlenose dolphins are considered generalists and eat a variety of prey species that are endemic to their habitat. Coastal populations generally feed on benthic invertebrates and fish, and offshore populations feed on pelagic squid and fish (NMFS 2013e).

The best estimate for the Northern Migratory Coastal stock of bottlenose dolphins is 9,604, with a minimum population estimate of 7,147 (Waring et al. 2010). There are no significant species-specific threats to bottlenose dolphins in the northwest Atlantic.

Short-beaked Common Dolphin

The short-beaked common dolphin is a small dolphin, generally less than 9.0 feet (2.7 meters) long and weighing about 440 pounds (200 kilograms) (NMFS 2014b). Short-beaked common dolphins prefer warm tropical to cool temperate waters, ranging between 52 to 88° Fahrenheit (10 to 28° Celsius) that are primarily oceanic and offshore and occurs along the continental slope in waters 650 to 6,500 feet (200 to 2,000 meters) deep (NMFS 2014b).

Common dolphins feed mainly on epipelagic schooling fish, such as sardines, and cephalopods like squid, feeding primarily on organisms in the vertically migrating deep scattering layer.

Short-beaked common dolphins are less frequently found in shallower waters (Culik 2010). However, it is considered common off Assateague Island (Assateague Island National Seashore 2000). There was one common dolphin stranding in Accomack County in 2011 and two in 2012 (Swingle et al. 2012, 2013). The common dolphin is unlikely to occur in the nearshore waters off WFF.

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The western North Atlantic stock is estimated at 67,191 individuals with a minimum estimate of 52,893 (Waring et al. 2013). Threats to common dolphins include incidental take in fishing gear and hunting (Waring et al. 2012, NMFS 2014b).

Harbor Seal

Harbor seals range from 5.6 to 6.3 feet (1.7 to 1.9 meters) in length and weigh up to 245 pounds (110 kilograms) (NMFS 2013f).

Harbor seals are generally non-migratory and are found on the Atlantic east coasts from the Canadian Arctic to New York and occasionally in the Carolinas (Waring et al. 2012). Harbor seals are a coastal species and frequently occupy bays, estuaries, and inlets (Baird 2001). There are insufficient data to estimate a population size for this species.

Prey includes a variety of fish, shellfish, and crustaceans (NMFS 2013f). There are no significant species-specific threats for harbor seals in the western North Atlantic. There is no current stock estimate for the harbor seal (Waring et al. 2013).

Harbor seals would be considered a rare visitor to WFF. During the five-year period from 2006 to 2010, a total of seven harbor seals stranded in Virginia (Waring et al. 2012).

Harbor Porpoise

Harbor porpoises range from 5 to 5.5 feet (1.5 to 1.7 meters) in length and weigh between 135 to 170 pounds (61 to 77 kilograms) (NMFS 2013g). Harbor porpoises inhabit cool temperate-to-subpolar waters, often where prey aggregations are concentrated (Watts and Gaskin 1985). In the Western North Atlantic, harbor porpoises range from West Greenland south to Cape Hatteras.

Harbor porpoises are rarely found in waters warmer than 63°F (17°C) and closely follow the movements of their primary prey, Atlantic herring (Gaskin 1992). They also feed on capelin and cephalopods (NMFS 2013g). They are frequently found in shallow waters, most often near shore, but they sometimes move into deeper offshore waters. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 490 feet (150 meters) deep (Waring et al. 2013). During fall and spring, harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south. During winter, intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina and lower densities are found in waters off New York to New Brunswick, Canada (Waring et al. 2013). They are usually seen in groups of two to five individuals. Harbor porpoises may be found in the waters off WFF during the winter.

There is no current stock estimate for the harbor porpoise (Waring et al. 2013). The main threat to this species is bycatch in fishing gear, including gillnets, herring weirs, and trawls (Waring et al. 2013).

Gray Seal

The gray seal is about 7.5 to 10 feet in length (2 to 3 meters) and weighs between 550 to 880 pounds (250 to 400 kilograms) (NMFS 2014c).

Gray seals are generally found in coastal waters in cooler waters, where their blubber maintains necessary body temperatures (NMFS 2014c). In U.S. waters, gray seals currently pup at three established colonies and one new one: Muskeget Island, Massachusetts; Green Island, Maine;

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and Seal Island, Maine; and more recently, at Matinicus Rock in Maine (Waring et al. 2012). Gray seals may be infrequent visitors to the waters off the coast of WFF, but are unlikely to occur in nearshore waters.

Gray seals are opportunistic and feed on fish, crustaceans, and mollusks (NMFS 2014c). Social feeding is often practiced by gray seals to capture prey effectively.

Current population numbers for the western North Atlantic gray seal stock is unknown (Waring et al. 2013), but is estimated at over 250,000 animals (NMFS 2014c). Threats to gray seals include entanglement in fishing gear, hunting, collision with vessels, chemical contamination, and marine debris ingestion (Waring et al. 2012, NMFS 2014c).

Fin Whale

The fin whale is federally- and state-listed as endangered and is considered depleted under the MMPA. Fin whales, the second largest species of whale, grow to a maximum length of approximately 75 feet (23 meters) in the northern hemisphere, and can weigh from 40 to 80 tons (35 to 75 metric tons) (NMFS 2013h). They are found in social groups that range from two to seven individuals (NMFS 2013h).

Fin whales prefer temperate and polar waters and are rarely seen in warm tropical waters (Reeves et al. 2002). They typically congregate in areas of high productivity and spend most of their time in coastal and shelf waters but can often be found in waters approximately 6,562 feet (2,000 meters deep) (Reeves et al. 2002). Fin whales are common off the Atlantic coast of the United States in waters immediately off the coast seaward to the continental shelf. In this region, they tend to occur north of Cape Hatteras where they accounted for about 46 percent of the large whales observed in surveys conducted between 1978 and 1982 (U.S. Department of Commerce 2010 as cited in Navy 2013). During the summer, fin whales in this region tend to congregate in feeding areas between 41°20' N and 51°00' N, from shore seaward to the 6,000-foot (1,823-meter) contour.

Fin whales feed on krill, small schooling fish, and squid in the summer and fast during the winter migration (NMFS 2013h). Little is known about fin whale migration patterns.

Currently, the minimum population estimate for the North Atlantic fin whale stock is 2,817 individuals with a best estimate of 3,522 individuals (Waring et al. 2013). Threats to the species include collision with vessels and entanglement in fishing gear (NMFS 2013h).

Fin whales may be found in ocean waters over the continental shelf off the coast of WFF as a result of the habitat preferences of their prey (Reeves et al. 2002), but are unlikely to occur in the nearshore area.

Humpback Whale

The humpback whale is federally- and state-listed as endangered and is considered depleted under the MMPA. Humpback whales grow to lengths of up to 60 feet (18 meters), with females larger than males (NMFS 2013i).

Humpback whales are distributed worldwide in all major oceans and most seas. They typically are found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where

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calving occurs. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration.

Humpback whales spend summer months in high-latitude feeding grounds building fat reserves by feeding on krill, plankton, and small fish and can consume up to 3,000 pounds (1,360 kilograms) of food per day (NMFS 2013i). Humpback whales have been observed using "bubble nets" by diving and releasing bubbles of air that float up in a column and trap prey inside; the humpbacks then lunge through the column of trapped prey to feed. Humpback whales are frequently piscivorous when in New England waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes (Waring et al. 2013). Humpback feeding habitats are typically shallow banks or ledges with high seafloor relief (Payne et al. 1990). They migrate seasonally, and spend the winter months in tropical or subtropical waters where they congregate and engage in mating activities.

The best available population estimate for humpback whales derived from photographic mark-recapture analyses (a technique using aerial photography and computer-aided statistical analysis that takes advantage of the recognizable natural species marking) in the North Atlantic Ocean is currently 11,570 individuals (Waring et al. 2013).

Threats to humpback whales include entanglement in fishing gear, collision with vessels, whale watch harassment, and habitat impacts (NMFS 2013i).

Humpback whales may be found in ocean waters off the coast of WFF during migration but are unlikely to occur in nearshore waters. Recent data suggests that habitat off the mid-Atlantic states (Virginia and North Carolina) may be important for juvenile humpbacks (Waring et al. 2013). A juvenile humpback whale stranded on the north Wallops Island beach in September 2012 (Associated Press and WVEC.com 2012).

North Atlantic Right Whale

The North Atlantic right whale is federally- and state-listed as endangered and is considered one of the most critically endangered populations of large whales in the world. Right whales weigh up to 140,000 pounds (63,500 kilograms) and are about 50 feet (15 meters) long (NMFS 2013j).

North Atlantic right whales breed during the winter in the coastal waters of the southeast United States and spend the summer feeding in New England waters and north to the Bay of Fundy and Scotian Shelf (NMFS 2013j). Three critical habitats – Cape Cod Bay/Massachusetts Bay/Stellwagen Bank, Great South Channel, and the coastal waters of Georgia and Florida in the southeastern United States – were designated by NMFS in 1994 (59 Federal Register 28805).

The North Atlantic right whale is a baleen feeder. Its diet consists mainly of the copepod *Calanus finmarchicus* and on other copepods and small invertebrates (Baumgartner and Mate 2003). Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently. Right whales are skim feeders and are known to feed below or at the surface (Kenney et al. 2001 as cited in Navy 2013) or within a few meters of the seafloor on near-bottom aggregations of copepods (Baumgartner et al. 2009).

The minimum number of North American right whales is 444 (Waring et al. 2013) and the stock was estimated at approximately 509 individuals in 2011 (North Atlantic Right Whale Consortium 2012).

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Their feeding habits, buoyancy, and twice-yearly migration route along and often close to the United States east coast, crossing shipping lanes, places the North Atlantic Right whale at risk. The decline of the North Atlantic right whale's population can largely be attributed to ship strikes and entanglement in fishing gear and nets, as well as historical whaling (Waring et al. 2013). The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality and serious injury was a minimum of 3.0 right whales per year from 2006 through 2010 (Waring et al. 2013). To reduce the number of ship strikes, NMFS has established regulations (73 Federal Register 60173) imposing speed restrictions in seasonal management areas for commercial ships 65 feet or longer. In addition, the Navy has adopted standard operating procedures for protecting right whales from ship strikes.

The North Atlantic right whale is unlikely to occur in the nearshore area off Wallops Island.

3.12.4 Environmental Consequences

3.12.4.1 No Action Alternative

Under the No Action Alternative, operational missions and activities would remain at current levels, and there would be no testing of HVPs or the railgun. There would be no impact on protected species or essential fish habitat.

3.12.4.2 Pad 5 Alternative (Preferred Alternative)

Impacts of testing at the Pad 5 Alternative are discussed for the onshore area (beach area) and the nearshore area. An in-depth analysis of in-water impacts from projectiles striking locations within the Virginia Capes OPAREA is included in the AFTT FEIS/OEIS (Navy 2013), which evaluates the impacts from at-sea training and testing activities and is incorporated here by reference. Potential direct impacts onshore on protected species include disturbances due to construction and exposure to noise, light, and magnetic fields during testing. Potential direct impacts on nearshore protected species include military expended materials, such as sabots, pusher plates, and armatures, detaching from projectiles and falling into the water. Indirect impacts include potential air quality impacts onshore and potential water and sediment quality impacts in the nearshore area.

Plants

There would be no direct or indirect construction or operation impacts on seabeach amaranth because it is not present on Wallops Island and has not been observed in annual surveys (NASA 2013c).

As the ecological community of the newly restored shoreline area in front of Pad 5 becomes established, suitable habitat for seabeach amaranth may become available in the area between the seawall/dune and the water. Continuing beach replenishment through the years may negate this possibility. Because seabeach amaranth does not occur more than approximately 3 feet (1 meter) above the beach elevation on the foredune, or anywhere behind it except in overwash areas, it is unlikely to colonize the Pad 5 site, which is elevated above the beach and behind the seawall/dune. NASA would continue to conduct annual surveys on Wallops Island to determine if it has colonized the beach.

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In accordance with Section 7 of the ESA, the potential effects of construction and testing activities under the Pad 5 Alternative would have no effect on seabeach amaranth. In accordance with NEPA, construction and testing activities would have no impacts on seabeach amaranth.

Fish

The Atlantic sturgeon is found in coastal waters off WFF. Atlantic sturgeon are benthic fish and are found primarily near the sea floor. Direct impacts could occur if expended munitions parts – armatures, pusher plates, and sabots – strike them when they fall into the ocean.

Fish at the surface, and just below, would be most susceptible to injury or death from strikes from expended military materials because the velocity of these materials would rapidly decrease upon contact with the water and as they travel through the water column. Consequently, most fish in the water column would have ample time to detect and avoid expended materials that fall through the water column. The probability, based on impact footprint area, of any of these items striking a fish is extremely low.

Military expended materials hitting the water could result in an extremely unlikely strike of an individual fish, or more likely in a short-term and local displacement of fish in the water column. However, these behavioral reactions are not expected to result in significant changes to an individual's fitness or species recruitment, and are not expected to result in population-level impacts. The overall number of military expended material under this alternative would result in an increase in the strike risk; however, it would not rise to the level of being a concern.

The impact of military expended material strikes would be inconsequential due to: (1) the limited number of Atlantic sturgeon found directly at the surface where military expended material strikes could occur, (2) the rare chance that a fish might be directly struck at the surface by military expended materials, (3) the ability of most fish to detect and avoid an object falling through the water below the surface, and (4) the low probability of strike based on the impact footprint area. The potential impacts of military expended material strikes would be short-term (seconds) and localized disturbances of the water surface and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

Chemical, physical, or biological changes to water or sediment quality would not be detectable and would remain below or within existing conditions or designated uses, as described in detail in the AFTT FEIS/OEIS (Navy 2013). This conclusion is based on the following:

- Many components of expended materials are inert or corrode slowly
- The alloys used in expended materials do not contain metals with high toxicities, and metal corrosion is a slow process that allows for dilution
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign; and
- Potential areas of negative impacts would be limited to small zones immediately adjacent to the expended materials.

Therefore, potential water and sediment quality impacts would be insignificant.

Under Section 7 of the ESA, the effect of testing activities on the Atlantic sturgeon under the Pad 5 Alternative is expected to be insignificant or discountable. This alternative may affect, but is

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unlikely to adversely affect, the Atlantic sturgeon. In accordance with NEPA, testing activities under the Pad 5 Alternative would have no significant impacts on the Atlantic sturgeon.

Essential Fish Habitat

In accordance with the EFH Final Rule published in the Federal Register on January 17, 2002 (67 Federal Register 2343), federal agencies may incorporate an EFH assessment into documents prepared for another purpose, such as this EA, provided the EFH assessment is clearly identified as a separate and distinct section of the document. Accordingly, the Navy intends for this section to serve as its EFH assessment.

Sabots, armatures, and pusher plates would break off after railgun firing and land in the nearshore area. However, due to the low numbers of sabots, pusher plates, and armatures that would enter nearshore waters, there would be negligible potential for contact with adults, juveniles, larvae, and eggs of managed species and prey species from military expended materials striking the water, passing through the water column, and settling on the bottom. Given the low probability for direct hits and the variety of prey species targeted by the managed species, any impacts to managed species or prey species would be negligible and would not noticeably affect the managed species or their ability to feed.

The military expended materials would sink to the seafloor. Most military expended materials that settle on soft bottom habitats, while not damaging the actual substrate, would inhibit the substrate's ability to function as a habitat by covering it with a hard surface. This would effectively alter the substrate from a soft surface to a hard structure and, therefore, would alter the habitat to be more suitable for organisms more commonly found associated with hard bottom environments. However, when HVP firing would be at the highest level, with an average of 250 projectiles fired annually, accumulated sabots on the seafloor would impact only 0.0017 percent of the total sabot petal impact area. Pusher plates would impact 0.0000075 percent and armatures would impact 0.000064 percent of the pusher plate and armature impact area. Expended materials that settle in the shallower, more dynamic environments of the continental shelf would likely be eventually covered over by sediments due to currents and other coastal processes or become encrusted by organisms. The firing of an average of 250 shots a year would have a negligible impact on soft and hard substrates and the biological resources associated with them.

Indirect impacts that could influence aquatic biological resources include change to water or sediment quality from the introduction of military expended materials into the ocean. The military expended materials associated with powder and railgun testing would be limited to up to 250 projectiles a year, including up to 50 live projectiles, which would be widely dispersed in space and time. Chemical, physical, or biological changes to water or sediment quality would not be detectable and would remain below or within existing conditions or designated uses, as described in detail in the AFTT FEIS/OEIS (Navy 2013; Section 3.1).

All adverse impacts on managed species, associated species, and EFH are expected to be temporary and localized. Military expended materials falling into the water under the Pad 5 Alternative may adversely affect EFH, but likely would result in minimal adverse effects on EFH, as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. Consistent with Navy policy (Navy 2011), the Navy consulted with the National Marine Fisheries Service in accordance with the Magnuson-Stevens Fishery Conservation and Management Act. In accordance with NEPA, testing activities under the Pad 5 Alternative would

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have no significant impacts on EFH. NMFS concurred with the Navy's determination (Appendix B).

Sea Turtles

Onshore Impacts (Nesting Sea Turtles)

Of the five species of sea turtles listed in Table 3.12-1 that may occur in the waters off WFF, only the loggerhead turtle has been observed on the beaches of WFF and is known to use Wallops Island beaches for nesting. Potential direct impacts on nesting turtles could include disturbances associated with construction, and noise and/or lighting disturbances associated with testing. Construction would take place during daylight hours. Nesting sea turtles and hatchlings would not be present during daylight hours, and therefore, noise or increased activity due to construction would have no effect on sea turtles and is not discussed further.

Lighting associated with night testing may disorient nesting sea turtles or hatchlings, but most testing would take place during daylight hours. There is a limited time period from April to early September when HVP testing and turtle nesting might occur at the same time. The longer day length during the sea turtle nesting season would reduce the need for night testing.

The closest sea turtle nest to Pad 5 in recent years was located 1,000 feet (305 meters) away from the guns. The seawall/dune physically separates the testing area and potential nesting habitat. Although the seawall/dune serves as a deterrent, there is a recorded instance of a loggerhead nesting on the sand-covered part of the seawall/dune in the past.

Man-made ambient lighting can impact sea turtle nesting and hatchling sea-finding activities by interfering with the visual cues sea turtles use to find nesting beaches and cues used by hatchlings to find the sea (Witherington and Martin 1996; USFWS 2010a). These cues include the natural light of the ocean horizon and lower elevations (Lohmann and Lohmann 1996). Magnetic fields are used for orientation once turtles are in a marine environment (Lohmann and Lohmann 1996).

If nighttime testing is required, possible mitigation measures to protect nesting sea turtles and hatchlings from light disturbances would include:

- Keeping the gun site dark when not in use (i.e., no outside security lights turned on).
- Using turtle-friendly lighting during night-firing events (e.g., amber light emitting diodes [LED], low-pressure sodium, or other lighting approved by WFF).
- If a sea turtle were to nest in front of Pad 5 in an area where lighting may disorient hatchlings, night operations would cease during the approximately two-week hatching window and the beach would be routinely monitored for nests during nesting season in order to predict hatching time.

Noise may also potentially disturb sea turtles. There are limited studies of sea turtle responses to sounds, most of which have been conducted in the water. A decibel represents a pressure value in decibels that expresses a ratio between the measured pressure and a reference pressure. Reference pressures vary between air and water. The sound pressure levels in air are usually referenced to the threshold level for human hearing of 20 micropascals (µPa), which is not applicable to water. The auditory system of the sea turtle appears to work through water and bone conduction, with lower frequency sound conducted through to skull and shell. Initial tests

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indicate that frequencies of sensitivity are similar in water and air, with the greatest sensitivity to frequencies below 1,000 Hertz (Dow Piniak et al. 2012).

Peak blast noise levels from the powder gun were predicted using DoD's Blast Noise Prediction (BNOISE2) program to establish ordnance blast noise contours, as described in Section 3.3.5. Peak blast noise levels predicted in peak sound levels (dBP) from firing the powder gun shown in Figure 3.12-2 are depicted in the calculated peak noise level PK 15(met), the noise level that is expected to be exceeded by 15 percent of all events accounting for statistical variation due to weather. As seen in this figure, the highest noise levels that sea turtles would be exposed to from powder gun firing is 150 dB, if nesting were to occur on the beach in front of Pad 5 and if nighttime testing were to be taking place.

Peak noise levels were also modeled for railgun operation. As shown in Figure 3.12-3, the highest noise level that sea turtles would be exposed to from railgun firing is 140 dB, if nesting were to occur on the beach in front of Pad 5 and if nighttime testing were to be taking place.

There is limited information regarding behavioral reactions of sea turtles to sound. Atmospheric or airborne noise may prevent sea turtles from entering an area (USFWS 2010a). However, the intensity of sea turtles' behavioral responses to a perceived sound depends on several factors, including the species, the animal's age, reproductive condition, past experience with the sound exposure, behavior (foraging or reproductive), the received level from the exposure, the type of sound (impulse or non-impulse), and duration of the sound. Any behavioral responses to gun firing is likely to be short-term (seconds to minutes) and of little immediate consequence for the sea turtle, given the relatively low sensitivity of sea turtles to sound. Based on the relatively low sensitivity of sea turtle hearing, and the limited amount of night testing that would occur, noise is not expected to have an effect on sea turtles that come ashore to nest.

The latent strength of the earth's magnetic field is 0.52 Gauss along the mid-Atlantic coast (Maus et al. 2010). The magnetic field produced by the EM railgun during firing is predicted to fall below this level within 120 feet (37 meters) of the gun. Because sea turtle nesting areas would be more than 120 feet (37 meters) from the firing point, there would be no adverse impacts from magnetic fields on nesting females or hatchlings when the EM railgun is being fired.

WFF would continue to adhere to its *Protected Species Monitoring Plan* (NASA 2013a) and implement protective measures for turtle nesting and hatchling protection.

Emissions from firing would be negligible and would have no significant impacts on air, surface water, or soils.

Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 5 Alternative are considered to be negligible, taking into account the ongoing monitoring at WFF and proposed mitigation measures if a turtle were to nest on the beach in front of the guns. The proposed action may affect, but is not likely to adversely affect, nesting sea turtles. In accordance with NEPA, testing activities would have no significant impacts on nesting sea turtles.

Nearshore Impacts (At-sea Sea Turtles)

This discussion analyzes the strike potential for sea turtles from military expended materials that would land in the nearshore area – sabots, pusher plates, and armatures. Offshore impacts are

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covered in the AFTT FEIS/OEIS (Navy 2013), which is also the source of much of the following discussion.

While disturbance or strike from an item as it falls through the water column is possible, it is not very likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. Therefore, the discussion of military expended materials strikes focuses on the potential of a strike at the surface of the water. While no strike from military expended materials has ever been reported or recorded, the possibility of a strike still exists. Therefore, the potential for sea turtles to be struck by military expended materials was evaluated using statistical probability modeling to estimate the likelihood. Specific details of the modeling approach including model selection and calculation methods can be found in Appendix G (Statistical Probability Model for Estimating Direct Strike Impact and Number of Potential Exposures) of the AFTT FEIS/OEIS (Navy 2013), which describes the methodology used in the AFTT analysis for impacts from strikes to sea turtles in the offshore area. The same methods were used for the nearshore strike analysis for this EA. Input values include munitions data (frequency, footprint, and type), size of the training and testing area, sea turtle density data, and size of the animal (area of potential impact). The analysis of the potential for a sea turtle strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all sea turtles would be at or near the surface 100 percent of the time, when in fact, sea turtles spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006; both as cited in Navy 2013).
- The model assumes the animal is stationary and does not account for any movement of the sea turtle or any potential avoidance.

To estimate the potential to strike a sea turtle, the highest probability of a strike was calculated by: (1) totaling the impact area of sabots, pusher plates, and armatures during the fifth year of the program (when HVP firing would be at the highest level), in the respective sabot petal or pusher plate and armature impact areas (Figure 2-4), and (2) using the sea turtle species with the highest average seasonal density. These highest estimates would then provide a point of comparison for all other sea turtle species. The sea turtle species with the highest average seasonal density is the loggerhead, with an estimated average seasonal density of about 0.18 animals per square nautical mile in the fall, when its density is the highest (Navy 2012b). The model results indicate a 0.0070 percent probability of sabots striking a single loggerhead sea turtle and even lower probabilities of pusher plates or armatures striking a loggerhead. These results indicate a high level of certainty that sea turtles would not be struck by military expended materials during testing activities.

There is a remote possibility that an individual turtle at or near the surface may be struck directly. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. However, most sea turtles only surface intermittently. Sea turtles are generally at the surface for short periods and spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006; both as cited in Navy 2013). The leatherback turtle is more likely to be foraging at or near the surface in the open ocean than other species, but the likelihood of being struck by expended material remains very low.

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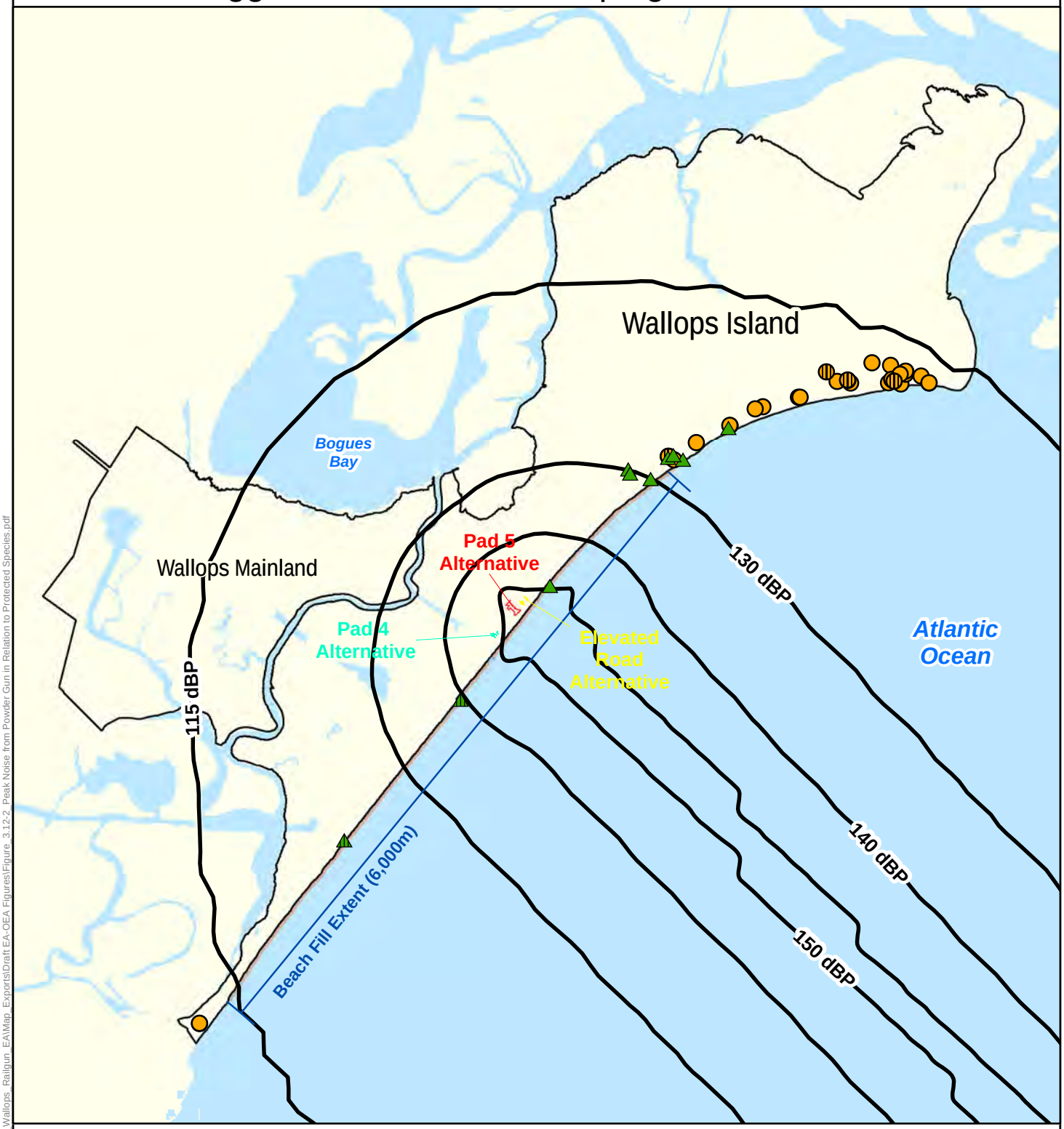
Peak Noise from Powder Gun in Relation to Loggerhead Turtles and Piping Plover Nests



Piping Plover Nest (2013)
Piping Plover Nest (2010-2012)
Loggerhead Sea Turtle Nest (2013)
Loggerhead Sea Turtle Nest (2010-2012)
5-Mile Low Angle Contour
Installation Boundaries

0 4,000 8,000
Feet

0 1,220 2,440
Meters

N

Sources: NASA 2010b, NASA 2011a, NASA 2012a, NASA 2013b, NASA 2013c.
Note: Noise Contour based on Powder Gun Firing a Projectile 5 Miles along a Direct Trajectory. A 155mm Howitzer Gun was modeled to represent the 5"/62 Powder Gun.

Figure 3.12-2

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EAIMap_Exports\Draft EA-OEA Figures\Figure_3.12-2_Peak Noise from Powder Gun in Relation to Protected Species.pdf

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Peak Noise from EM Railgun in Relation to Loggerhead Turtles and Piping Plover Nests

Sources: NASA 2010b, NASA 2011a, NASA 2012a, NASA 2013b, NASA 2013c.
Note: Noise Contour based on 32-MJ EM Railgun Firing.

Figure 3.12-3

Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EA\Map_Exports\Draft EA-OEA Figures\Figure_3.12-3_Peak Noise from EM Railgun in Relation to Protected Species.pdf

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Military expended materials that hit the water could result in a short-term and local displacement of sea turtles in the water column. However, these behavioral reactions are not expected to result in substantial changes to an individual's fitness or species recruitment, and are not expected to result in population-level impacts The overall numbers of military expended material under this alternative would result in an increase in the strike risk; however, it would not rise to the level of being a concern.

The direct impact of military expended material strikes would be inconsequential due to: (1) the limited number of sea turtles found directly at the surface where military expended material strikes could occur, (2) the rare chance that a sea turtle might be directly struck at the surface by military expended materials, (3) the ability of most sea turtles to detect and avoid an object falling through the water below the surface, and (4) the low probability of strike based on the small impact footprint area. The potential impacts of military expended material strikes would be short-term (seconds), and localized disturbances of the water surface and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

Indirect impacts of testing include changes to water and sediment quality. Military expended materials associated with powder and railgun testing would be limited to a maximum of 250 projectiles a year, which would be widely dispersed in space and time. Chemical, physical, or biological changes to water or sediment quality would not be detectable and would remain below or within existing conditions or designated uses, as described in detail in the AFTT FEIS/OEIS (Navy 2013). This conclusion is based on the following:

- Many components of expended materials are inert or corrode slowly
- The alloys used in expended materials do not contain metals with high toxicities and metal corrosion is a slow process that allows for dilution
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign; and
- Potential areas of negative impacts would be limited to small zones immediately adjacent to the expended materials.

Sea turtles would not be indirectly impacted by metals in the water column or sediments, as metals would undergo little decay or biodegradation. Given the small number and size of expended materials, any input from decay of these materials into water and/or sediment would be insignificant.

Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 5 Alternative are considered to be negligible or discountable. The proposed action may affect, but is not likely to adversely affect, at-sea sea turtles. In accordance with NEPA, testing activities would have no significant impacts on at-sea sea turtles.

Birds

Testing along the oceanfront of Wallops Island has the potential to impact shorebirds that are present near the testing area. No testing would occur in the vicinity of the active bald eagle nest or the peregrine falcon tower, both located in the northern portion of Wallops Island (Figure 3.12-1). Because there would be no direct or indirect impacts to bald eagles or peregrine falcons

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from the Proposed Action, they are not discussed further in this section. The remainder of this discussion focuses on the piping plover and red knot, which are also considered to represent other shorebirds.

Currently, piping plovers nest at the southern and northern ends of Wallops Island (Figure 3.12-1), with the closest recorded nest 6,050 feet (1,844 meters) from Pad 5. In the future, the newly reestablished beach along the seawall/dune in front of the guns may be used as nesting habitat by piping plovers, although plovers generally prefer habitats more like the ends of Wallops Island with access to ocean beaches and protected bays. WFF Environmental Office personnel routinely monitor for piping plovers and nesting activity.

Flocks of red knots have been documented stopping and feeding on Wallops Island during spring migration and may potentially be found near Pad 5 during testing during migration, but they do not nest at WFF.

Direct impacts could occur from noise and light associated with testing, which could startle or disturb birds. There would be no magnetic effects from EM railgun firing as magnetic fields would drop to background levels 120 feet (37 meters) from the firing point. There would be no direct strikes, as the firing line is checked prior to firing; if any birds are sighted, testing would be delayed until they are cleared.

Construction would occur during daylight hours; therefore, there would be no potential lighting impacts associated with construction. Most testing would occur during the day. Flashes of light associated with firing would last only a few milliseconds and would be similar to a less extensive lightning flash associated with a storm. The maximum number of rounds fired would be one round every 45 minutes to 1 hour. This is considered less disruptive than regular flashes from a lighthouse. The historic Assateague Lighthouse has a flash pattern of two consecutive flashes every five seconds **(**Chincoteague Natural History Association 2014), and no documentation was found indicating light effects on plovers or other shorebirds from the lighthouse. Therefore, use of lighting is unlikely to disturb nesting birds at night. There would be negligible, if any, effects from night lighting.

Construction activities would result in short-term increases in noise levels during certain activities. Birds foraging along the beach in front of the firing area may move to other areas during construction. Piping plovers were recorded nesting at Toms Cove Hook on the Chincoteague National Wildlife Refuge at the same time the area was receiving heavy recreational use, indicating that piping plovers can habituate to some degree of human activity (Patterson et al. 1990).

Noises associated with hypervelocity projectile firing may affect birds. Physiological responses of birds and other wildlife to noise documented in the literature include an increased heart rate, altering of metabolism and hormone balance, and behavioral reactions such as head raising, body shifting, trotting short distances, flapping of wings, and panic and escape behavior (Radle 2007). These effects may cause energy expenditure, reduced feeding, habitat avoidance, reproductive losses, and bodily injury.

Direct disturbances are limited to the birds themselves and not to their eggs. A review of the literature examining laboratory tests of exposure of eggs to sonic booms and other impulsive noises on hatching of eggs indicates that even under extraordinary circumstances, noise up to the sonic boom range, would not damage an avian egg (Wyle Acoustics Group 2008). However,

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eggs could be affected by predation if nesting birds temporarily leave a nest or fail to develop if the nest is abandoned.

The noise generated from firing would be impulsive noise, similar to the noise from lightning. In fact, the EM railgun sounds much like lightning when it fires (Borrell 2008). No studies of the reaction of piping plovers or other shorebirds to lightning or thunder were found in the literature, but piping plovers and red knots are assumed to be regularly exposed to sounds associated with extreme weather. Both the powder gun and the railgun would fire in an upward-arcing trajectory, away from the beach area. The seawall/dune would provide some muffling of the sound traveling towards the beach area.

Dooling and Popper (2007) reviewed the literature on auditory effects on birds to evaluate the effects of highway noise on birds. They concluded that birds are resistant to permanent auditory damage and hearing loss from noise exposure, even following extraordinarily intense impulse noise exposures. They recommended an interim guideline of 140 dB for bird exposure to a single impulsive sound (Dooling and Popper 2007); however, there are no published studies to support this number and other factors, such as the proximity to the impulsive noise would also need to be considered.

Larkin et al. (1996) conducted a literature review on the effects of military noise on wildlife. He was unable to find many controlled studies, but anecdotal accounts that describe terrestrial wildlife living with noise loud enough to cause pain in humans suggested that birds are unlikely to be physiologically impacted by loud noises and may habituate to them.

Brown et al. (1999) studied the influence of weapons testing on nesting and roosting bald eagle behavior, nest success, and productivity at Aberdeen Proving Ground, Maryland. Noise levels ranged from 82 to 126 dBP. They found that in most cases, eagles showed no reaction to impulsive noise. When eagles did react, the most common reaction was a head turn. There was no difference in reactions to sound levels above and below 110 dBP. Overall numbers of bald eagle young fledged per occupied territory, young fledged per breeding pair, and young fledged per successful nest did not differ from control areas in Maryland.

A comprehensive study of the potential impact of military noise on the red-cockaded woodpecker at Fort Stewart, Georgia was conducted by Delaney at al. (2002). Three seasons of noise and behavioral data were collected to develop dose-response relationships and to assess noise impacts on individual and population-level fitness. Over ten thousand hours of video surveillance tapes were obtained at disturbed and undisturbed sites. Data collected from these sites included large caliber fire from 50 to 800 feet (15 to 244 meters) away to the source of the noise. Noise levels at the cavity height ranged from 55 to 119 dB. Correlation of noise level with red-cockaded woodpecker productivity was examined using noise contours generated by the BNOISE and Small Arms Range Noise Assessment Model noise models and training data supplied by Fort Stewart. Data indicated that training noise had no significant impacts on the reproductive success of the red-cockaded woodpecker.

The relevance of the bald eagle and woodpecker studies to the piping plover and red knot is unknown. Gladwin et al. (1988) examined the effects of aircraft noise and sonic booms on wildlife and found that waterfowl were the group of birds reporting the greatest percent disturbance (63 percent), followed by raptors (17 percent), and shorebirds (11 percent). Peak blast noise levels from powder gun and railgun firings (Figure 3.12-2 and 13.12-3) show that piping plover nests on Wallops Island from 2010 to 2013 would be within the 115 dBP noise

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contour. The relevance of the bald eagle and woodpecker studies to the piping plover, red knot, and other protected species is unknown. However, because the sensitivity of shorebirds falls within the range between raptors and cavity-nesters, the studies suggest that only birds near the firing would be disturbed.

Noise guidelines specific to piping plovers have been issued by the USFWS for fireworks displays (USFWS 1997). The guidelines released by USFWS' Northeast Region recommend that the launch site be located a minimum of 3/4 mile (3,960 feet or 1.2 kilometers) from the nearest plover nesting and/or foraging area (USFWS 1997). As mentioned previously, the closest recorded piping plover nest was 6,050 feet (1.15 miles or 1.84 kilometers) from Pad 5. However, applying the fireworks display guidance to the Proposed Action is not considered appropriate, as the powder gun or railgun would fire one shot lasting a few milliseconds at a frequency no greater than once every 45 to 60 minutes. In contrast, firework displays involve many more explosions in a much longer time period. A description of firework displays at the Monterey Bay National Marine Sanctuary in California is as follows:

> The vast majority (97 percent) of fireworks displays authorized in the Sanctuary between 1993 and 2005 were aerial displays that usually include simultaneous low-level displays. An average large display will last 20 minutes and include 700 aerial shells and 750 low-level effects. An average smaller display lasts approximately 7 minutes and includes 300 aerial shells and 550 low-level effects…Low-level displays sometimes compensate for the absence of an aerial show by squeezing a larger number of effects into a shorter timeframe… A large low-level display may expend 4,900 effects within a seven-minute period, and a small display will use an average of 1,800 effects within the same timeframe. Some fireworks displays are synchronized with musical broadcasts over loudspeakers and may incorporate other non-pyrotechnic sound and visual effects. (76 Federal Register 29196)

Therefore, a smaller potential impact area based on gun firing for possible application of mitigation measures is recommended. The firing impact area in front of the gun is defined as the area that can be visually monitored for the presence of piping plovers using binoculars, and is approximately 1,000 feet (300 meters) of beach or 500 feet to either side of an observer standing on the seawall/dune. The shortest distance from the front of Pad 5 to the outer side of the seawall/dune is 155 feet (47 meters), providing additional distance from the firing point.

Based on nesting records from the past several years and plovers' general preference for habitats similar to the ends of Wallops Island where there is less human disturbance and access to ocean beaches and protected bays, piping plovers are considered unlikely to nest in front of the guns. They also are unlikely to nest in front of the guns because of beach replenishment that is taking place and will continue to take place regularly to maintain this part of the beach. Newly-placed dredged sand has few invertebrates for shorebirds to forage upon.

In the event that a piping plover nests in an approximately 1,000-foot (300-meter) band along the beach in front of a gun being readied for testing, the following mitigation measures are under consideration:

- Testing would be suspended until the chicks hatch or until it is determined that the nest has failed. Nests would be monitored following the *Protected Species Monitoring Plan* (NASA 2013a).

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In addition to piping plovers that may be nesting, piping plover adults and chicks and adult red knots may forage along the shoreline in front of the guns. The following mitigation measure is under consideration for foraging piping plovers and red knots:

- If piping plovers or red knots are observed within an approximately 330-feet (100-meter) band along the beach in front of the gun being tested, mitigation would be implemented to temporarily suspend operations until the bird(s) move out of this area. This distance is based on studies suggesting that only birds near the firing point may be disturbed. Monitoring would cease approximately fifteen to twenty minutes prior to testing to allow observers to return to a safe area.

Noise from the Proposed Action would have negligible impacts on piping plovers and red knots whether or not mitigation measures are implemented.

The latent strength of the earth's magnetic field is 0.52 Gauss along the mid-Atlantic coast (Maus et al. 2010). The magnetic field produced by the railgun during firing is predicted to fall below this level within 120 feet (37 meters) of the gun. Because piping plover nesting areas and red knot and other shorebird foraging areas are more than 120 feet (37 meters) from the firing point, there would be no exposure of birds or eggs to elevated magnetic fields and there would be no adverse impacts from magnetic fields on piping plovers, red knots, and other shorebirds.

There would be no indirect effects on air, surface water, or soils from testing as emissions from firing would be negligible, as described in Section 3.4.2.

In accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 5 Alternative are considered to be negligible. The proposed action may affect, but is not likely to adversely affect, the piping plover and is not likely to jeopardize the red knot. If piping plovers were to nest in front of the In accordance with NEPA, testing activities would have no significant impacts on the piping plover, red knot, and other shorebirds and there would be no takes of species protected under the Migratory Bird Treaty Act.

Marine Mammals

The strike potential of marine mammals from military expended materials that would land in the nearshore area – sabots, pusher plates, and armatures – is similar to that of at-sea sea turtles. The same methods and model that were used to estimate sea turtle strike probability were also used to estimate marine mammal strike probability. There is a remote possibility that an individual marine mammal at or near the surface may be struck directly. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. Marine mammals are generally at the surface for short periods and spend most of their time submerged (Costa and Block 2009).

While disturbance or strike from an item falling through the water column is possible, it is not very likely because the objects generally sink slowly through the water and can be avoided by most marine mammals. Therefore, the discussion of military expended materials strikes focuses on the potential of a strike at the surface of the water. While no strike from military expended materials has ever been reported or recorded, the possibility of a strike still exists. The potential for marine mammals to be struck by military expended materials was evaluated using statistical probability modeling to estimate the likelihood. Specific details of the modeling approach including model selection and calculation methods can be found in Appendix G (Statistical Probability Model for Estimating Direct Strike Impact and Number of Potential Exposures) of the AFTT FEIS/OEIS (Navy 2013). Input values include munitions data (frequency, footprint, and

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type), size of the training and testing area, sea turtle density data, and size of the animal (area of potential impact). The analysis of the potential for a marine mammal strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all marine mammals would be at or near the surface 100 percent of the time, when in reality, marine mammals spend up to 90 percent of their time under the water (Costa and Block 2009).
- The model assumes the animal is stationary and does not account for any movement of the marine mammal or any potential avoidance.

To estimate the potential to strike a marine mammal, the highest probability of a strike was calculated by totaling the impact area of sabots, pusher plates, and armatures during the fifth year of the program when HVP firing would be at the highest level, in the respective sabot petal or pusher plate and armature impact area (Figure 2-4), and using the marine mammal species with the highest average seasonal density. These highest estimates would then provide a point of comparison for all other marine mammal species. The marine mammal species with the highest average seasonal density is the harbor porpoise, with an estimated average seasonal density of about 1.32 animals per square nautical mile in the winter, when it occurs in the nearshore area off Virginia (Navy 2012b). The model results indicate a 0.0075 percent probability of sabots striking a single harbor porpoise and even lower probabilities of pusher plates or armatures striking a harbor porpoise. These results indicate a high level of certainty that marine mammals would not be struck by military expended materials during testing activities.

For military readiness activities, MMPA Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. MMPA Level B harassment includes all actions that disturb or are likely to disturb a marine mammal or marine mammal stock in the wild through the disruption of natural behavioral patterns. The Proposed Action is not expected to result in any Level A or B harassment.

Indirect impacts of testing include changes to water and sediment quality. The military expended materials associated with powder and railgun testing would be limited to a maximum of 250 projectiles a year, which would be widely dispersed in space and time. Marine mammals would not be indirectly impacted by metals in the water column or sediments, as metals would undergo little decay or biodegradation. Given the small number and size of expended materials, any input from decay of these materials into water and/or sediment would be insignificant.

Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 5 Alternative are considered to be negligible or discountable. The proposed action may affect, but is not likely to adversely affect, the fin whale, humpback whale, and North Atlantic right whale. There are no reasonably foreseeable takes of marine mammals in accordance with the MMPA associated with testing activities. In accordance with NEPA, testing activities would have no significant impacts on marine mammals.

3.12.4.3 Pad 4 Alternative

Impacts at the Pad 4 Alternative would be similar to that of the Pad 5 Alternative because the same action would be taking place in the same area – approximately 1,020 feet (310 meters) away – with similar conditions.

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Plants

Seabeach amaranth is not present on Wallops Island and has not been observed in annual surveys. Impacts on seabeach amaranth under the Pad 4 Alternative would be identical to those under the Pad 5 Alternative; there would be no direct or indirect impacts. In accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 4 Alternative would have no effect on seabeach amaranth. In accordance with NEPA, testing activities would have no impacts on seabeach amaranth.

Fish

Potential effects on the Atlantic sturgeon under the Pad 4 Alternative would be identical to those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. Therefore, under Section 7 of the ESA, the effect of testing activities on the Atlantic sturgeon under the Pad 4 Alternative is expected to be insignificant or discountable. This alternative may affect, but is not likely to adversely affect, the Atlantic sturgeon. In accordance with NEPA, testing activities under the Pad 4 Alternative would have no significant impacts on the Atlantic sturgeon.

Essential Fish Habitat

In accordance with the EFH Final Rule published in the Federal Register on January 17, 2002 (67 Federal Register 2343), federal agencies may incorporate an EFH assessment into documents prepared for another purpose, such as this EA, provided that the EFH assessment is clearly identified as a separate and distinct section of the document. Accordingly, the Navy intends for this section to serve as its EFH assessment.

Potential effects on essential fish habitat under the Pad 4 Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. All adverse impacts on managed species, associated species, and EFH are expected to be temporary and localized. Military expended materials falling into the water under the Pad 4 Alternative may adversely affect EFH, but likely would result in minimal adverse effects on EFH, as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. In accordance with NEPA, testing activities under the Pad 4 Alternative would have no significant impacts on EFH.

Onshore Impacts (Nesting Sea Turtles)

Potential effects on the nesting sea turtles under the Pad 4 Alternative would be almost identical to those under the Pad 5 Alternative. Under the Pad 4 Alternative the closest sea turtle nest to date is 715 feet (218 meters) away, slightly closer than under the Pad 5 Alternative. The seawall/dune between the test area and the restored beach provides physical separation between the testing area and potential nesting habitat on the beach. Based on the relatively low sensitivity of sea turtle hearing, noise is not expected to have an effect on sea turtles that come ashore to nest.

Lighting associated with night testing may disorient nesting sea turtles, but an effort would be made to schedule most testing during daylight hours. In the event that a sea turtle nests near Pad 4, possible mitigation measures as described under the Pad 5 Alternative could be implemented to reduce potential impacts from the use of nighttime lighting.

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Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 4 Alternative are considered to be negligible. The proposed action may affect, but is not likely to adversely, affect nesting sea turtles. In accordance with NEPA, testing activities would have no significant impacts on nesting sea turtles.

Nearshore Impacts (At-sea Sea Turtles)

Potential effects on at-sea sea turtles under the Pad 4 Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 4 Alternative are considered to be negligible or discountable. The proposed action may affect, but is not likely to adversely affect, at-sea sea turtles. In accordance with NEPA, testing activities would have no significant impacts on at-sea sea turtles.

Birds

Potential effects on birds under the Pad 4 Alternative would be similar to those under the Pad 5 Alternative. Currently, piping plover nesting areas are located at the southern and northern ends of Wallops Island (Figure 3.12-1), with the closest recorded piping plover nest 5,757 feet (1.1 miles or 1.8 kilometers) from the proposed guns. If a piping plover were to nest in front of the guns, possible mitigation measures as described under the Pad 5 Alternative could be implemented. There would be no indirect effects on air, surface water, or soils from testing as emissions from firing would be negligible.

In accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 4 Alternative are considered to be negligible. The proposed action may affect, but is not likely to adversely affect, the piping plover and is not likely to jeopardize the red knot. In accordance with NEPA, testing activities would have no significant impacts on the piping plover, red knot, and other shorebirds and there would be no takes of species protected under the Migratory Bird Treaty Act.

Marine Mammals

Potential effects on marine mammals under the Pad 4 Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for all alternatives. In accordance with Section 7 of the ESA, potential effects of testing activities under the Pad 4 Alternative on marine mammals are considered to be negligible or discountable. The proposed action may affect, but is not likely to adversely affect, the fin whale, humpback whale, and North Atlantic right whale.

There are no reasonably foreseeable takes of marine mammals in accordance with the MMPA associated with testing activities. In accordance with NEPA, testing activities would have no significant impacts on marine mammals.

3.12.4.4 Elevated Road Alternative

Impacts at the Elevated Road Alternative would be similar to that of the Pad 5 Alternative because the same action would be taking place in the same area – approximately 280 feet (85 meters) away – with similar conditions.

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Plants

Seabeach amaranth is not present on Wallops Island and has not been observed in annual surveys. Impacts on seabeach amaranth under the Elevated Road Alternative would be identical to those under the Pad 5 Alternative; there would be no direct or indirect impacts. In accordance with Section 7 of the ESA, potential effects of testing activities under the Preferred Alternative would have no effect on seabeach amaranth. In accordance with NEPA, testing activities would have no impacts on seabeach amaranth.

Fish

Potential effects on the Atlantic sturgeon under the Elevated Road Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. Therefore, under Section 7 of the ESA, the effect of testing activities on the Atlantic sturgeon under the Elevated Road Alternative is expected to be insignificant or discountable. This alternative may affect, but is not likely to adversely affect, the Atlantic sturgeon. In accordance with NEPA, testing activities under the Elevated Road Alternative would have no significant impacts on the Atlantic sturgeon.

Essential Fish Habitat

In accordance with the EFH Final Rule published in the Federal Register on January 17, 2002 (67 Federal Register 2343), federal agencies may incorporate an EFH assessment into documents prepared for another purpose, such as this EA, provided the EFH assessment is clearly identified as a separate and distinct section of the document. Accordingly, the Navy intends for this section to serve as its EFH assessment.

Potential effects on essential fish habitat under the Elevated Road Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. All adverse impacts on managed species, associated species, and EFH are expected to be temporary and localized. Military expended materials falling into the water under the Elevated Road Alternative may adversely affect EFH, but likely would result in minimal adverse effects on EFH, as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. In accordance with NEPA, testing activities under the Elevated Road Alternative would have no significant impacts on EFH.

Sea Turtles

Onshore Impacts (Nesting Sea Turtles)

Potential effects on the nesting sea turtles under the Elevated Road Alternative would be almost the same as those under the Pad 5 Alternative. Under the Elevated Road Alternative the closest sea turtle nest to date is 1,980 feet (604 meters) away, further than under the Pad 5 Alternative. The seawall/dune between the test area and the restored beach provides physical separation between the testing area and potential nesting habitat. Based on the relatively low sensitivity of sea turtle hearing, noise is not expected to have an effect on sea turtles that come ashore to nest.

Lighting associated with night testing may disorient nesting sea turtles, but an effort would be made to schedule most testing during daylight hours. In the event that a sea turtle nests near the

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Elevated Road, possible mitigation measures as described under the Pad 5 Alternative could be implemented to reduce potential impacts from the use of nighttime lighting.

Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Elevated Road Alternative are considered to be negligible. The proposed action may affect, but is not likely to adversely affect, nesting sea turtles. In accordance with NEPA, testing activities would have no significant impacts on nesting sea turtles.

Nearshore Impacts (At-sea Sea Turtles)

Potential effects on at-sea sea turtles under the Elevated Road Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. Therefore, in accordance with Section 7 of the ESA, potential effects of testing activities under the Elevated Road Alternative are considered to be negligible or discountable. The proposed action may affect, but is not likely to adversely affect, at-sea sea turtles. In accordance with NEPA, testing activities would have no significant impacts on at-sea sea turtles.

Birds

Potential effects on birds under the Elevated Road Alternative would be similar to those under the Pad 5 Alternative. Currently, piping plover nesting areas are located at the southern and northern ends of Wallops Island (Figure 3.12-1), with the closest recorded piping plover nest 7,038 feet (1.3 miles or 2.1 kilometers) from the proposed guns. There would be no indirect effects on air, surface water, or soils from testing as emissions from firing would be negligible.

In accordance with Section 7 of the ESA, potential effects of testing activities under the Elevated Road Alternative are considered to be negligible. The proposed action may affect, but is not likely to adversely affect, the piping plover and is not likely to jeopardize the red knot. If a piping plover were to nest in the shoreline area within the firing radius, possible mitigation measures as described under the Pad 5 Alternative could be implemented. In accordance with NEPA, testing activities would have no significant impacts on the piping plover, the red knot, or other shorebirds; and there would be no takes of species protected under the Migratory Bird Treaty Act.

Marine Mammals

Potential effects on marine mammals under the Elevated Road Alternative would be the same as those under the Pad 5 Alternative, as the at-sea impacts would be the same for both alternatives. In accordance with Section 7 of the ESA, potential effects of testing activities under the Elevated Road Alternative on marine mammals are considered to be negligible or discountable. The proposed action may affect, but is not likely to adversely affect, the fin whale, humpback whale, and North Atlantic right whale.

There are no reasonably foreseeable takes of marine mammals in accordance with the MMPA associated with testing activities. In accordance with NEPA, testing activities would have no significant impacts on marine mammals.

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3.12.5 Ongoing Monitoring and Management Measures and Possible Mitigation Measures

WFF administers a *Protected Species Monitoring Plan* (NASA 2013a) to manage threatened and endangered species in accordance with Section 7 of the ESA. The monitoring plan details monitoring methods and the frequency of monitoring of protected species within the property boundaries of Wallops Island. ESA-protected species covered by this plan include the loggerhead sea turtle, green sea turtle, leatherback sea turtle, piping plover, red knot, and seabeach amaranth. Other species of interest surveyed include at a minimum Wilson's plover, American oystercatcher (*Haemotopus palliates*), and colonial nesting birds such as tern species (NASA 2013a). WFF confers with the USFWS and the Virginia Department of Game and Inland Fisheries to determine what other species will be surveyed and to confirm survey methods. The monitoring plan also includes the marine mammal and sea turtle stranding program managed at WFF in cooperation with the Virginia Aquarium.

Monitoring and protective measures currently in place at WFF would be carried out regardless of whether the Proposed Action is implemented. Avoidance and minimization measures currently being implemented at WFF are presented in (Table 3.12-5) for each of the species addressed in this report. All of these measures are considered part of existing conditions and are thus treated as such in the effects analysis and determinations contained in this EA.

Possible mitigation measures could be implemented if sea turtles or piping plovers nest in front of the guns. These include the following measures for sea turtles if nighttime testing takes place:

- Keeping the gun testing site dark when not in use.
- Using turtle-friendly lighting during night testing.
- Ceasing night operations during the hatching window if a sea turtle nests in front of the guns. The beach would be monitored for nests during nesting season in order to predict hatching time.

In the event that a piping plover nests in front of the guns, i.e., within an approximate 1,000-foot (300-meter) area, mitigation under consideration includes:

- Suspending testing until the chicks hatch or until it is determined that the nest has failed. The nest would be monitored following the *Protected Species Monitoring Plan* (NASA 2013a).

If a foraging piping plover or red knot is observed within an approximately 330-feet (100-meter) area on the beach in front of a gun that is being prepared for firing, a possible mitigation measure would be:

- Suspending testing temporarily until the bird(s) move out of the area.

Previous and current section 7 consultations between NASA and USFWS and the Navy and NMFS are also still relevant and applicable including:

- Biological Opinion for the Expansion of Wallops Flight Facility and Ongoing Operations, Accomack County, Virginia (Project# 2010-F-0105) (USFWS 2010a).
- *Programmatic Biological Opinion on the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program* (USFWS 2010b).

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The Section 7 consultation between the Navy and NMFS documented in the *Biological Opinion and Conference Opinion on Atlantic Fleet Training and Testing Activities (2013-2018)* (NMFS 2013k) is also relevant and applicable to the Proposed Action.

Actions required under the terms and conditions of the Programmatic Biological Opinion on the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program, which incorporates the Biological Opinion for the Expansion of Wallops Flight Facility and Ongoing Operations, Accomack County, Virginia (USFWS 2010a), which are potentially relevant to the Proposed Action are listed in Table 3.12-6.

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Table 3.12-4: WFF Protected Species Monitoring and Management Measures

Seabeach Amaranth
• One complete seabeach amaranth search occurs annually in August. If seabeach amaranth is found, they will be marked with "Area Closed" signs around plants. Rope will be strung between the signs to discourage trespassing. • Send annual report to USFWS.
Sea Turtles
• Monitor sea turtle nests and send annual nest report to USFWS. • Sea turtle crawl track and nest searches will be conducted three times per week, as practicable, from May through August. When a sea turtle crawl track is found on the beach, monitoring staff determines whether the crawl resulted in a nest. Staff will gently dig by hand into the body pit to locate the egg chamber, to determine if eggs were laid. • Nest protection will be implemented. A predator screen will be positioned over all nests and monitoring staff will sweep a dusting of sand over the screen to hide it from predators and trespassers. Nests will be marked, thus establishing a buffer zone, to protect the nest from human activity. The nest will be monitored three times per week, as practicable. • Hatching procedures will be followed. One week prior to the predicted hatch window, staff will rake and sweep away tire tracks and debris east of a turtle nest to insure hatchlings will have a clear path to the ocean. Appropriate building lights will be turned off if needed and turtle friendly amber light emitting diode lights will be installed. Staff will excavate nests a minimum of 90 days after egg deposition to determine hatching and emergence success.
Piping Plover
• Field personnel will conduct surveys to document the arrival of piping plovers. Beginning in early March, beach monitoring areas will be surveyed three times per week, as practicable, for piping plover arrival, establishment of territories, courtship display, and preliminary nest scrapes. • Send annual report to USFWS. • Three times per week, as practicable, nest searching and monitoring will begin when territorial pairs are firmly documented and will continue to August 31, or until the last chick fledges. • Once located, nests will be marked and checked three times per week, as practicable, for incubating adults until chicks hatch. • Predator-proof exclosures will be placed around nests. • After the eggs hatch, field personnel will record the number of eggs remaining in the nest cup. Broods will be located three times per week, as practicable, until the chicks either fly or reach 25 days in age.
Red Knot
• Monitoring will include the date, time, observer, place of encounter; flock size, and estimated number of banded red knots. • Send annual report to USFWS.
Source: NASA 2013a.

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Table 3.12-5: Potentially Relevant Actions Required Under USFWS Terms and Conditions

1. Fully implement the activities related to listed species within the Shoreline Restoration and Infrastructure Protection Program draft Programmatic Environmental Impact Statement: Mitigation and Monitoring Plan, for seawall extension, offshore dredging, and sand placement activities. NASA must provide an annual report summarizing the survey and monitoring efforts, the location and status of all occurrences of protected species that are recorded, and any additional relevant information. Reports will be provided to the Service's Virginia Field Office in digital format, at the address, provided on the letterhead by December 31 of each year.
2. Develop a training and familiarization program for all personnel conducting construction activities and NASA operations in areas where listed species may occur. This training program shall include basic biological information about all listed species and be sufficient to allow personnel to tentatively identify the species and its likely habitat to allow them to incorporate appropriate avoidance and minimization measures into their activities.
3. Following launches of rockets that produce an expected sound intensity> 150 dB seaward of the dune or seawall, surveys must be conducted for injured, dead, or impaired birds and wildlife. These surveys must be conducted as soon as possible following launches and within 2 hours of the launch or the first daylight following launch. Surveys for dead, injured, or impaired wildlife must still be conducted as soon as possible following a launch, in addition to the use of cameras. Reports/DVDs will be provided to the Service's Virginia Field Office in digital form within 15 days of each launch event.
4. Report any evidence of potential nesting activity of green sea turtles or leatherback sea turtles on Wallops Island to the Service's Virginia Field Office, within one business day of observing the activity.
5. Care must be taken in handling any dead specimens of proposed or listed species that are found to preserve biological material in the best possible state. In conjunction with the preservation of any dead specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are Appropriate and effective. Upon locating a dead specimen, notify the Service's Virginia Law Enforcement Office and the Service's Virginia Field Office.

Source: USFWS 2010b.

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3.13 Utilities

Infrastructure and utilities include potable water systems, wastewater treatment systems, electric utilities, communications, and solid waste management. The source for this section is the 2013 *Integrated Contingency Plan* (NASA 2013). New construction and new missions, as described in Chapter 3, may require usage of one or more of these services.

3.13.1 Affected Environment

3.13.1.1 Potable Water

WFF obtains all of its potable water from groundwater supply wells located within the boundaries of the installation. The water is used primarily for domestic purposes and fire protection. Groundwater withdrawal, usage, and quality are regulated by the Virginia Department of Environmental Quality and by the Virginia Department of Health.

The Wallops Island and Mainland potable water system is a non-transient, non-community water system that utilizes two groundwater wells and serves a peak population of 725 persons. The potable water supply wells are 245 feet (75 meters) and 265 feet (80 meters) below the ground surface and withdraw groundwater within the middle Yorktown-Eastover aquifer. Water is stored in an 80,000-gallon (300,000-liter) ground-level tank (U-049) located on the Mainland, adjacent to the treatment facility, prior to being pumped to three elevated tanks in the island's water distribution system. The southernmost tank, Building X-46, has a capacity of 100,000 gallons (380,000 liters). Building W-55 has a volume of 150,000 gallons (570,000 liters). The northernmost tank, Building V-90, has a capacity of 50,000 gallons (190,000 liters). WFF limits the Wallops Island potable water system groundwater withdrawal to 1,800,000 gallons (6,800,000 liters) per month and 13,000,000 gallons (50,345,000 liters) per year.

3.13.1.2 Wastewater Treatment

Wastewater generated on the northern portion of Wallops Island is discharged to two septic tanks on the north end of the island. The septic tanks are pumped out biennially and the septage is transported to the wastewater treatment plant on Main Base. Wastewater generated on the remainder of Wallops Island is sent to one of five pump stations and pumped through a 7-mile (11-kilometer) force main to the Main Base collection system, through which it is transported to the treatment plant.

NASA owns and operates the wastewater treatment plant on Main Base. The plant has the capacity to treat up to 300,000 gallons (1,100,000 liters) per day and currently treats flows of approximately 60,000 gallons (230,000 liters) per day. Treated wastewater from the wastewater treatment plant is discharged via a single outfall to an unnamed freshwater tributary to Little Mosquito Creek under WFF's Virginia Pollutant Discharge Elimination System permit VA0024457.

3.13.1.3 Electric Power

Electrical power is delivered to the Mainland and Wallops Island by A&N Electric Cooperative from the Wallops Island substation in Wattsville through a single set of 12.47-kilovolt buried conductors. This feeder is routed along the road and interconnects to WFF on a pole just outside

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of the Mainland/Wallops Island gate, where it transitions underground into the U-012 switching station. The utility provider regulates voltage at the Wallops Island substation via single phase regulators.

Two 3-megawatt generators and a control room were added to Building U-012 in March 2013 to provide centralized emergency power for the launch range and other mission critical infrastructure on Wallops Island and Mainland. The Facilities Management Branch operates the backup power generator when either service is not sufficient or short-term power services throughout the facility are needed for special projects.

The Mainland/Wallops Island load is the primary consumer of power from the Wallops Island substation and capacity is not currently an issue. However, due to increased development in the Captain's Cove area, the load on the Wattsville substation has grown in recent years.

3.13.1.4 Communications

Communication services to Wallops Island are provided by commercial providers.

3.13.1.5 Waste Collection and Disposal

Waste collection and disposal services for WFF are provided under contract with a private vendor. Solid waste from both commercial and construction sources at WFF may be taken to either the North Accomack County Landfill (in the town of Atlantic) or the South Accomack County Landfill (in Melfa). Approximately 70 acres (28 hectares) of the 113-acre (46-hectare) southern landfill have been used. Approximately 20 acres (8 hectares) of the 140-acre (57-hectare) northern landfill have been used.

In 2011, WFF launched a single-stream recycling program. Recycling containers were 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. In 2012, WFF diverted 39 percent of its solid waste from local landfills.

3.13.2 Environmental Consequences

The impact analysis for infrastructure and utilities compares existing capacity and demand on a utility to a projected capacity and demand. New facility construction may contribute to the total projected demand. A determination of significance is made when the projected increase in demand for a utility would exceed the planned capacity for that utility such that the utility provider would not be able to service additional demands while maintaining the same level of service for existing customers.

3.13.2.1 No Action Alternative

Under the No Action Alternative, the Navy would not install a 5" powder gun and an EM railgun, and associated facilities and equipment on WFF's Wallops Island. Operational missions and activities would remain at current levels, and there would be no change to current utility systems or demand. There would be no impact to utilities due to implementation of the No Action Alternative.

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3.13.2.2 Pad 5 Alternative (Preferred Alternative)

Electrical and communications cables would be extended from existing service lines and installed in underground conduit to serve the personnel/command shelters, storage shelters, a radar instrumental power van, a mobile Weibel radar, the pulsed power system for the railgun, and pole lighting around the site. The pulsed power system would store energy in capacitors, and would precisely switch and manage the energy over a few milliseconds in order to fire the railgun. The use of this system would ensure that the electrical distribution system at WFF would not be adversely affected by surges or sudden increased demand resulting from the firing of the railgun. The two 3-megawatt generators WFF added in March 2013 to provide centralized emergency power for the launch range and other mission critical infrastructure on Wallops Island would further ensure that the power supply is adequate and that the island's other activities would not suffer brownouts from the firing of the railgun.

Depending on testing requirements and objectives, the Pad 5 site would be staffed by approximately 11 to 15 people for approximately eight hours or more on each day of testing. Test personnel would be present for about five days for each set of tests (Rinko, pers. comm., November 7, 2013). In the context of the total number of personnel working at WFF Wallops Island, these additional personnel working at the installation for relatively brief periods of time each month would generate minimal increased demand for potable water and sewage treatment.

The initial construction of the facility would generate a small surge of construction-related debris and garbage, but the volume would be somewhat minimized through the use of prefabricated materials and structures at the site. EO 13514, *Federal Leadership in Environmental Energy, and Economic Performance*, requires a 50 percent reduction in construction and demolition materials and debris by fiscal year 2015. Therefore, the construction contractor would be required to divert at least 50 percent of construction and demolition materials and debris through recycling. The contractor would keep track of the weight of construction and demolition materials diverted, as well as the total weight of materials sent to the landfill, and provide the data in a report upon completion of construction. Ongoing operations at the site would produce waste that would generally be domestic in nature (i.e., loose paper, cardboard cartons) but would also include rubbish related to the maintenance of mechanical equipment and the guns (i.e., used solvents, lubricants, and other petroleum products, as well as their associated spent containers). Construction debris as well as operational waste would be collected and disposed of in accordance with established WFF procedures, and would not be expected to exceed the capacity of local landfills to accept them.

Support structures erected at Pad 5 would be linked to the existing voice and communications systems at WFF as necessary. It is expected that the additional demand for these services at the project site would be well within the capacity of the WFF communications system to accommodate them.

For the reasons outlined above, the implementation of the Pad 5 Alternative would have no significant impacts on utilities at WFF.

3.13.2.3 Pad 4 Alternative

The implementation of the Pad 4 Alternative would have no significant impacts on utilities at WFF, for the same reasons described for the Pad 5 Alternative.

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3.13.2.4 Elevated Road Alternative

The implementation of the Elevated Road Alternative would have no significant impacts on utilities, for the same reasons described for the Pad 5 Alternative.

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4 Cumulative Impacts and Other Considerations

The approach taken in this analysis of cumulative effects follows the objectives of NEPA, Council on Environmental Quality (CEQ) regulations, and CEQ guidance. The CEQ regulations (40 Code of Federal Regulations [C.F.R.] §§ 1500-1508) implementing the procedural provisions of NEPA define cumulative impact as follows:

> Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions 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 a period of time (40 C.F.R. § 1508.7).

The analysis of cumulative effects may go beyond the scope of project-specific direct and indirect effects to include expanded geographic and time boundaries, and a focus on broad resource sustainability. The true geographic range of an action's effect may not be limited to an arbitrary political or administrative boundary. Similarly, the effects of an action may continue beyond the time the action ceases. This "big picture" approach is becoming increasingly important as growing evidence suggests that the most significant effects to natural and socioeconomic resources result not from the direct effects of a particular action, but from the combination of individual, often minor, effects of multiple actions over time. The underlying issue is whether or not a resource can adequately recover from the effect of a human action before being exposed to subsequent action or actions.

Consistent with CEQ (1997) guidance, this analysis focuses on potential cumulative effects that are "truly meaningful" rather than analyzing the cumulative effects of the Proposed Action "on the universe." Therefore, this analysis focuses on the following potential cumulative effects:

- WFF range activities
- Recreational and commercial use of the waters off WFF
- Noise in the vicinity of WFF
- Protected species

In this chapter, an effort has been made to identify past and present actions associated with the resources analyzed in Chapter 3, plus those actions that are in the planning phase – limited to future actions that are reasonably foreseeable (not speculative). Only actions that have the potential to interact with the Proposed Action are addressed in this cumulative analysis. For example, construction or demolition projects planned at WFF that have no potential to interact with the Proposed Action are not discussed here. The cumulative impact analysis evaluates only actions with potential effects on the environment that are fundamentally similar to the anticipated effects of the Proposed Action, in terms of the nature of the effects, the geographical area affected, and the timing of the effects.

For the purposes of assessing cumulative impacts, the Navy reviewed all relevant and available environmental documentation pertaining to actions considered in the cumulative effects analysis.

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The level of information available for the different actions varies. The best available data are used in the analysis.

Ideally, the effects of all actions would be quantifiable, and the cumulative results combined as appropriate. In reality, quantifiable data are available for only a portion of the activities. The cumulative analysis incorporates specific numbers and values for potential effects, where available; descriptive information is used in place of quantitative measures where they are unavailable. This approach provides the decision-maker with the most current information to evaluate the consequences of the Proposed Action.

At this time, environmental impact analyses have not been conducted for several of the past and present, and reasonably foreseeable future actions identified. Therefore, assessments of the environmental effects of these projects are not currently available for consideration within the analysis of cumulative effects.

This cumulative effects analysis covers actions from 2009 through the period during which the Proposed Action would be carried out – the next six or seven years – depending upon when the project begins. The geographical action area for this analysis is the area covered by R-6604A and the Atlantic Ocean Danger Zone from the shore out to 3 nautical miles.

4.1 Recent Past, Present, and Reasonably Foreseeable Future Actions

4.1.1 NASA Activities

4.1.1.1 NASA's Proposed Projects and Mission Activities

In their master plan (NASA 2008), NASA proposes to implement a suite of new construction and demolition projects and new missions that are needed to ensure continued growth at WFF over a 20-year planning horizon, while also preserving the ability to safely conduct its historical baseline of operations.

NASA's proposed projects and mission activities at WFF include:

- Institutional support projects – construction and demolition of facilities and routine site activities.
- Operational missions and activities – scientific and research programs, mission operations, airfield and airfield operations, piloted aircraft, unmanned aerial systems, rocket operations, rocket-boosted projectile testing, payloads, tracking and data systems, balloons, and autonomous underwater vehicles.

Proposed projects that are most likely to have cumulative impacts when combined with the action proposed in this EA include projects on Wallops Island that would lead to new or expanded operations. These projects are not defined sufficiently to assess their cumulative effects in detail. The projects are shown on Figure 4-1:

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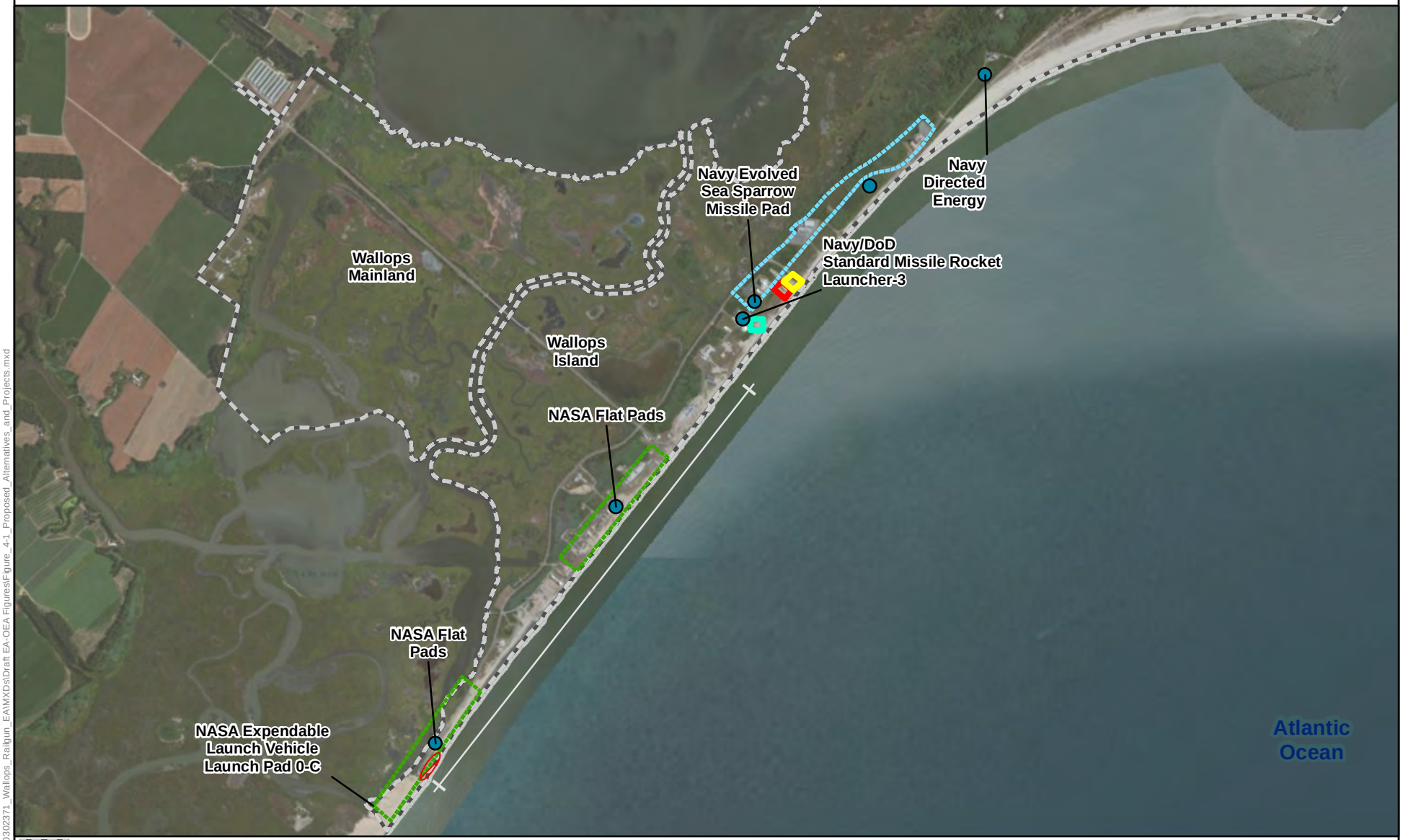
Cumulative Impact Projects on Wallops Island



Path: L:_Common\GIS_Data\60302371_Wallops_Railgun_EA\MXDs\Draft EA-OEA Figures\Figure_4-1_Proposed_Alternatives_and_Projects.mxd

Source: NASA 2013

Figure 4-1

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- Directed Energy – DoD and the Navy are pursuing a variety of high-energy laser and high-power microwave weapon system technologies that are in various stages of development. Wallops Island is being considered for future experiments and tests. Specific test scenarios are dependent on actual test requirements and are currently unknown.
- DoD Standard Missile Rocket Launcher-3 – The Navy's SCSC would construct a dedicated launch pad to support a land-based vertical launch training system using a DoD SM-3 interceptor missile system. The SM-3 rocket launcher is being developed as part of the AEGIS Ballistic Missile Defense System used by DoD to detect, track, and destroy ballistic missiles of all ranges. Although not currently in place at WFF, the SM-3 is used by the Navy as part of missile training exercises in conjunction with UAS or drone targets. Both the SM-3 and the drone target are compatible with the vertical launching system found aboard many Navy surface ships. The launch pad would measure approximately 105 square feet (10 square meters) and would be located near the Navy's AEGIS facility (Buildings V-10 and V-20) on Pad 4 along with a blockhouse with electric and water connections. This permanent launch pad is considered a connected action to MISSILEX (surface-to-air) training operations presented in the AFTT EIS/OEIS (US Navy 2013). Drone targets would be either launched from WFF or air-launched from military aircraft in the VACAPES OPAREA controlled airspace.
- Evolved Sea Sparrow Missile (ESSM) Pad – The Navy's SCSC would construct a launch pad and block house to support a land-based guided missile launching system for the ESSM. This 144-square-foot (13-square-meter) pad would replace a mobile launch system currently used for this activity at WFF.
- Expendable Launch Vehicle (ELV) Launch Pad 0-C – The Mid-Atlantic Regional Spaceport currently operates two ELV pads at the south end of Wallops Island. As rocket technology advances and new business opportunities present themselves, launch activity on Wallops Island is expected to increase. Stand-off distances are vital for safety (see hazard arcs on Figure 4.1.1), and to minimize scheduling conflicts, reduce operational impact to concurrent activities at WFF, and accommodate new ELV technology, NASA proposed to build a third ELV pad at the current location of the UAS airstrip at the south end of Wallops Island. The estimated size of the Pad 0-C complex would be 6.4 acres (2.6 hectares) with approximately 3.2 acres (1.3 hectares) of impervious surface.
- NASA Flat Pads – In response to expendable launch vehicle rocket technology advances and new business opportunities as noted above, NASA would construct two flat pads on the southern end of Wallops Island measuring approximately 240 square feet (20 square meters). Construction of the new pads would allow flexibility in the size and launch frequency of sounding rockets.

Projects that would increase operations and range use but require no new infrastructure include:

- Broad Area Maritime Surveillance (BAMS) UAS – The Navy BAMS UAS is a high-altitude, long-endurance UAS that can be used to conduct continuous open-ocean and nearshore surveillance of targets as small as exposed submarine periscopes. The Navy would conduct operational flights of the BAMS UAS on a weekly basis for an indefinite period beginning in mid-2014. BAMS would take off from the WFF airfield and transit

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through R-6604 en route to W-386 in the Virginia Capes Range Complex. BAMS operations would not lead to an increase in current WFF airfield operations, which are 61,000 annually.

- Expanded Space Program – NASA would expand their programs involving the potential for intermediate-class launch vehicles capable of delivering supplies to the International Space Station and Human Spaceflight Missions. WFF would make their facilities available for commercial customers for research, development, and operation of human spaceflight systems. These may include horizontal launch and landing vehicles and vertical launch and landing vehicles and orbital vehicles.
- Expansion of Restricted Airspace R-6604 – NASA owns and operates restricted airspace R-6604A/B, which covers the entire Wallops Island region and part of the northern portion of runway 4/22, one of the three existing runways on the Main Base. Current and forecast experimental aircraft test and evaluation activities, specifically, UAS, have provided challenges for the airspace surrounding WFF. Therefore, WFF proposes to expand the area by adding R-6604C. This expansion is considered a risk mitigation measure that would help protect general aviation from unavoidable hazards associated with experimental test flights.

4.1.1.2 Shoreline Restoration and Infrastructure Protection Program

A Record of Decision for the NASA SRIPP EIS was signed on December 13, 2010 (NASA 2010). The alternative selected (Alternative 1) entails extending the existing rock seawall/dune on Wallops Island a maximum of 4,600 feet (1,400 meters) south of its southernmost point. A length of shoreline was to be filled with beach quality sand dredged from an offshore sand shoal, approximately 1,500 feet (460 meters) north of the Wallops Island-Assawoman Island property boundary and extending north for 3.7 mi (6.0 km).

An initial seawall/dune extension of approximately 1,430 feet (435 meters) was implemented in 2011, prior to the placement of the initial beach fill. Further seawall/dune extension may be completed in the future as funding becomes available. In addition, between April and August 2012, approximately 3,200,000 cubic yards (2,446,000 cubic meters) of fill were placed along the Wallops Island shoreline starting approximately 460 meters (1,500 feet) north of the Wallops Island-Assawoman Island property boundary and extending north to the terminus of the existing rock seawall/dune, creating an approximately 100-foot- (30-meter-) wide beach and dune.

The scope of the SRIPP Programmatic EIS included the project's 50-year design life. As such, it considered the effects of regularly scheduled beach re-nourishment at an approximate frequency of every five years. Accordingly, over the next 20 years, approximately three to four re-nourishment activities may occur. As a component of re-nourishment, NASA may dredge additional sand from the offshore shoals or may remove sand, as needed, from the north end of Wallops Island and bring it to the south end of the island.

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4.1.1.3 Wallops Island Post-Hurricane Sandy Shoreline Repair

NASA prepared a Final EA June 2013 for restoration of their shoreline after Hurricane Sandy, which swept the newly-restored beach away. The Proposed Action, which is expected to be implemented in summer 2014, is to repair the Wallops Island rock seawall and place approximately 800,000 cubic yards (611,643 cubic meters) of sand along the southern two-thirds of the Wallops Island shoreline. Following the Record of Decision for the SRIPP EIS in December, 2010, WFF and the U.S. Army Corps of Engineers placed along the shoreline 3.2 million cubic yards (2.4 million cubic meters) of sand and extended the rock seawall/dune in 2011 and 2012. Hurricane Sandy made landfall in late October 2012, requiring repair of the seawall/dune and nourishment of the southern two-thirds of the recently-nourished beach.

4.1.1.4 Expansion of the WFF Launch Range

An EA was prepared in 2009 to address the proposed expansion of the launch range at WFF. Under the Proposed Action, the preferred alternative, NASA and the Mid-Atlantic Spaceport (MARS) expanded and upgraded facilities to support medium to large class suborbital and orbital ELV launch activities from WFF. Components of the Proposed Action included site work required to support launch operations (such as facility construction and infrastructure improvements); testing, fueling, and processing operations; up to two static fire tests per year; and launching of up to six ELVs and associated spacecraft annually from Pad 0-A in addition to the 12 existing launches from Pad 0-B (NASA 2009). The first mission of the largest ELV thus far launched from WFF, an Antares, took place on Sept. 18, 2013, when it was launched from WFF to the International Space Station.

4.1.1.5 North Wallops Island Unmanned Aerial Systems Airstrip

In 2012 NASA prepared an EA to analyze the potential environmental consequences resulting from the construction and operation of a new UAS airstrip on the north end of Wallops Island. The project includes construction of an asphalt airstrip measuring approximately 3,000 feet (900 meters) long and 75 feet (25 meters) wide (NASA 2012). UAS operations will typically be conducted year round during WFF's normal air traffic control tower hours (i.e., Monday through Friday, 6:00 a.m. to 6:00 p.m.). The limit for the noisiest UAS to use the airstrip would be a Viking 300, which has a 25 horsepower motor, and for the largest UAS, a Viking 400, which has a 20-foot (6-meter) wingspan and is 14.7 feet (4.5 meters) long.

4.1.2 Projects and Actions by Others

There are ongoing and reasonably foreseeable projects that have been considered in evaluating cumulative effects on resources within the region.

4.1.2.1 Public Recreation

Although Wallops Island is closed to public access, the adjacent waterways and marshes to the north and west are regularly used by the public for activities such as boating, waterfowl hunting, fishing, and harvesting shellfish. Details regarding level and frequency of use are not available; however, it is assumed that most of these activities take place year-round, with hunting only taking place during fall and winter months.

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4.1.2.2 Navy Atlantic Fleet Training and Testing (AFTT)

The Navy prepared an EIS/OEIS in 2013 to evaluate the potential environmental effects associated with military readiness training and research, development, testing, and evaluation activities conducted within the AFTT study area (Navy 2013). The AFTT study area pertinent to this EA includes the VACAPES Range Complex, including special use airspace with associated warning and restricted areas and surface and subsurface sea space of the VACAPES OPAREA. The VACAPES Range Complex also includes established mine warfare training areas located within the lower Chesapeake Bay and off the coast of Virginia.

The EIS/OEIS was prepared to renew and combine current regulatory permits and authorizations; address evolving training and testing requirements; 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 (Navy 2013). As described in Section 1.4, the in-depth analysis of in-water impacts from projectiles striking locations within the Virginia Capes Operating Area is included in the AFTT FEIS/OEIS (Navy 2013), which evaluates the impacts from at-sea training and testing activities and is incorporated by reference in this EA.

4.1.2.3 Permanent Danger Zone Amendment

In October 2012, the U.S. Army Corps of Engineers expanded the Atlantic Ocean danger zone around Wallops Island and Chincoteague Inlet, Virginia to a 30-nautical mile sector necessary to protect the public from hazards associated with WFF's rocket launch operations (33 C.F.R. § 334.130).

4.1.2.4 Town Center at Wallops Spaceport

On May 3, 2012, Atlantic Town Center Properties requested a change in the future land use designation for approximately 131 hectare (324 acres) of land from agricultural to village development. The site is located on Route 175 and Route 679 approximately 3 kilometers (2 miles) east of Route 13 near Wattsville. If the request is approved, the Wattsville Village Development area would be approximately 440 hectares (1,088 acres) in size (County of Accomack, Department of Planning 2012). The development would be called the Town Center at Wallops Spaceport and there are plans for 300 residential units, retail space, and offices in the center of the complex, which comprises 42 acres (104 acres) of land (Cicoira 2013).

4.2 Summary of Cumulative Impacts Relative to the Proposed Action

Environmental effects associated with the Proposed Action were analyzed in Chapter 3. These effects were determined individually to be non-significant or to have no effect. The Proposed Action may have cumulative impacts when combined with other similar actions occurring in the region of influence, on the resources discussed below.

4.2.1 Cumulative Impacts on Range Operations

Under the Proposed Action, the Navy would fire the guns on approximately 20 days the first program year and approximately 50 days in the fifth program year. The increased use of R-

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6604A would have negligible effects on non-military airspace users because the proposed gun firing would not increase activation of R-6604A substantially. R-6604A currently is activated most days during the year and was released for potential use by civil aviation during only 37.6 percent of the hours in fiscal year 2013. Proposed Action gun firing typically would occur within blocks of time otherwise scheduled by WFF. This would be true also for the other future projects that would require increased use of the range.

To support HVP testing under the Proposed Action, WFF would restrict vessel movements near Wallops Island for several hours, and if required, would stop vessel movements through Chincoteague Inlet typically for 30 to 60 minutes per projectile firing. Based on a median value of 45 minutes per firing, vessel movements through the inlet could be restricted approximately 80 hours annually in the first and second years, approximately 110 hours annually in the third and fourth year, and approximately 190 hours in the fifth year. Because NASA would announce the time and duration of tests in advance and work with the public to minimize delays during the tests, which are intermittent, and may allow the passage of vessels between shots, these impacts would not be significant.

Although the impacts of all of the recent and present projects considered together would not have significant impacts on range operations, the increase in activities would require more intensive range scheduling. Plans for the future projects that would contribute to range use are not advanced enough to determine how much range time they would require and what the cumulative impacts on range operations would be. Cumulatively, it is likely that the Proposed Action combined with the future projects would have more effect on commercial and recreational uses of the waters near Wallops Island; users may be restricted from using range areas for longer periods of time and be affected more days of the year than at present. However, by issuing notices in advance and by only closing the parts of the range affected for the shortest time possible, the cumulative effects are not likely to be significant.

4.2.2 Cumulative Impacts on Noise Levels

Noise from operations would occur more frequently because of the increase in the number of noise-producing activities at WFF. While the 60 sounding rockets and 18 orbital rockets NASA currently launches annually from Wallops Island are not expected to increase, other activities, such as the proposed DoD SM-3 rocket launches near the powder gun and EM railgun and use of the new UAS airstrip on the northern part of Wallops Island would increase. (UAS flights are not expected to generate loud noise, however, because craft using the Wallops airstrip are limited to 25 horsepower motors.) Cumulatively, loud noises, such as from rocket launches and gun firing, would occur more frequently. Because the activities are well-removed from sensitive land uses, however, the cumulative effects would not be significant.

4.2.3 Cumulative Impacts on Protected Species

While the frequency of noise-producing events would not have significant cumulative effects on people, it does have the potential to disturb the protected species that use the beach for foraging and nesting because of the cumulative increase in operations (the Proposed Action would result in a maximum of 250 shots fired annually) and the general increase in activity. On Wallops Island, in addition to existing sounding and orbital rocket firing and proposed SM-3 rocket firing and railgun/HVP gun firing, ESSMs are fired, and up to 1,040 UAS sorties are carried out annually (larger, noisier UASs and other aircraft use the Main Base runways, not the airstrip on

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the north end of Wallops Island). Other sources of disturbance to beach-dependent species can occur from recreational use of the beach, security patrols, monitoring of protected species, and regular nourishment of the beach during nesting season. Resident wildlife may habituate to noise-producing activities, while transient wildlife such as shorebirds may be more sensitive to disturbance. WFF would continue to monitor protected species to determine whether disturbances are affecting them. Given WFF's program to monitor and minimize impacts to protected species on Wallops Island, the cumulative effects of the projects would not be significant.

4.2.4 Summary of Cumulative Effects

Table 4-1 shows the potential environmental effects of each action in the region of influence potentially contributing to a cumulative effect, the potential environmental effects of the Proposed Action, and the potential cumulative effects of all actions combined. Impacts on resources are classified in the table as:

- No impact (NI) – No change to the resource.
- Impact not significant (NS) – Minor adverse effects may be detectable, but they do not appreciably affect the long-term extent or value of the resource. Examples would be construction-related noise and ground disturbance or an increase in noise levels in the instant the guns are fired. Adverse impacts may be mitigated (such as by carrying out soil and erosion controls during construction) to ensure they are less than significant.
- Impact significant (S) – Significant adverse impacts exceed normal variability, appreciably affect the value or extent of an important resource, and may affect the viability of the resource. Full mitigation of adverse effects is not possible, or mitigation success is not likely, and long-term deterioration of the resource may be unavoidable.
- Impact beneficial (B) – Impacts on the resource are positive.

4.3 Greenhouse Gas Emissions and Climate Change

WFF activities make an incremental contribution to greenhouse gas emissions, representing a very small percentage of total United States emissions. The potential effects of greenhouse gas emissions are by nature global and cumulative, as individual sources of greenhouse gas emissions are not large enough to have an appreciable effect on climate change. An appreciable impact on global climate change would only occur when proposed greenhouse gas emissions combine with emissions from other man-made activities on a global scale.

The Proposed Action would contribute a negligible amount of greenhouse gases. When combined with other past, present, and reasonably foreseeable future actions, the Proposed Action would result in for negligible, long-term, indirect, negative impacts on climate.

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Table 4-1: Summary of Cumulative Impacts

	WFF Range Activities	Recreational and Commercial Use of Waters off WFF	Operations Noise in Vicinity of WFF	Protected Species
Past and Present Actions				
SRIPP	B	NS	NI	NS
Post Hurricane Sandy Shoreline Repair	B	NI	NI	NS
Expansion of Wallops Launch Range	NS	NS	NS	NS
UAS Airstrip North Wallops Island	NS	NI	NS	NS
Navy AFTT	NS	NS	NS	NS
Danger Zone Amendment	B	NS	NS	NI
Reasonably Foreseeable Future Actions				
Directed Energy	NS	NS	NI	NI
DoD SM-3 Rocket Launcher	NS	NS	NS	NS
ESSM Pad (Operations already take place)	NI	NI	NI	NI
ELV Pad 0-C	NS	NS	NS	NS
NASA Flat Pads	NS	NS	NS	NS
BAMS UAS	NS	NI	NS	NI
Expanded Space Program	NS	NS	NS	NS
Expansion of R-6604	B	NI	NS	NI
Town Center at Wallops Spaceport	NI	NI	NI	NI
Proposed Action				
Installation of Powder Gun and Railgun and Testing of HVPs	NS	NS	NS	NS
Cumulative Impacts				
Cumulative Impacts of All Actions	NS	NS	NS	NS
Notes: B = Beneficial, NI = No Impact, NS = Impact not Significant, S = Impact Significant				

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4.4 Unavoidable Adverse Impacts

Unavoidable adverse impacts of the Proposed Action would include short-term, localized disturbances to the ocean bottom due to HVP firing. Sabots, pusher plates, and armatures would remain in the ocean after firing and would be covered by sediment over time. Unavoidable adverse impacts due to expended materials associated with testing would be minor, temporary, and not significant.

4.5 Relationship between Short-Term Uses of Man's Environment and the Enhancement of Long-Term Productivity

Adherence to the testing protocols would minimize the effects of testing activities on the environment. Consequently, the majority of the effects of the activities would be temporary in nature (as described in Chapter 3) and would have no significant adverse long-term impacts on the maintenance and enhancement of long-term productivity. There would be minimal short-term adverse effects on the environment; however, they would be brief and localized.

4.6 Irreversible and Irretrievable Commitment of Resources

Irretrievably and irreversibly committed resources are those that are consumed during the construction and implementation of a project and that cannot be reused. Because their reuse is impossible, they are considered irretrievably and irreversibly committed to the development of the proposed project. These resources would include expendable materials necessary for the development of the testing area, as well as fuels and other forms of energy that are utilized during project implementation.

During the HVP testing, non-renewable resources would be consumed. Since the reuse of these resources may not be possible, they could be considered irreversibly and irretrievably committed. Non-renewable resources would include the energy resources and projectiles necessary for the development and firing of the powder gun and EM railgun.

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