FINAL SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT
ANTARES 200 CONFIGURATION EXPENDABLE LAUNCH VEHICLE
AT WALLOPS FLIGHT FACILITY

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Lead Agency:	National Aeronautics and Space Administration
Cooperating Agency:	Federal Aviation Administration Office of Commercial Space Transportation
Proposed Action:	Processing, Static Fire, and Launch of the 200 Configuration Antares Expendable Launch Vehicle at Wallops Flight Facility
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ABSTRACT

This Supplemental Environmental Assessment (SEA) addresses the proposed processing, static fire, and launch of the 200 Configuration Antares Expendable Launch Vehicle (ELV) from the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center's Wallops Flight Facility (WFF), located in Accomack County, Virginia. The SEA has been prepared as a supplement to the 2009 *Final Environmental Assessment Expansion of the Wallops Flight Facility Launch Range*, and therefore focuses on the differences between the current Antares configuration (i.e., the "100" Configuration) at WFF and a proposed upgraded version (i.e., the "200" Configuration). Updated information regarding WFF's environmental context is also provided, as appropriate. This SEA analyzes the potential direct, indirect, and cumulative environmental effects of two alternatives: the Proposed Action and the No Action Alternative.

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Acronyms and Abbreviations

AGL	Above Ground Level
Al	Aluminum
AMOY	American oystercatcher
AP	Ammonium perchlorate
BO	Biological Opinion
C3PO	Commercial Crew and Cargo Program Office
CEA	Cumulative effects analysis
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CNWR	Chincoteague National Wildlife Refuge
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CRS	Commercial Resupply Services
CSLA	Commercial Space Launch Act
dB	Decibel
dBA	A-weighted decibel
DNL	Day-night level
DOT	Department Of Transportation
DPS	Distinct Population Segment
EA	Environmental Assessment
ELV	Expendable Launch Vehicle
EO	Executive Order
ES	Envelope spacecraft

ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAA-AST	Federal Aviation Administration Office of Commercial Space Transportation
FCD	Federal Consistency Determination
FONSI	Finding of No Significant Impact
FR	Federal Register
GHG	Greenhouse gas
GWP	Global warming potential
HCEA	Hillis-Carnes Engineering Associates, Inc.
HIF	Horizontal Integration Facility
HTPB	Hydroxyl-terminated polybutadiene
ISS	International Space Station
JLUS	Joint Land Use Study
kg	Kilogram
km	Kilometer
LED	Light-emitting diode
LMLV-3	Lockheed Martin Launch Vehicle-3
LNM	Launch Noise Model
LOX	Liquid oxygen
m	Meter
MARS	Mid-Atlantic Regional Spaceport
N_2O	Nitrous oxide
N/A	Not applicable
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act

NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NRHP	National Register of Historic Places
O_3	Ozone
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
psu	Practical salinity unit
RP-1	Refined petroleum-1
SEA	Supplemental Environmental Assessment
SPL	Sound pressure level
SRIPP	Shoreline Restoration and Infrastructure Protection Program
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USN	U.S. Navy
VCP	Virginia Coastal Zone Management Program
VCSFA	Virginia Commercial Space Flight Authority
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
WFF	Wallops Flight Facility

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1 Introduction and Purpose and Need for Action

1.1 Background

The National Aeronautics and Space Administration (NASA) has prepared this Supplemental Environmental Assessment (SEA) to evaluate the potential environmental impacts of the proposed processing, static fire, and launch of an upgraded Antares Expendable Launch Vehicle (ELV) at Wallops Flight Facility (WFF). This SEA has been prepared in accordance with the National Environmental Policy Act (NEPA), as amended (Title 42 of the United States Code [U.S.C.] 4321–4347), the Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA (40 Code of Federal Regulations [CFR] 1500–1508), NASA's regulations for implementing NEPA (14 CFR Subpart 1216.3), *NASA NEPA Management Requirements* (NASA Procedural Requirements 8580.1A [**NASA, 2012a**]), and Federal Aviation Administration (FAA) Order 1050.1F, *Environmental Impacts: Policies and Procedures* (**FAA, 2015a**).

On August 29, 2009, NASA issued a Finding of No Significant Impact (FONSI)[1] for its *Final Environmental Assessment Expansion of the Wallops Flight Facility Launch Range (Final EA)*[2] (**NASA, 2009a**). In its FONSI, NASA identified no significant effects on the human environment associated with Alternative 1, which entailed NASA and Commonwealth of Virginia-funded construction of facilities; testing, fueling, and processing of liquid-fueled ELVs and associated spacecraft; conducting up to two ELV static test fires per year; and launching up to six liquid-fueled ELVs from the Virginia Commercial Space Flight Authority's (VCSFA) Mid Atlantic Regional Spaceport (MARS) Pad 0-A. The *Final EA* identified Orbital Sciences Corporation's (since renamed Orbital ATK) Taurus II (since renamed Antares) as the largest liquid-fueled ELV to be processed at WFF and launched from MARS Pad 0-A.

Since issuing its FONSI, between 2009 and 2013, NASA and the VCSFA collectively implemented the *Final EA's* Alternative 1 by constructing a Horizontal Integration Facility (Building X-079) on mid-Wallops Island, modifying Building V-055 on north Wallops Island to repurpose it as a spacecraft fueling facility, constructing a liquid fueling facility adjacent to Pad 0-A, and upgrading the Pad 0-A launch structure to support medium-class liquid-fueled ELVs. The sole occupant of these facilities thus far has been Orbital ATK, which was initially awarded NASA's Commercial Crew and Cargo Program Office (C3PO) Commercial Orbital Transportation Services contract in 2008 and then subsequently awarded the C3PO Commercial Resupply Services (CRS) contract to provide cargo and disposal services to the International Space Station (ISS) through at least 2017.

Upon final certification of the new launch pad and support facilities by NASA's safety organization, Orbital ATK conducted one approximately thirty-second Antares static fire test in February 2013. Subsequently, between April 2013 and July 2014, Orbital ATK performed four

[1] The FONSI is available online at http://sites.wff.nasa.gov/code250/docs/expansion_ea/MARS_FINAL_FONSI_signed.pdf.
[2] The *Final EA* is available online at http://sites.wff.nasa.gov/code250/docs/expansion_ea/EWLR_FEA.pdf.

successful launches of the Antares ELV, three of which transported the Cygnus spacecraft to orbit from Pad 0-A. However, on October 28, 2014, Orbital ATK's fifth Antares flight, named ORB-3, suffered a catastrophic failure shortly after liftoff. In response to the ORB-3 mishap, Orbital ATK has proposed an accelerated introduction of an enhanced version of Antares that was not originally considered in the *Final EA*. Accordingly, NASA has prepared this SEA to consider the potential environmental effects of Orbital ATK's proposal.

1.1.1 Relationship to 2009 Final EA

Both CEQ and NASA NEPA regulations (at 40 CFR § 1502.9(c) and 14 CFR § 1216.308, respectively) require the preparation of supplements to existing NEPA documents should: 1) a Federal agency propose substantial changes to an action that are relevant to environmental concerns; or 2) significant new information arises having a notable bearing on the potential environmental effects of an action. Based upon the scope of the proposed action considered in this SEA (see Section 2.3), it is unlikely that either of these two circumstances exists. Notwithstanding this fact, agencies may prepare supplements to further the purposes of NEPA, which is the approach that NASA has taken for considering the environmental effects of the upgraded Antares ELV.

In supplemental NEPA documents, the focus is on the potential environmental effects of the change in the action or availability of new information, as appropriate. To this end, the description of the action and/or the analyses that remain unchanged are summarized and incorporated by reference in the supplement. Consistent with this approach, NASA has prepared this document as a supplement to the *Final EA* focusing specifically on the updated Antares configuration. As such, much of the *Final EA* is incorporated by reference with new information and analysis provided as appropriate.

Additionally, one static fire test and five previous launches (including the ORB-3 mishap) of the Antares ELV from WFF have provided insights into both operational components and environmental effects that may not have been fully considered in the *Final EA*. In these instances, the updated information is presented in this SEA as either a component of the No Action Alterative, Proposed Action, or both, as appropriate, such that it may be considered when comparing the potential environmental effects of the two alternatives.

1.1.2 Cooperating Agency

NASA, as the WFF property owner that holds the land use agreement with VCSFA for the operation of MARS Pad 0-A, is the Lead Agency in preparing this SEA. The U.S. Department of Transportation's (DOT) FAA Office of Commercial Space Transportation (FAA-AST) has served as a Cooperating Agency because it possesses both regulatory authority and specialized expertise regarding the Proposed Action.

The FAA licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-Federal launch and reentry sites, as authorized by Executive Order (EO)

12465, *Commercial Expendable Launch Vehicle Activities* **(40 FR, 7099)**, and the Commercial Space Launch Act of 2011 (CSLA, 51 U.S.C. Subtitle V, ch. 509, §§ 50901-50923). Commercial launch providers proposing to operate at NASA's WFF would be required to apply for an FAA-issued launch operator license. Similarly, existing launch providers and/or the existing commercial launch site operator at WFF may be required to modify their FAA-issued licenses in the future. Orbital ATK must apply for a modification to its existing FAA-issued Antares launch license to conduct launches of the upgraded Antares ELV from WFF. Similarly, VCSFA may be required to modify its existing FAA-issued launch site operator license to allow for the upgraded ELV.

If, after reviewing this SEA, the FAA determines the launch activities would not individually or cumulatively result in significant impacts on the human environment, the FAA would adopt the SEA and issue its own FONSI to support the issuance of launch licenses for the activities described in this SEA. The FAA will draw its own conclusions from the analysis presented in this SEA and assume responsibility for its environmental decision and any related mitigation measures.

1.2 Purpose and Need for the Proposed Action

1.2.1 Purpose

The purpose of NASA's Proposed Action is to restore the Antares launch capability at VCSFA's MARS Pad 0-A on Wallops Island.

1.2.2 Need

The Proposed Action is needed because the Antares launch capability at WFF has been suspended by Orbital ATK following the ORB-3 mishap in October 2014. The National Aeronautics and Space Act (51 U.S.C. § 20112(a)(4)) directs NASA to "seek and encourage, to the maximum extent possible, the fullest commercial use of space." Furthermore, the 2010 National Space Policy directs Federal agencies to "ensure that United States Government space technology and infrastructure are made available for commercial use on a reimbursable, noninterference, and equitable basis to the maximum practical extent." NASA's authorization of VCSFA and Orbital ATK to process, static fire test, and launch the upgraded Antares ELV at WFF respond directly to its statutory and policy direction to promote a viable U.S. commercial launch capability.

In addition, to ensure redundant (i.e., two separate, available providers), U.S.–based cargo delivery and disposal services to the ISS following the retirement of the Space Shuttle in 2011, NASA awarded the CRS contract to two U.S. companies, Orbital ATK being one. Restoration of the Antares launch capability at WFF would once again ensure that this strategic objective is met as the U.S. fulfills its treaty obligations with respect to operation of the ISS.

1.2.3 Cooperating Agency Purpose and Need

The purpose of FAA's action of issuing launch licenses is to fulfill the agency's responsibilities under the CSLA for oversight of commercial space launch activities, including issuing launch site operator licenses for the operation of commercial space launch sites, and launch licenses to operate launch vehicles.

The need for FAA's action results from the statutory direction from Congress under the CSLA to protect the public health and safety, safety of property, and national security and foreign policy interests of the U.S. and to encourage, facilitate, and promote commercial space launch and reentry activities by the private sector in order to strengthen and expand U.S. space transportation infrastructure.

1.3 Changes between Draft and Final SEA

Based upon comments received on the Draft SEA, consultations with resource agencies, and its own internal review, NASA made the following substantive changes the Draft SEA which are reflected in this Final SEA:

- A map depicting the extent of the affected environment has been added as Figure 3-1;
- A summary of the Coastal Zone Management Act consistency review conducted by the Virginia Department of Environmental Quality has been added to Section 3.1.3.3;
- Information regarding the effects of launch-induced fires and launch failures on wildlife has been added to Section 3.2.2.2;
- A summary of 2015 avian and sea turtle nesting activity on the Wallops Island beach has been added to Sections 3.2.2.1 and 3.2.4.2;
- Updated information on the northern long-eared bat has been added to Sections 3.2.4.2 and 3.2.4.3;
- A summary of NASA's Endangered Species Act consultation with the U.S. Fish and Wildlife Service has been added to Section 3.2.4.3;
- A summary of the potential effects of launch failures on historic properties has been added to Section 3.3.2.3; and
- Comments received on the Draft SEA and NASA's responses to them have been included as Appendix A.

2 Proposed Action and Alternatives

2.1 Introduction

This Chapter provides a discussion of the alternatives under consideration for the restoration of the Antares launch capability at WFF. The *Final EA* considered in detail three potential alternatives for expanding NASA's and MARS's then baseline operations at WFF. In the FONSI for the *Final EA*, Alternative 1 was NASA's preferred alternative that it subsequently implemented. Therefore, the focus of this SEA is returning the launch capability described and analyzed for Alternative 1 in the *Final EA*, however with an upgraded Antares configuration. Accordingly, the No Action Alternative and the Proposed Action are evaluated in this SEA.

2.2 No Action Alternative

CEQ's NEPA implementing regulations require that an agency "include the alternative of no action" as one of the alternatives it considers (40 CFR 1502.14[d]). The No Action Alternative serves as a baseline against which the impacts of the Proposed Action are compared. Under the No Action Alternative for this SEA, NASA would not allow VCSFA and Orbital ATK to process, static fire test, or launch an upgraded version of Antares from Pad 0-A. Processing and launch operations would continue with the currently configured Antares ELV (in the *Final EA* named Taurus II) as described in Sections 2.2.2 and 2.2.3 of the *Final EA*.

However, since completing the 2009 *Final EA*, NASA has acquired further range surveillance assets employed during ELV launches, in particular a UH-1 helicopter. Coupled with existing fixed wing radar and visual spotter aircraft and surface vessels, these vehicles comprise the fleet of assets used by NASA during launch countdowns to ensure that designated hazard areas are clear of non-participating craft. In general, UH-1 helicopter surveillance flights occur twice per launch countdown and range in altitude from 60 meters (m) above ground level (AGL) to 1,500 m AGL. The helicopter's primary area of surveillance responsibility is the lagoon area between Wallops Island and the mainland Eastern Shore of Virginia; however, its flights can also range up to several kilometers (km) offshore. Each surveillance flight is approximately 2.5 hours in duration.

In addition to the helicopter, NASA typically employs 1-2 fixed wing aircraft per launch attempt. Fixed wing radar surveillance aircraft operate the majority of the time at 4,500 m AGL and remain within the Virginia Capes airspace east of Wallops Island. Fixed wing spotter aircraft operate in the same area but their altitude varies from between 150 m and 4,500 m AGL. The spotters spend less than approximately ten percent of their flight time below 460 m; only descending to low altitudes to visually obtain a call sign from an encroaching boat or to get the attention of the crew. Once a line of communication has been established with the boat, the spotter aircraft promptly ascend to higher altitudes. Most of the spotters fly for around 4 hours total and the radar planes fly between 4 to 5.5 hours per mission. As these aircraft must cover an area sometimes in excess of 10,500 square km, it is rare that they spend any measurable amount of time around a single point.

Additionally, the WFF range's contracted surface surveillance and law enforcement vessels (i.e., boats) can include up to eight inboard- and outboard powered boats, ranging in size up to approximately 14 m in length.

Because these air and sea based surveillance activities were not considered in the 2009 *Final EA*, but are a key component of establishing the Wallops Range's readiness for an ELV launch, they are considered in this SEA as a component of the No Action Alternative.

2.3 Proposed Action

NASA's Proposed Action is to authorize the VCSFA and Orbital ATK to process, static fire test, and launch the 200 Configuration Antares ELV from WFF. Summarizing the activities described in Section 2.2.2 and 2.2.3 of the *Final EA* (which would be the same for either Antares configuration), NASA's authorization would allow:

- Delivery of rocket and payload hardware and support equipment to the WFF Main Base and Island via overland transportation (existing road or rail) or via the WFF airfield (Section 2.2.2 of the *Final EA*);
- Staging and processing the Antares ELV at the Horizontal Integration Facility (HIF: Building X-079) on mid Wallops Island (Section 2.2.2 of the *Final EA*);
- Processing the spacecraft at the Payload Processing Facility (Building H-100) on the western portion of WFF's Main Base or a future processing facility on north Wallops Island (Section 2.2.1.2 of the *Final EA*);
- Fueling the spacecraft at the existing fueling facility (Building V-055) on north Wallops Island or a future fueling facility on Wallops Island (Section 2.2.1.3 of the *Final EA*);
- Conducting two static fire tests and launching up to 6 ELVs and associated spacecraft annually from MARS Pad 0-A on south Wallops Island (Section 2.2.3 of the *Final EA*).

In addition to authorizing the activities to occur at WFF, NASA would also provide to Orbital ATK and VSCFA a variety of launch range services, including:

- Use of government-owned facilities and ground support equipment;
- Pre- and post-launch launch safety analysis and oversight; and
- Range surveillance and clearance activities on launch day (as detailed in Section 2.2 of this SEA under the No Action Alternative).

2.3.1 Antares 200 Configuration ELV

The Antares ELV is a two- or three-stage rocket that, depending on mission requirements, could employ different motors/engines on each stage (more detail is provided in Section 2.4 of the *Final EA*). Orbital ATK classifies Antares using a three-digit numeric key based on which engine/motor combination is employed on the particular rocket. The first number in the key describes the first stage liquid-fueled engines (of which it always has two), the second number, the solid-fueled second stage motor, and the third number, the optional third stage, which could be liquid- or solid-fueled.

The Antares classification is as follows:

- First Stage: AJ-26 = 1 RD-181 = 2
- Second Stage: Castor 30 = 1 Castor 30B = 2 Castor 30XL = 3
- Third Stage: None = 0 Hypergolic = 1 Star 48 = 2

For example, an Antares with AJ-26 first stage engines, a Castor 30XL second stage, and no third stage would be considered a 130 Configuration. All previous Antares ELV launches from WFF have been with the AJ-26 first stage-powered “100” Configuration, employing each of the three available second stage motors with no third stage.

Orbital ATK has proposed to conduct future Antares launches from WFF employing solely the “200” Configuration, beginning with a 230 (**Figure 2-1**).[3] The 200 Configuration is very similar to the 100 Configuration, with the primary difference being the first stage engines employed.

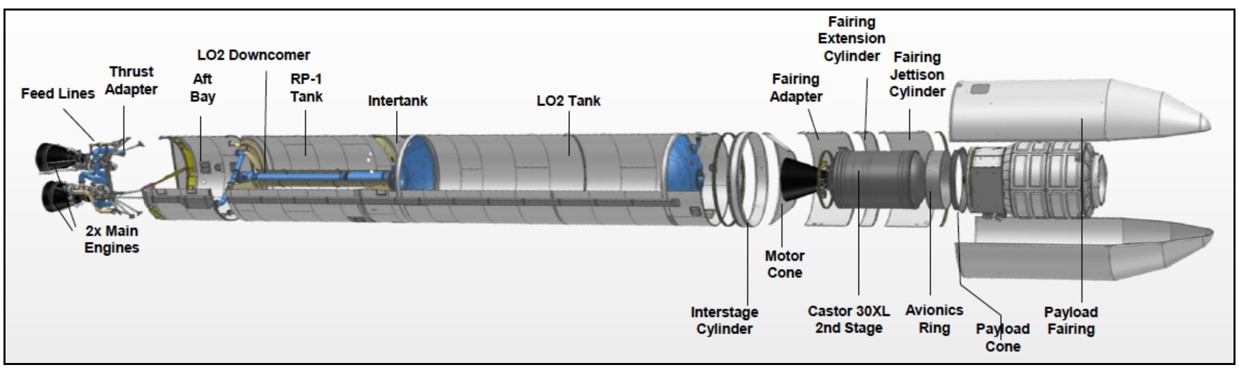

Figure 2-1: Antares 200 Configuration ELV (230 Configuration depicted)

[3] Although the formal ORB-3 mishap investigation report has not yet been released to the public, Orbital ATK has publicly acknowledged that the mishap was due to a problem with one of the rocket’s first stage engines, necessitating the proposed upgrade from the “100” configuration to the “200” configuration Antares.

Rather than using two Aerojet-Rocketdyne provided AJ-26 liquid oxygen (LOX) and refined kerosene (RP-1) fueled engines, the 200 Configuration would employ two NPO Energomash-provided RD-181 engines (which also use LOX and RP-1). These newly manufactured engines would be more powerful (up to approximately 17 percent more thrust at sea level, depending on throttle setting) than the previous AJ-26 engines and consequently would allow for a heavier payload to be placed into orbit. Aside from the new engines and modifications to valves and piping in the first stage fuel feed system, modifications to structural and thermal components in the first stage, and changes to avionics and wiring, the 200 Configuration Antares would remain largely unchanged from the earlier 100 Configuration.

Outside of the rocket itself, the 200 Configuration Antares would require slightly different ground support equipment (used to handle and test rocket components) and fueling infrastructure. A comparison of the 100 and 200 Configuration Antares ELVs is provided in **Table 2-1**.

Table 2-1: Comparison of Antares ELV Configurations

	Parameter	100 Configuration (No Action)	200 Configuration (Proposed Action)	Net Difference
Overall	Length (m)	42	42	None
	Diameter (m)	3.9	3.9	None
	Mass at Liftoff (kg)	296,000	294,000	- 2,000
Stage 1 (Liquid)	Number of Engines	2	2	None
	Per-Engine Thrust at Sea Level (kg force)	167,000	196,000	+ 29,000
	Propellants	LOX / RP-1	LOX / RP-1	None
	Propellant Quantities (kg)	179,000 / 65,000	174,000 / 65,000	- 5,000 / -232
Stage 2 (Solid)	Propellants	AP/Al/HTPB	AP/Al/HTPB	None
	Propellant Quantities (kg)	25,000	25,000	None
Stage 3 (Solid or Liquid)	Propellants if Solid	AP/Al/HTPB	AP/Al/HTPB	None
	Propellant Quantities if Solid (kg)	2,010	2,010	None
	Propellants if Liquid	Hydrazine / Nitrogen Tetroxide	Hydrazine / Nitrogen Tetroxide	None
	Propellant Quantities if Liquid (kg)	350 / 350	350 / 350	None
Spacecraft	Type	Cygnus or ES	Cygnus or ES	None
	Approx. Mass to Low Earth Orbit (kg)	6,355	7,065	+ 710

Key: LOX = Liquid Oxygen; RP-1 = Refined Kerosene; AP = Ammonium Perchlorate
Al = Aluminum; HTPB = Hydroxyl Terminated Polybutadiene
m = meter; ES = Envelope Spacecraft; kg = kilogram

2.3.2 Antares 200 Configuration Spacecraft

In addition to Orbital ATK's Cygnus spacecraft (described in detail in Section 2.4.2.1 of the *Final EA*) employed to provide cargo delivery ("upmass") and disposal ("downmass") services to the ISS, the 200 Configuration Antares could also transport into orbit what NASA considers a "routine spacecraft (or payload)."

In November 2011, NASA completed the *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles* (*Final Routine Payloads EA*)[4], within which WFF was assessed as a launch site (**NASA 2011a**). The purpose of the *Final Routine Payloads EA* was to reduce data and excessive paperwork by analyzing the potential environmental impacts of similar actions in one EA. Many of the future Earth and space exploration missions planned by NASA or its partners would require spacecraft that are similar in overall design, materials, and engineering as well as instrument or payload systems. Likewise, these spacecraft would be launched using ELVs selected from a group of domestic launch vehicles. The missions would also have other common elements, including spacecraft prelaunch processing, launch scenarios, and resource use.

As such, when conducting an environmental review of a proposed spacecraft launch, NASA evaluates the proposed spacecraft design against the Routine Payload Checklist (see Section 2.1.2 and Appendix C of the *Final Routine Payloads EA*) to determine if it meets the description of a NASA routine payload. If the mission meets the definition of a routine payload, this finding would be documented by processing a Record of Environmental Consideration (REC) in accordance with NASA's NEPA procedural requirements and guidance, citing the *Final Routine Payloads EA*. If one or more routine spacecraft characteristics exceed or are not included in the characteristics specified in Table 2-1 and Appendix C of the *Final Routine Payloads EA*, further environmental analysis to meet NEPA and other environmental regulatory requirements would be conducted, as necessary and appropriate.

Although the Antares 200 Configuration ELV was not addressed in the 2011 *Final Routine Payloads EA*, launches of spacecraft on it from WFF would qualify for inclusion as a routine payload upon completion of the NEPA process for it (i.e., this SEA). As stated in Section 1.4 of the 2011 *Final Routine Payloads EA*:

> In the event that other launch vehicles or other launch sites become available after the publication of this NEPA document, they would be considered NEPA-compliant under this EA if they meet the following criteria:
>
> …NASA has completed the NEPA process for the specific launch vehicle at a specific launch site.

[4] The *Final Routine Payloads EA* is available online at http://sites.wff.nasa.gov/code250/docs/FINAL%20NASA%20Routine%20Payload%20EA.pdf

Consistent with this stated approach for NEPA compliance, assuming timely completion of this SEA, NASA would consider future spacecraft proposed for launch from WFF on the Antares 200 Configuration ELV to be routine in nature (and therefore qualifying them for a streamlined NEPA review) should their characteristics fall within those already established by the 2011 *Final Routine Payloads EA.*

3 Affected Environment and Environmental Consequences

The purpose of this Chapter is to consider the current conditions of the affected environment and compare it to those conditions that might occur should NASA implement either of the alternatives. NEPA requires a focused analysis of the resources potentially affected by an action or alternative; the results of which should be presented in a comparative fashion allowing decision makers and the public to differentiate among the alternatives. Furthermore, CEQ regulations for implementing NEPA also require the discussion of impacts in proportion to their significance, with only enough discussion of non-significant issues to show why more study is not warranted.

Affected Environment

The affected environment for this SEA includes Wallops Island, the nearshore zone over which surveillance aircraft and the Antares ELV would fly, and the offshore areas within which the Antares ELV would jettison its flight hardware (**Figure 3-1**).

Because there is a complete description of all potentially affected resource areas in the 2009 *Final EA*, only those environmental resources that have measurably changed since then or would be affected by the proposed action in a different way than discussed in the *2009 Final EA* are presented in this SEA; otherwise they are incorporated by reference.

Resources Carried Forward for Detailed Analysis

Table 3-1 presents the results of the process of identifying resources to be analyzed in detail in this SEA. The general organization of resource areas is consistent with the *Final EA*; however, some have been grouped and/or renamed for clarity. For example, while the *Final EA* identified four separate resource areas of *Surface Water*, *Wetlands*, *Marine Waters*, and *Groundwater*, this SEA combines them into a single resource entitled *Water Resources*. Additionally, the *Final EA* discussed the affected environment and environmental consequences in separate chapters; this SEA combines the two.

Resources Considered but Eliminated from Detailed Analysis

Numerous resources were considered in the *Final EA*, but warrant no further examination in this SEA because either the resource has not notably changed or the proposed upgrade to the 200 Configuration Antares ELV would have little, if any, bearing on the original analyses and conclusions drawn in the *Final EA*. Those resources not warranting further discussion are also presented in **Table 3-1**.

Table 3-1: Resources Considered for Analysis in this SEA

Resource in 2009 *Final EA*	**Analyzed in Detail in this SEA?**	**If *Yes*, SEA Section If *No*, Rationale for Elimination**
Physical Environment: Section 3.1		
Topography and Drainage	No	No construction proposed.
Geology	No	No construction proposed.
Soils	Yes	Section 3.1.1
Surface Waters	Yes	Section 3.1.2
Wetlands	Yes	Section 3.1.2
Marine Waters	Yes	Section 3.1.2
Floodplains	No	No alteration to floodplain would occur.
Coastal Zone	Yes	Section 3.1.3
Stormwater	No	No changes in drainage patterns or impervious surface discussed in Section 4.2.2.5 of *Final EA*.
Wastewater	No	No changes in quantity or type of wastewater discussed in Section 4.2.2.6 of *Final EA*.
Groundwater	Yes	Section 3.1.2
Air Quality	Yes	Section 3.1.4
Noise	Yes	Section 3.1.5
Orbital and Reentry Debris	No	No change in requirements discussed in Section 4.2.5 of *Final EA*.
Hazardous Materials and Waste	No	No change in the types or quantities of hazardous materials or waste discussed in Section 4.2.6 of *Final EA*.
Radiation	No	No change in the use of ionizing or non-ionizing radiation discussed in Section 4.2.7 of *Final EA*.
Biological Environment: Section 3.2		
Vegetation	Yes	Section 3.2.1
Terrestrial Wildlife and Birds	Yes	Section 3.2.2
Threatened and Endangered Species	Yes	Section 3.2.4
Marine Mammals	Yes	Section 3.2.3
Fish	No	No change in impacts as identified in Section 4.3.4 of *Final EA*.
Social Environment: Section 3.3		
Population	No	No change to impacts identified in Section 4.4.1 of *Final EA*.
Recreation	No	No change in impacts as identified in *Final EA*.
Employment and Income	No	No change to impacts identified in Section 4.4.1 of *Final EA*.
Environmental Justice	No	No change to impacts identified in Section 4.4.2 of *Final EA*.
Health and Safety	No	No change in requirements discussed in Section 4.4.3 of *Final EA*.
Land and Water Uses	Yes	Section 3.3.1
Cultural Resources	Yes	Section 3.3.2
Transportation	No	No change to impacts identified in Section 4.4.5 of *Final EA*.
DOT Act Section 4(f) Lands	Yes	Section 3.3.3

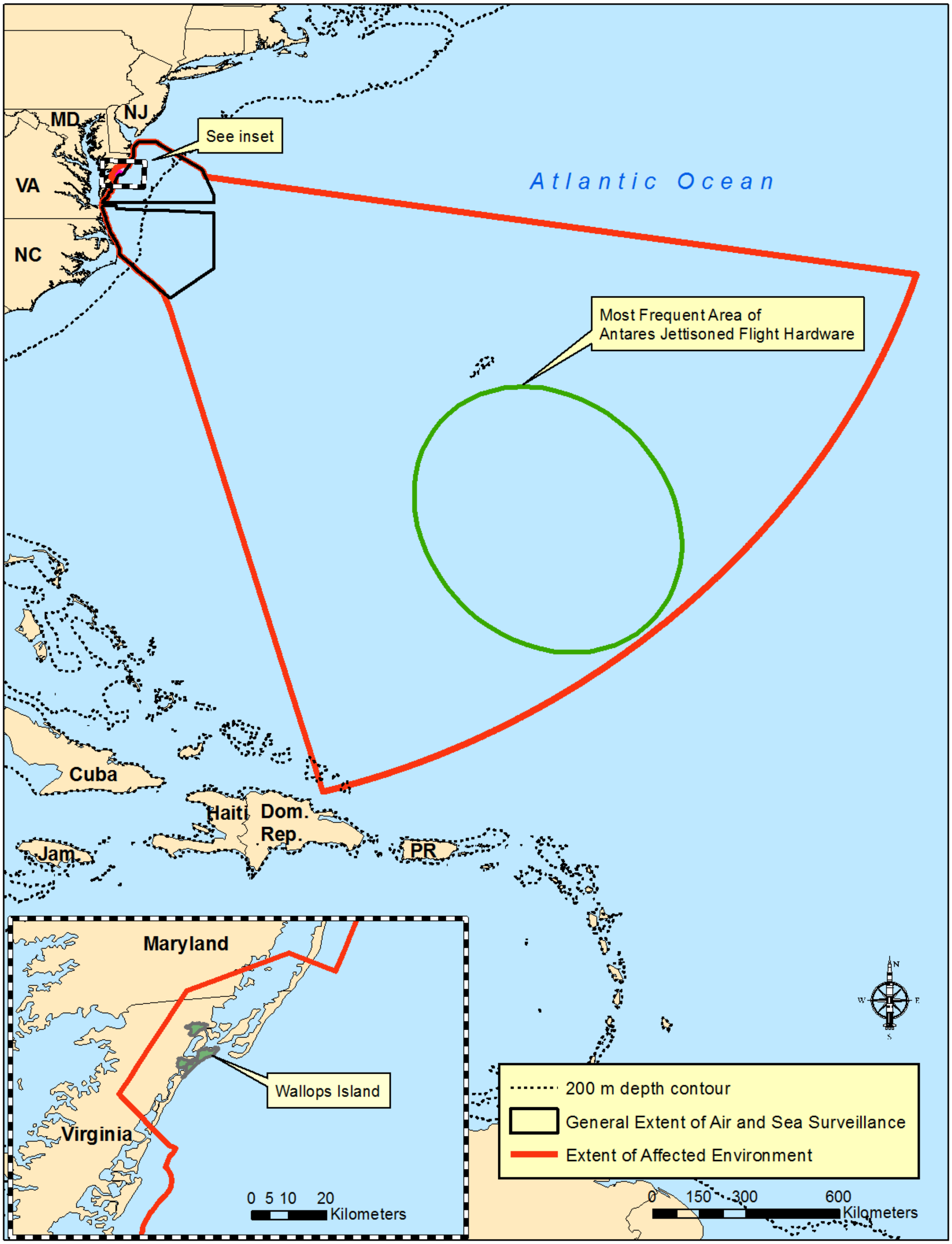

Figure 3-1: Extent of Affected Environment Considered in this SEA

3.1 Physical Environment

3.1.1 Soils

3.1.1.1 Affected Environment

Section 3.1.1.3 of the *Final EA* describes in detail the soils on Wallops Island. In summary, the soils within and adjacent to the Pad 0-A launch complex are Fisherman and Camocca fine sands, which range from poorly drained (in wetland/marsh areas) to excessively drained (in upland areas) (**USDA, 1994**).

3.1.1.2 Environmental Consequences

No Action Alternative

Section 4.2.1.2 of the *Final EA* describes the potential effects of 100 Configuration Antares launches on soils at Wallops Island. The *Final EA* indicates that launch activities would not impact soils as they would occur over the impervious surface at Pad 0-A. While this conclusion is largely true under nominal launch scenarios, recent long-term studies conducted at Kennedy Space Center, Florida show that ablation of launch vehicle or launch pad components during normal launch operations (albeit at a larger scale in the case of the Space Shuttle) could result in the deposition of metals immediately around the launch pad (**Bowden et al., 2014**).

In the case of a launch failure in the vicinity of the launch pad (e.g., ORB-3), it is probable that in addition to metals, petroleum products (derived from the first stage RP-1 fuel) or perchlorate (derived from the second stage ammonium perchlorate oxidizer) would be deposited in the upper meter of soil. However, field sampling and analysis conducted following the ORB-3 mishap (**VCSFA, 2015**) support the conclusion that soil contamination would most likely be localized to the Pad 0-A complex. Furthermore, **VCSFA (2015)** determined that neither the levels of metals nor perchlorate detected following ORB-3 warranted soil removal due to their concentrations being below either background levels on Wallops Island (e.g., **Tetra Tech, 2009**; **Weiss, 2008**) or conservatively applied screening levels (i.e., **USEPA, 2015**). Petroleum contaminated soil from ORB-3 was limited to a several hundred square meter area adjacent to Pad 0-A, and was removed shortly following the mishap and disposed of at a licensed treatment facility (**VCSFA, 2015**).

The *Final EA* did not discuss in detail the potential effects of launch-induced fires on soils. However, observations from previous Antares launches has shown that the rocket's hot exhaust can lead to the ignition of nearby vegetation (particularly of common reed [*Phragmites australis*]), therefore, warranting its discussion in this SEA. **Certini (2005)** provides a comprehensive discussion of the effects of fire on soil characteristics; which, in summary, include increased soil temperature due to loss of vegetation and darkened soil coloring, increased pH, increased water repellence, reduced organic matter content, and an increased availability of soil nutrients. Yet, these effects are generally ephemeral and will return to pre-fire conditions within weeks to years following the event. Due to the potential launch-induced fire risk, NASA has undertaken a *Phragmites* control program (**NASA, 2014a**), in which a combination of regular aerial herbicide application and controlled burns are employed to reduce the fuel load and thereby the fire risk around the Pad 0-A complex. As such, the potential for future launch fire-induced effects to nearby soils would be low. Even if fires were to occur, the extent of effects would be limited to south Wallops Island.

Proposed Action

The potential effects of the Proposed Action on soils would be the same as those under the No Action Alternative.

3.1.2 Water Quality

3.1.2.1 Affected Environment

Section 3.1.3 of the *Final EA* describes in detail the water resources both adjacent to the Pad 0-A complex and under the ELV's downrange flight corridor. In summary, within the Pad 0-A complex, launch-generated deluge water is contained within a concrete retention basin that is followed in sequence by a geo-textile fabric lined basin. A water control structure allows these basins to be manually drained to a series of four constructed "ponds" which were built to manage on-site storm water. These four "ponds" drain in sequence to an outfall located in adjacent wetlands west of the launch complex. West of the launch complex is an extensive network of emergent and scrub-shrub estuarine wetlands. Immediately east of the launch complex is the Atlantic Ocean.

Surface waters in the vicinity of Wallops Island are saline to brackish and are influenced by the tides (**Chance, 2014**). East of Wallops Island, oceanic waters over the continental shelf generally range between 32 to 35 practical salinity units (psu) throughout the year, with higher salinity water (36 psu or greater) found near the Gulf Stream (**Mountain ,2003**).

The shallow groundwater within and in the vicinity of the Pad 0-A complex is tidally influenced and generally encountered 0.5 to 1 m below the ground surface. The hydraulic gradient is relatively flat. However, groundwater generally flows toward the estuarine wetlands to the west or the Atlantic Ocean to the east, depending on the proximity to these water bodies.

3.1.2.2 Environmental Consequences

No Action Alternative

Sections 4.2.2.1 and 4.2.2.2 of the *Final EA* describe in detail the potential effect of the 100 Configuration Antares launches on surface waters, wetlands, and marine waters. Sections 4.2.2.6 and 4.2.2.7 of the *Final EA* describe potential effects on wastewater and groundwater. In summary, under nominal launch conditions, the Pad 0-A deluge water could potentially be of low pH (due to formation of carbonic acid) and/or contain particulate matter (due to ablation of the launch pad or vehicle) or petroleum products (from unburned RP-1). As such, NASA is required by its Virginia Department of Environmental Quality (VDEQ) issued discharge permit to sample the impounded Pad 0-A deluge water prior to release. NASA's monitoring of the first four 100 Configuration Antares launches found all tested parameters to be within Virginia's water quality standards (NASA, unpubl., data), and in each instance, the deluge water was released to the downstream infiltration "ponds" within several days following launch. Likewise, quarterly monitoring of Wallops Island outfall water quality has not detected results outside of the limits specified in NASA's Virginia Pollutant Discharge Elimination System permit (NASA, unpubl. data). The *Final EA's* discussion of potential effects on groundwater focuses on groundwater use, which has remained within the monthly and annual limits specified in NASA's historic VDEQ-issued groundwater withdrawal permit since establishing the 100 Configuration launch capability (NASA, unpubl. data).

Although Section 4.2.2.1 of the *Final EA* details the potential effects to water resources of RP-1 released during a launch failure, the *Final EA* did not, however, discuss the potential fire-induced effects on water resources, nor did it discuss the effects of unburned solid propellant on water quality resulting from a launch mishap. As such, these analyses are provided herein.

Potential indirect effects on water quality resulting from launch-induced fires include elevated water temperature (a temporary phenomenon) and increases in nutrient levels and pH, which are very closely coupled with the effects of fire (e.g., increased nutrient availability) in adjacent upland areas. The duration of this effect has been shown to last from several months (e.g., **Earl & Blinn, 2003**) to years in freshwater systems; however, given the regular tidal influx in most of the wetland areas around the Pad 0-A site, it is expected that nutrient levels would return to pre-fire conditions on the lower end of that range.

In the event of a launch failure, it is likely that fragments of unburned solid propellant would enter nearby surface waters, potentially resulting in the release of perchlorate (e.g., **Lang et al., 2001**), an environmentally-persistent compound (**Urbansky, 2002**) that can be hazardous to humans if consumed in large enough quantities (**Soldin et al., 2001**). However, perchlorate diffuses more slowly in saline waters such as those that surround Pad 0-A (**Fournier & Brady, 2005**). Combined with the regular tidal flux, the physical action of waves, and the dilution that would occur, it is unlikely that surface waters would contain perchlorate levels in excess of those shown to cause adverse effects on aquatic organisms (**Hines et al., 2002**). As was evidenced by the field sampling and analysis following the ORB-3 mishap (**VCSFA, 2015**), most likely perchlorate levels would be present in appreciable concentrations only in small, isolated water bodies (**Hines et al., 2002**).

Should a launch failure occur over land, perchlorate could also impact the shallow groundwater, especially if in direct contact with unburned solid propellant. This effect was also observed following the ORB-3 mishap (**VCSFA, 2015**). The shallow groundwater on Wallops Island is not a drinking water source; rather, drinking water is supplied from deep water wells on the Mainland, approximately 3.7 km west of Pad 0-A. Also, a thick clay layer is present below the shallow groundwater on Wallops Island (**HCEA, 2009**), which would prevent downward migration of contamination.

Offshore in the Atlantic Ocean, the residual RP-1 propellant in the jettisoned Antares first stage would adversely affect water quality; however, when released in open water, light refined petroleum products (such as RP-1) usually spread into thin slicks and sheens and often do not persist very long; their low viscosity and high rates of loss by evaporation and dispersion into the water column tend to limit toxic effects under even low-to-moderate wave energy (**Michel & Rutherford, 2014**). As such, the No Action Alternative would have negligible to minor impacts on water quality.

Proposed Action

The potential effects of the Proposed Action on water quality would be the same as those under the No Action Alternative.

3.1.3 Coastal Zone Management

3.1.3.1 Regulatory Context

Section 307 of the Coastal Zone Management Act requires Federal agency activities to be consistent, to the maximum extent practicable, with the enforceable policies of states' federally approved coastal management programs. To meet this requirement, Federal agencies must determine whether their activities could have reasonably foreseeable effects on coastal uses or resources. If such effects are reasonably foreseeable, agencies then provide state coastal management programs with Federal Consistency Determinations (FCD) for their review; resulting in either a state's consistency concurrence or objection. In Virginia, the VDEQ is the lead agency for implementing the Virginia Coastal Zone Management Program (VCP). Although Federal lands (including NASA's Wallops Island) are excluded from Virginia's Coastal Management Area, any activity on Federal land that has reasonably foreseeable effects on coastal uses or resources must still demonstrate consistency. Because launching the Antares ELV from WFF would have likely coastal effects, NASA must prepare a FCD for the action.

3.1.3.2 Affected Environment

Section 3.1.2.5 of the *Final EA* describes in detail the VCP and its nine enforceable policies. NASA prepared a FCD in conjunction with the 2009 *Draft EA*; VDEQ concurred with NASA's determination in a June 18, 2009 letter. However, given that the last consistency review occurred approximately six years ago, NASA has prepared a new FCD for the Proposed Action.

3.1.3.3 Environmental Consequences

No Action Alternative

In a June 18, 2009 letter, VDEQ concurred that processing, testing, and launching the 100 Configuration Antares ELV from WFF would be consistent with the enforceable policies of the VCP.

Proposed Action

Based on the information and analysis in this SEA and the FCD prepared in parallel with it, NASA determined that its Proposed Action is consistent to the maximum extent practicable with the enforceable policies of the VCP (**NASA, 2015b**). NASA submitted its FCD to VDEQ in June 2015. In a letter dated August 20, 2015, VDEQ concurred with NASA's determination.

3.1.4 Air Quality

3.1.4.1 Affected Environment

Section 3.1.3 of the *Final EA* describes in detail the regulatory context and types and quantities of air pollutants emitted from NASA's activities on Wallops Island.

To summarize, air quality in a given location is described by the concentration of various pollutants in the atmosphere. Atmospheric pollutants can be divided into two general categories: 1) "criteria" pollutants, which include ozone (O_3), carbon monoxide (CO), nitrogen dioxide, sulfur dioxide, particulate matter less than 10 and 2.5 microns in diameter, and lead; and 2) greenhouse gases (GHGs)[5], which include carbon dioxide (CO_2), methane, nitrous oxide (N_2O), O_3, and several hydro- and chlorofluorocarbons.

Each GHG is assigned a global warming potential (GWP), which is the gas's ability to trap heat; GWP is standardized to CO_2, which has a GWP value of 1. For example, N_2O has a GWP of 310, meaning it has a global warming effect 310 times greater than CO_2 on an equal-mass basis. For simplification, total GHG emissions are often expressed as a CO_2 equivalent (CO_2e). GHGs are relatively stable in the atmosphere and are essentially uniformly mixed throughout the troposphere and stratosphere; therefore, the source location does not affect the climatic impact of GHG emissions, and regional climate impacts are likely a function of global emissions.

The layer of atmosphere closest to the Earth's surface is the troposphere. This layer extends from sea level to about 18 km. The mixing layer (sometimes referred to as the boundary layer) is the layer of air, within the troposphere, directly above the Earth that is relatively well mixed. This layer extends to a height of approximately 915 m, referred to as the mixing height, above which the free troposphere extends to the tropopause. Typically, temperature and density decrease with altitude in the atmosphere up to the mixing height. At the mixing height, however, the temperature begins to increase with altitude and creates an inversion that prevents air borne

[5] Per USEPA regulations, criteria pollutants are measured in short tons while GHG are measured in metric tonnes.

emissions from rising past the mixing height (**Visconti, 2001**). Almost all of the airborne pollutants emitted into the ambient atmosphere are transported and dispersed within the mixing layer.

Since completion of the 2009 *Final EA*, in October 2010, MARS obtained a stationary source air emissions permit from the VDEQ for operating Pad 0-A as a liquid-fueled rocket engine test stand (i.e., to conduct static fire tests). Among other requirements, the permit includes a 26.2 tons per year emissions limit for CO. Under the Clean Air Act, permits are not required for emissions of criteria pollutants from mobile sources. Therefore, as a mobile source CO emissions from Antares launches are not considered when determining compliance with the annual permit limit. This is a key concept to understand when reviewing the overall emissions estimates presented in **Table 3-2**.

3.1.4.2 Environmental Consequences

The primary emissions from the launch of either configuration of the Antares ELV would be CO, CO_2 and water vapor resulting from the combustion of the rocket's first stage propellants – RP-1 and LOX. For the purposes of evaluating air quality impacts in this SEA, emissions are considered to be minor if the Proposed Action would result in an increase of 250 tons per year or less for any criteria pollutant (i.e., CO). The 250 tons per year value is used by the EPA in its New Source Review standards as an indicator for impact analysis for listed new major stationary sources in attainment areas. No similar regulatory thresholds are available for mobile source emissions. Lacking any mobile source emission regulatory thresholds, this threshold is used to equitably assess and compare mobile source emissions.

Furthermore, the discussion of air quality effects within the lower troposphere is defined within the mixing layer to a height as at or below 915 m AGL. The EPA has accepted this height as the nominal height of the atmospheric mixing layer in assessing contributions of emissions to ground-level ambient air quality under the Clean Air Act (**USEPA 1992**). Although launch vehicle emissions from operations at or above 915 m above ground surface would occur, these emissions would not result in appreciable ground-level pollutant concentrations.

In the *Final EA*, emissions of CO_2 were calculated for the entire first stage flight profile because GHGs are not limited by the mixing layer of the atmosphere. For the assessment of GHGs, 25,000 tonnes is applied as a threshold below which such emissions would be considered minor. Per recent CEQ draft guidance, this volume is not considered a significance threshold under NEPA but rather the point at which detailed GHG quantitative analysis would be warranted (**CEQ, 2014**). Therefore, applying the 25,000 tonnes benchmark in this SEA provides a tangible frame of reference for comparing the potential GHG emissions from the alternatives.

No Action Alternative

In the *Final EA*, Antares 100 Configuration CO emissions were calculated for six launches per year and two 52-second static fire tests of the first stage engines. In summary, each launch would emit approximately 7.7 tons of CO below the atmospheric mixing layer. Each static fire would emit approximately 12.3 tons of CO. Therefore, in total; 71 tons of CO would be emitted per year; well below the 250 tons per year employed in this SEA as a screening level for assessment of impacts.

In the *Final EA*, Antares 100 Configuration CO_2e emissions were also calculated for two static fire tests and for the Stage 1 engines during normal launch. In summary, each static fire test would emit 21.5 metric tonnes of CO_2. Each normal launch would emit 112.4 metric tonnes of CO_2. Therefore, over six launches and two static fire tests, a maximum of 717.4 tonnes of CO_2e would be emitted per year, well below the threshold of 25,000 tonnes of CO_2e per year.

Although surveillance aircraft emissions were not calculated in the *Final EA* for the No Action Alternative, a recently conducted analysis (**NASA, 2013b** and its Appendix F) of operating a launch site and recovering sounding rocket flight hardware in Alaska is applicable due to the similarities of the types and numbers of aircraft employed. Employing the Emissions and Dispersion Modeling System (**FAA, 2010**), the analysis found all aircraft (both fixed wing and helicopter) related criteria pollutant emissions to be less than 1 ton annually, with the exception of CO, which was approximately 6 tons per year. Furthermore, CO_2e emissions were estimated to be approximately 100 tonnes annually (**NASA, 2013b**), well below CEQ's draft threshold for triggering quantitative analysis (**CEQ, 2014**). Starting with the outputs of the **NASA (2013b)** analysis, and applying a simple, yet conservative scaling approach (multiplying by a factor of four) considering both flight time and the specific type of aircraft involved in range surveillance activities, it may be concluded that both criteria pollutant and GHG emissions would also be well below both the 250 tons per year (criteria) and 25,000 tonnes per year (GHG) thresholds. Likewise, the same conclusion is reached when adding the emissions of both the rocket and surveillance aircraft. Therefore, in summary, no perceptible change in air quality would be expected due to the No Action Alternative.

Proposed Action

On a per-launch basis, the 200 Configuration Antares ELV would emit approximately 9.4 tons of CO within the mixing layer, resulting in a total of approximately 56.6 tons per year for six launches. Orbital ATK is proposing to conduct static fire testing of the first stage but for a shorter duration than originally conducted for the 100 Configuration Antares. As such, each approximately 20-second static fire test would emit approximately 3.4 tons of CO, for a total of approximately 63.5 tons of CO emitted per year for two static fire tests and six launches.

Greenhouse gas (i.e, CO_2) emissions for the 200 Configuration Antares would contribute approximately 660 tonnes over six launches per year and, at approximately 5.8 tonnes per event, static test fires would contribute approximately 11.6 tonnes per year for two tests. Therefore, in total, approximately 671.5 tonnes of CO_2 would be emitted per year.

When considering the quantities of criteria and GHG pollutants emitted for both normal launch and static fire testing, the Proposed Action would result in fewer pollutant emissions, largely due to the shorter static fire duration for the 200 Configuration Antares (See **Table 3-2**). Furthermore, when compared to the screening criteria described earlier in this section, these results indicate that effects of the Proposed Action on air quality would be minor.

Table 3-2: Comparison of 100- and 200-Configuration Antares ELV Emissions

	CO	CO_2
Antares ELV Configuration	**Tons per year**	**Metric tonnes per year**
100 Configuration (No Action)	74	717.4
200 Configuration (Proposed Action)	63.5	671.5
Net Change	- 10.5	- 45.9

Note: Values presented assume 2 static test fires and 6 launches per year

Surveillance aircraft related emissions (both criteria pollutants and GHGs) would be the same as under the No Action Alternative.

3.1.5 Noise

Noise is defined as unwanted sound. Section 3.1.4 of the *Final EA* describes in detail the noise fundamentals and standards that are relevant to the Proposed Action.

However, the *Final EA* did not include a discussion of the Day-Night Level (DNL) noise metric. DNL is a cumulative noise metric that accounts for all noise events in a 24-hour period. Typically, DNL values are expressed as the level over a 24-hour annual average day. To account for increased human sensitivity to noise at night, a 10 dB penalty is applied to nighttime events (occurring between the hours of 10:00 p.m. and 7:00 a.m.). DNL is based on long-term cumulative noise exposure. Noise studies used in the development of the DNL metric did not include rocket noise, which are, in general, irregularly occurring events. It is therefore acknowledged that the suitability of DNL for infrequent rocket noise events is uncertain. However, it is a noise metric required under FAA's NEPA procedures (**FAA, 2015a**), and accordingly it is presented herein.

3.1.5.1 Affected Environment

Since completing the *Final EA*, NASA sponsored a study to characterize the ambient in-air sound levels on Wallops Island (**BRRC, 2011**). Two of the study sites were on the Wallops Island beach; the northernmost site was located approximately 200 m west of the surf zone in the Recreational beach area; the southernmost site was just south of the existing Unmanned Aerial Systems airstrip, approximately 100 m from the surf zone.

The average daily background levels for the northernmost site ranged from 30 to almost 50 A-weighted decibels (dBA), with a constant level of low-frequency sound likely caused by the wind and surf. The site demonstrated an increase in sound levels during the daylight hours likely due to increased wind. The southern site also had the same general characteristics; however, sound levels were higher, between 40 and 50 dBA, which was likely related to the closer proximity to the surf zone.

3.1.5.2 Environmental Consequences

The primary focus of this section is to employ new information to characterize the noise generated by the alternatives and to assess the potential effects on human receptors. The potential noise-induced effects on non-human receptors are discussed in this SEA under the sections *Wildlife and Birds*, *Marine Mammals*, and *Threatened and Endangered Species*.

Per FAA's NEPA procedures, a Proposed Action results in a significant noise impact if it would cause noise sensitive areas to experience an increase in noise of DNL 1.5 dB or more at or above DNL 65 dB noise exposure when compared to the No Action Alternative for the same timeframe (**FAA, 2015a**).

No Action Alternative

Section 4.3.2 of the *Final EA* describes in detail the expected noise associated with the processing, static fire, and launch of a 100 Configuration Antares ELV. The *Final EA* did not discuss the potential effects of range surveillance aircraft; therefore, it warrants further analysis herein.

Surveillance Aircraft: Noise levels from helicopter-based range surveillance activities were calculated using the FAA's Integrated Noise Model **(FAA, 2008)**. Each surveillance operation would have slightly different flight tracks and altitudes, would be short in duration (lasting several hours per launch), and would be infrequent. Accordingly, maximum sound pressure levels directly under the aircraft are presented in lieu of contours or levels at specific fixed receptor sites. Furthermore, the modeled aircraft is the Bell 216 Huey II (the civilian variant of NASA's UH-1 surveillance helicopter). Estimates of noise levels on the ground directly under the helicopter are presented in **Table 3-3**.

In contrast to helicopter-generated noise, sound pressure levels are not estimated in this SEA for fixed wing surveillance aircraft because of their lower source levels (as compared to helicopters) much higher flight altitudes during operation, and offshore operating areas.

In summary, although no aircraft-based range surveillance operations would expose persons on the ground to unsafe noise levels, there is the potential for temporary annoyance if related sounds were heard within the context of the natural quiet of a wildlife refuge or recreation area (e.g., **Fidell et al., 1996**). The quiet of uninhabited areas may be temporarily interrupted by aircraft activity. However, aircraft activity would be infrequent and short in duration. Furthermore, sounds of overflights are frequent occurrences in the vicinity of WFF's active airfield on the Main Base. Therefore, the effects of surveillance-generated noise would not be substantial.

Table 3-3: Modeled Surveillance Helicopter Sound Pressure Levels on the Ground

Altitude (m AGL)	Sound Pressure Level (dB(A))	
	Constant Speed Departure	Hovering
8	N/A	110
15	N/A	102
91	88	82
150	83	76
305	76	68
460	72	64
610	68	60

Source: **NASA, 2013b**

ELV Launches: When preparing the 100 Configuration Antares noise analysis for the *Final EA*, NASA employed a calculation methodology (derived from **NASA, 1973**) that relates rocket-generated thrust to maximum unweighted sound pressure level. The analysis indicated that people offsite of NASA property would not be exposed to unsafe noise levels. The results of this analysis are detailed in Section 4.2.4 of the *Final EA*. Figure 24 of the *Final EA* (page 133) graphically shows the noise levels potentially generated by the Antares 100 Configuration in relation to noise receptors within the area surrounding WFF.

Of note, is the discrepancy between the A-weighted values presented in the text of the 2009 *Final EA* and the unweighted sound pressure levels presented on the map. The thrust-sound pressure methodology employed for the *Final EA* provides unweighted sound pressure levels; however, these values were erroneously presented as A-weighted values in the text of the 2009 *Final EA*.

Subsequent to preparing the 2009 *Final EA* analysis, NASA has begun employing a more sophisticated noise modeling methodology for estimating sound pressure levels generated by ELVs at WFF (i.e., the "RUMBLE" model: **James et al., 2014**). Likewise, FAA-AST has also developed an **Eldred 1973 –** based noise model named Launch Noise Model (LNM) for its own use (**FAA, 2015b**). In support of preparing this SEA, WFF obtained updated sound pressure level profiles for the 100 Configuration Antares employing both RUMBLE and LNM. **Table 3-4** compares these data to the sound pressure level predictions presented in the *Final EA*.

When comparing the 2009 *Final EA* unweighted sound pressure level values to those generated by the updated noise models, it is evident that the values in the *Final EA*, while based on a much simpler methodology, are within the range of those estimated by the most up-to-date modeling techniques.

Table 3-4: Antares 100 Configuration Sound Pressure Levels At Selected Locations

2009 *Final EA* Location Description	Approx. Distance from Pad 0-A (km)	2009 *Final EA* Maximum SPL (dB)	Unweighted Maximum SPL (dB)		A-weighted Maximum SPL (dBA)	
Model		NASA 1973	LNM	RUMBLE	LNM	RUMBLE
Estimated Sound Pressure Levels						
Northern boundary of the piping plover habitat on south Wallops Island	1.5	124	121	126	111	109
Community of Assawoman	3.2	117	114	119	102	98
Town of Chincoteague	10.6	107	102	108	84	80
Wallops Main Base	12.3	106	101	107	83	78
Distance to OSHA Hearing Conservation Criterion (km)						
Distance to 115 dBA Hearing Conservation Criterion	N/A	4.3	N/A		1.0	0.9

Key: N/A = Not Applicable SPL = Sound Pressure Level

Furthermore, although the *Final EA* did not actually present A-weighted sound pressure levels, based on the results of the updated RUMBLE and LNM analysis, it is clear that people on the ground would not be exposed to sound pressure levels in excess of nationally accepted standards (e.g., the Occupational Safety and Health Administration [OSHA] 115 dBA level for a 15-minute exposure) adopted for hearing conservation (**Table 3-4**). This conclusion is supported by the facts that 1) NASA enacts pre-launch, patrolled, mandatory exclusion areas both on land and offshore, which prevent people from being exposed to sound pressure levels in excess of OSHA criteria; and 2) the duration of sound exposure for an Antares launch would not exceed several minutes, well below the fifteen minute threshold inherent in the OSHA standard.

To calculate DNL for the No Action Alternative, FAA employed its LNM (**ICF, 2015**). Under the defined modeling scenario (described in detail in **ICF, 2015**), the No Action Alternative includes and up to 6 launches per year of the Antares 100 Configuration ELV at MARS Pad 0-A as well as up to 12 launches per year of the “envelope” solid-fueled Lockheed Martin Launch Vehicle-3 (LMLV-3) at MARS Pad 0-B (**NASA, 2005**).[6]

Figure 3-2 shows the modeled DNL contours for the No Action Alternative. The green rocket trajectory is associated with the Antares 100 (i.e., the No Action Alternative), the pink trajectory is associated with the Antares 200 (i.e., the Proposed Action), and the blue trajectory is associated with the LMLV (common to both alternatives). There are no noise sensitive areas (e.g., residences) within the 65 dB DNL noise contour. In fact, the noise contour is wholly

[6] Other noise-generating activities such as range surveillance (helicopters and fixed-wing aircraft) were not incorporated into LNM, because their contribution to the annual average DNL would be small compared with launch vehicle noise contributions.

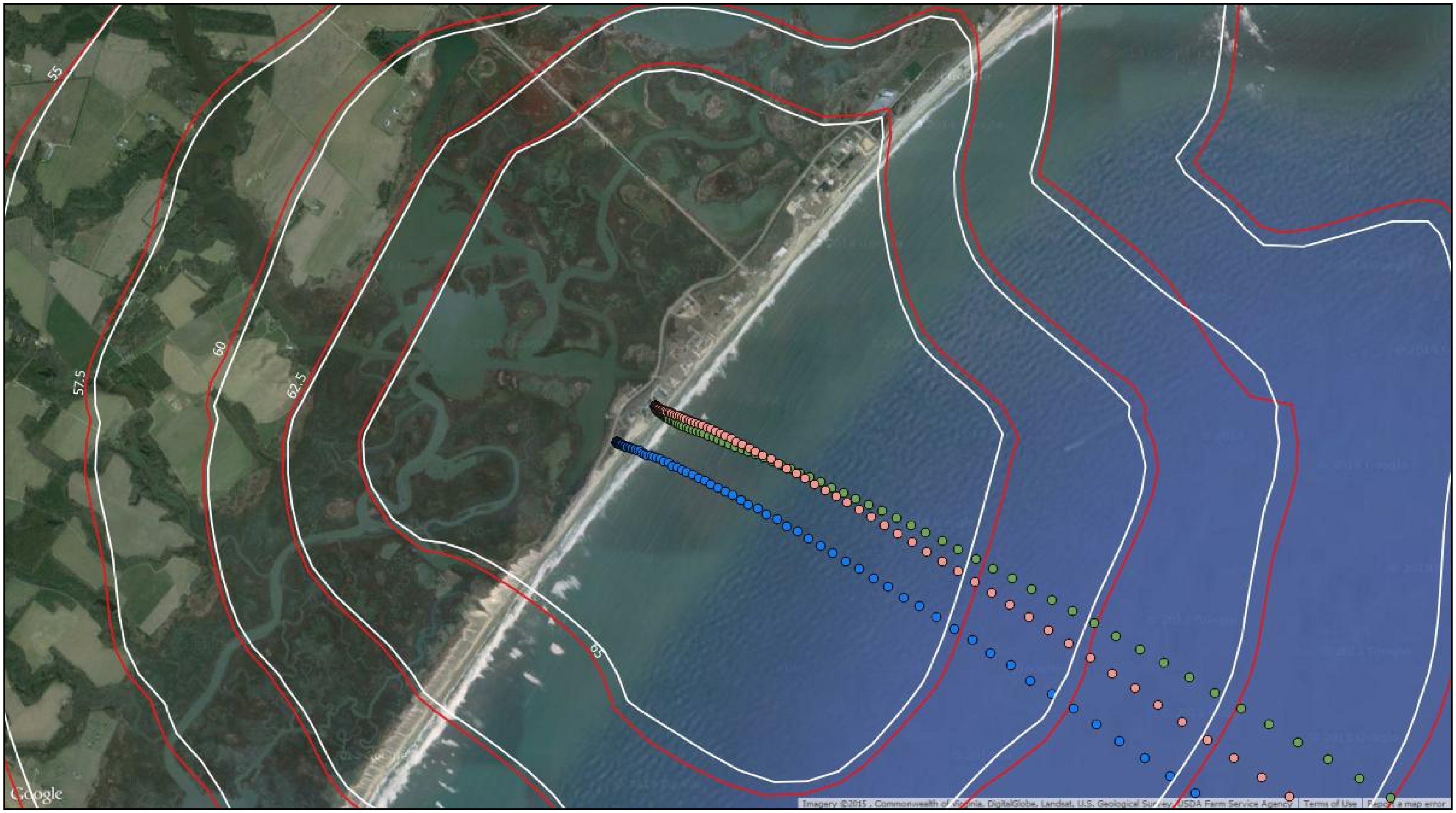

Figure 3-2: Day-Night Level Comparison of No Action (White Line) and Proposed Action (Red Line) Alternatives Note that the 65 dB Contours are the Innermost Shown (Source: ICF, 2015)

within NASA property on Wallops Island, the estuarine waters and marshes to the west, and the Atlantic Ocean to the east.

Although not specifically modeled in the 2009 *Final EA* or for this SEA using RUMBLE or LNM, sound pressure levels generated by 100 Configuration Antares static fire tests would be comparatively lower than for launches due to both the constant injection of deluge water into the rocket's exhaust plume (**Kandula & Lonergan, 2007**) and the fact that the exhaust would be directed through the pad's flame duct to the east for the entire duration of the noise event.

Proposed Action

Surveillance aircraft related noise would be the same as under the No Action Alternative.

Employing LNM to estimate maximum sound pressure levels during launch of the 200 Configuration Antares, **ICF (2015)** found that it would be less than 2 dBA louder than the 100 Configuration Antares at the same receptor site. Despite this difference in estimated sound pressure level, it can be concluded that the sound pressure levels generated under the Proposed Action would not be substantially different from the perspective of a potential human receptor. Under ideal listening conditions (i.e., a laboratory), some people may be able to detect differences of approximately 1 dB, but most people with normal hearing can usually detect differences of 2 or 3 dB. However, in the outside environment, sound level changes of 2 or 3 dB might not be as noticeable, while a 5 dB change would likely be perceived as a clear and noticeable change. In consideration of these facts, it is unlikely that most persons exposed to Antares-generated far field noise would notice the difference. Furthermore, modeling (also using LNM) for the Antares 200 shows that the 115 dBA contour line would be approximately 1.1 km away from Pad 0-A, supporting the conclusion that sound pressure levels would be within accepted standards for hearing conservation at distances where people would be exposed to launch noise (**ICF, 2015**).

FAA used its LNM to also calculate DNL for the Proposed Action (**ICF, 2015**). As compared to the No Action Alternative, the analysis methodology is the same except for its substitution of the 200 Configuration Antares in lieu of the 100 Configuration. **Figure 3-2** shows the modeled DNL contours for the Proposed Action. As can be seen in the figure, the Proposed Action DNL contours are slightly larger than the No Action DNL contours, but only by less than 1 dB. There are no noise sensitive areas (e.g., residences) within the 65 DNL contour and due to the minor increase in noise above the baseline conditions (i.e., the No Action Alternative), the Proposed Action would not result in a significant noise impact per FAA's definition (**FAA, 2015a**).

3.2 Biological Environment

3.2.1 Vegetation

3.2.1.1 Affected Environment

Section 3.2.1 of the *Final EA* describes in detail the vegetation that is found on Wallops Island. In summary, within the Pad 0-A complex, the majority of vegetation is mown grass. The constructed stormwater management "ponds" within the pad fence line and areas west of the pad are dominated by common reed. East of the pad on the beach's artificial dune crest and fore-slope is American beachgrass (*Ammophila breviligulata*), which was planted as part of the Wallops Island Shoreline Restoration and Infrastructure Protection Program (**NASA, 2010**).

3.2.1.2 Environmental Consequences

No Action Alternative

Section 4.3.1 of the *Final EA* describes in detail the expected effects of processing, static firing, and launching a 100 Configuration Antares ELV on vegetation. In summary, the most notable effect would be foliar burning by the rocket's hot exhaust, which is described in the *Final EA* as "localized scorching and spotting." Assuming a launch rate of 6 ELVs per year, this effect could recur multiple times throughout the year.

Observation of previous Antares 100 Configuration ELV launches, however, has shown the effects of fire can be more pronounced than described in the *Final EA.* In 2014, NASA implemented a *Phragmites* control plan (**NASA, 2014a**) to reduce the probability of an ELV-induced fire. The control efforts have been focused on the areas immediately adjacent to the Pad 0-A complex. However, in the event of a launch failure, fires could be ignited in more distant areas.

This was the case for the ORB-3 mishap, during which approximately 15 acres of vegetation, primarily comprised of common reed and bayberry (*Morella* spp.*)*, were ignited during the mishap and burned completely. Post-fire, species composition could return to pre-burn levels within as little as one growing season; however, it is probable that reaching pre-burn biomass levels would likely take several growing seasons (**Schmalzer et al., 1991**). In either case (i.e., normal launch or mishap event), the extent of the burned area would be confined to southern Wallops Island and would not constitute a substantial adverse effect.

In the event of a launch failure, unburned RP-1 propellant could be released onto vegetation within the Pad 0-A complex and to the adjacent wetlands. Summarizing the results of 32 published studies of oil spills, **Michel & Rutherford (2014)** found that light refined petroleum products, such as kerosene (which is similar to RP-1), have been shown to have the highest acute toxic effects on marsh vegetation. The time of year in which such a release were to occur would likely dictate the magnitude of potential effects, with times of dormancy (i.e., winter) resulting in the least, and times of active growth, the greatest. In either case, the extent of the release would likely be contained within the Pad 0-A complex and immediately adjacent to it; consistent with observations from the ORB-3 mishap (**VCSFA, 2015**).

Perchlorate, a compound that would likely be released during a launch failure, has been reported to inhibit seed germination and growth of some agricultural crops (**Adema & Henzen, 1989**). As such, its presence could, to some extent, adversely affect plant growth. Additionally, as summarized by **Smith (2006)**, perchlorate has been shown to readily accumulate in a number of plants, particularly in their leaves (discussed as this relates to wildlife in Section 3.2.2.2 of this SEA). However, similar to the RP-1 propellant, the extent of such effects would be localized to the Pad 0-A area.

Proposed Action

The potential effects of the Proposed Action on vegetation would be the same as those under the No Action Alternative.

3.2.2 Wildlife and Migratory Birds

3.2.2.1 Affected Environment

Section 3.2.2 of the *Final EA* describes in detail the terrestrial wildlife and migratory birds that inhabit the Wallops Island area either on a transient or year-round basis. This section provides both a summary and updated information particularly focusing on avian activity on the Wallops Island beach, since the initial beach re-construction (**NASA, 2010**) did not occur until 2012, three years after the *Final EA* was completed. Those species listed for protection under the federal Endangered Species Act (ESA) are discussed in Section 3.2.4 of this SEA.

Avifauna: The Wallops Island beach provides important nesting and foraging habitat for a number of migratory waterbirds, including gulls, terns, and sandpipers. Waterbird numbers on the beach peak through the fall and spring migrations, during which the beach provides stopover habitat for resting and feeding as the birds transit between breeding and wintering grounds.

Given that the Wallops Island beach is renourished every 2-5 years, for periods of time (months to a year) following each renourishment cycle, it is mostly devoid of food sources, and of limited foraging value. As such, it is expected that, consistent with past observations, the majority of waterbird activity will continue to be concentrated on north Wallops Island, approximately 5 km north of Pad 0-A.

In accordance with its Protected Species Management Plan (**NASA, 2015d**), NASA conducted regular monitoring of the Wallops Island beach between March and August 2015 to determine the level of avian nesting activity on the shorefront. Two American oystercatcher (AMOY; *Haematopus palliatus*) nests were identified on mid- and south Wallops Island, respectively; however, neither fledged chicks (NASA, unpubl. data). In 2014, the two nests found on north Wallops Island also met with the same fate (**NASA, 2014b**). In 2013, no AMOY nests were observed on the Wallops Island beach (**NASA, 2013b**). During the 2012 monitoring period, one AMOY nest was identified on north Wallops Island; however; it was predated shortly after its discovery (**NASA, 2012c**). No colonial waterbird nesting activity has been observed on the

Wallops Island beach since NASA began its regular beach nesting bird surveys in spring 2010 (**NASA, 2014b**).

3.2.2.2 Environmental Consequences

No Action Alternative

Section 4.3.2 of the *Final EA* describes in detail the expected effects of processing, static firing, and launching a 100 Configuration Antares ELV on terrestrial wildlife and migratory birds. The *Final EA* did not discuss the potential effects of range surveillance on wildlife or birds; therefore, it warrants further analysis in this section.

Surveillance Aircraft: Studies of the effects of helicopter overflight on waterbirds have shown (1) temporary behavioral responses to low-altitude overflight, ranging from assuming an alert posture to taking flight; (2) responses decreasing in magnitude as overflight elevation increases; and (3) rapid resumption of the behaviors exhibited prior to the overflight (e.g., **Komenda-Zehnder et al., 2003**). Early research in Florida by **Kushlan (1979)** detected limited adverse effects when a helicopter overflew nesting waders (e.g., egrets). The majority of birds overflown did not exhibit any response to the stimulus, and those that left their nests returned in less than five minutes. Summarizing previous Dutch studies, **Smit & Visser (1993)** found shorebirds (e.g., bar-tailed godwit [*Limosa lapponica*] and curlew [*Numenius* spp.]) to be particularly sensitive to helicopter overflights at less than 250 m AGL, resulting in flushing of between 33 to 75 percent of birds overflown, depending on the species. Flushing a bird from its nest can result in a range of potential adverse effects, including predation or abandonment of the chicks (the most severe) to unnatural energy expenditure of the parents (the least severe).

Based on their research, **Komenda-Zehnder et al. (2003)** recommend that potential effects on waterbirds can be reduced substantially if helicopters maintain minimum altitudes of at least 450 m. However, it is also noted that the birds within their study site were within an area of somewhat regular disturbance, which could have led to some habituation. Birds in more remote areas subject to helicopter surveillance, such as the barrier islands south of Wallops Island, which may be less accustomed to such stimuli, could be more sensitive to helicopter overflights. On the contrary, those within the marshes between Wallops Main Base and Island are more likely to have become habituated to aircraft-induced stimuli.

Maintaining an altitude in excess of that recommended by **Komenda-Zehnder et al. (2003)** would be possible when transiting from the Main Base airfield to an offshore surveillance area, for example. However, surveillance operations between Wallops Mainland and Island would require a lower altitude, likely several hundred meters AGL, which would be expected to startle nearby waterbirds. Although, when considered within the context of the infrequency and short duration of the overflight, coupled with the already present air traffic in the area, range surveillance activities would not lead to substantial effects on these waterbirds.

Helicopter-based range surveillance activities could be conducted during the nesting season of eagles and other raptors. Songbirds and raptors vary in their responses to overflight, but documented responses have been limited to short-term behavioral responses and no effects that would be measurable at a population level have been recorded. For example, **Windsor (1977)** conducted a study in which nine active peregrine falcon (*Falco peregrinus*) nests were exposed to regular aircraft (fixed wing and helicopter) overflights ranging in altitude from 75 to 305 m. Of the nine nests studied, only one was abandoned. The other eight, however, showed no effect on hatch rate or fledging rate. Similarly, **Andersen et al., (1989)** evaluated the effects of low altitude helicopter overflights on red-tailed hawks (*Buteo jamaicensis*), concluding that while some birds were observed to flush from nests, most habituated to the stimuli and overflights did not appear to adversely influence nesting success. **Grubb & Bowerman, (1997)** documented approximately half of the breeding bald eagles (*Haliaeetus leucocephalus*) exposed to helicopters in flight to respond at a median distance of 250 m from the nest. The USFWS National Bald Eagle Management Guidelines (**USFWS, 2007**) recommends at least a 300 m helicopter flight buffer around active eagle nests. Consistent with these recommendations, during bald eagle nesting season, the NASA surveillance helicopter maintains such a buffer to ensure no adverse effects on the active bald eagle nest on north Wallops Island (**NASA, 2012b**). Therefore, in summary, the helicopter surveillance flights under the No Action Alternative would not have a substantial adverse effect on raptors.

Because fixed-wing aircraft would provide surveillance over the open ocean, seabird species would most likely be exposed to stressors induced by these activities. Fixed-wing surveillance aircraft flying at altitudes greater than 457 m AGL would generally be expected to cause minimal, if any, response from birds on the ground or sea surface (based on data provided in reviews, including **NPS, 1994; Manci et al., 1988; Larkin et al., 1996; Gladwin et al., 1987**). Low-level flights would be expected to disturb seabirds, eliciting an alert or escape behavior (**Brown, 1990**); however, in consideration of the infrequency and short duration of low level flights, the resultant effects would be minor. A similar conclusion may be reached regarding surveillance vessels, which could induce both visual and acoustic stimuli, consequently disturbing birds. However, as such disturbances also would be short in duration and infrequent, both surveillance flights and vessels under the No Action Alternative would not have a substantial adverse effect on seabirds.

ELV Launches: Wildlife exposed to elevated sound pressure levels from ELV launches are expected to exhibit a startle response that could interfere with normal behaviors, including breeding, feeding, and sheltering. This may include flushing birds from nests when incubating eggs, interruption of feeding or courtship, or similar responses. The combination of the sound with a visual stimulus such as a rocket in flight is expected to magnify the startle responses, particularly for those species in close proximity to the launch sites. Because the noises associated with rocket launches are infrequent and of short duration, wildlife species are expected to return to normal behavior within a few minutes to hours following the disturbance. Due to the reproductive cycle of potentially affected species, potential disruption of breeding activities would happen between the months of April and August.

Launches from Pad 0-A would occur well south of the areas of the beach that have historically hosted the greatest level of avian nesting activity. However, the presence of the renourished beach could attract birds into areas where launches would occur; thereby, increasing the probability for adverse interactions. Effects on prey availability are expected to be a contributing factor, and given that the renourished beach is likely to remain in a biologically suppressed state for the foreseeable future, it is probable that avian species would continue to congregate on the more forage-rich areas of north Wallops Island.

The potential effects of launch-induced fires and launch failures on wildlife and migratory birds were not discussed in the *Final EA*; therefore they are discussed herein.

As summarized by **Engstrom (2010)**, the direct effects of launch-induced fires on wildlife would be species-specific, and largely dependent upon one's ability to detect and avoid the fire. For example, mobile species, including deer and birds, would likely flee the area to an adjacent refuge. Less mobile organisms, including reptiles and amphibians, would likely experience injury or mortality. In the longer term, burned areas could prove to be of lesser habitat value for some species, but beneficial for others. For example, species that forage on conifer seeds (e.g., small mammals) could be negatively affected if these trees/shrubs experience mortality. In contrast, species such as whitetail deer (*Odocoileus virginianus*) could benefit from the leafy, successional growth (as a source of browse) that would likely occur following a fire. In either case, the extent of the burned areas would be limited to the area adjacent to Pad 0-A, and resultant effects on wildlife would be minor.

In the event of a launch failure, it is possible that wildlife could be exposed to perchlorate-containing water (see Section 3.1.2.2 of this SEA), which, if the uptake is in large enough quantities, could induce various physiological effects, including changes to hormone production, development, and reproduction (**Dean et al., 2004**). However, it is not expected that wildlife species would ingest appreciable quantities of perchlorate, as the waters surrounding Pad 0-A are saline (e.g., **Chance, 2014**), rendering their value as a drinking water source for most species very low. For example, ingestion of salt water has been shown to have adverse effects on dabbling ducks (**Barnes & Nudds, 1991**; **Mitcham & Wobeser, 1988**). Even some of the more saltwater-reliant waterfowl (i.e., diving ducks) show preference for fresh water when seeking a drinking water source (e.g., **Adair et al., 1996**). Similarly, **Davenport & Macedo (1990)** demonstrated that estuarine diamondback terrapins (*Malaclemys terrapin*) opportunistically exploit fresh and brackish waters to replenish their body water stores. Accordingly, exposure of wildlife to perchlorate-containing waters would not likely be from drinking, but rather incidental to foraging or traversing.

Forage items could also be exposed to perchlorate, absorb it, and in turn expose wildlife species by way of ingestion. For example, some plants (aquatic and terrestrial) can bioconcentrate perchlorate to concentrations that are several hundred-fold higher than ambient water or soil concentrations (**Tan et al., 2004**). Aquatic invertebrates and fish have also been shown to uptake perchlorate, albeit much less than plants (**Dean et al., 2004**). However, the highly mobile nature of avian species in the area may limit their resultant exposure (**Smith, 2006**). Similarly, potentially affected mammalian species (i.e., raccoons [*Procyon lotor*]) have also proven to be very mobile in barrier island habitats (**Dueser et al., 2013**). Furthermore, a Texas study did not detect appreciable levels of perchlorate in raccoons despite its being found in suitable forage items (**Smith et al., 2005**).

To summarize, the general consensus in the scientific literature is that perchlorate demonstrates a general lack of bioconcentration in wildlife and avian species (**Dean et al., 2004; ITRC, 2005**). Therefore, when considered with the low concentrations of perchlorate expected to occur in surface waters (see Section 3.1.2.2 of this SEA), and generally limited exposure pathways, the effects of a launch failure on wildlife or migratory birds would be minor.

Proposed Action

The potential effects of the Proposed Action on wildlife would be generally the same as those under the No Action Alternative. Although there would be slightly greater sound pressure levels generated by the Antares 200 Configuration ELV, which could theoretically have a greater potential for disturbing birds and other terrestrial species, it is unlikely this would happen. Birds and other non-human vertebrates can typically discriminate between sounds of different intensity provided the differences are at least between 1 to 4 dB (**Dooling et al., 2000**). Since the additional sound pressure levels produced by the 200 Configuration Antares would be approximately 2 dBA, it is possible that exposed terrestrial species would be able to discern the difference. However, it is expected that any resultant behavioral response would be very similar to that under the No Action Alternative.

3.2.3 Marine Mammals

3.2.3.1 Affected Environment

Section 3.2.4 of the *Final EA* describes in detail the marine mammals that inhabit the waters east of Wallops Island either on a transient or permanent basis. Those species listed for protection under the ESA are discussed in Section 3.2.4 of this SEA. Of the approximately nineteen species of non-ESA listed marine mammals that could be present offshore of Wallops Island, the North Atlantic bottlenose dolphin (*Tursiops truncatus*) would be the most common, and could be within offshore waters at any time of year but is most frequently encountered during the non-winter months. During winter, the species is rarely observed north of the North Carolina-Virginia border. Those individuals encountered would be expected to be the coastal morphotype; the offshore morphotype are primarily found farther offshore.

3.2.3.2 Environmental Consequences

No Action Alternative

Section 4.3.4 of the *Final EA* describes in detail the expected effects of processing, static firing, and launching a 100 Configuration Antares on marine mammals. Potential effects include direct or proximate strike (by a descending item), exposure to an ELV-generated sonic boom, and potential degradation of water quality due to onboard materials, including batteries and propellants. The *Final EA* did not discuss the potential effects of range surveillance activities on these species; therefore, it warrants further analysis in this section.

Transmission of noise from aircraft into the water would be possible; however, individuals would have to be at or near the surface at the time of an overflight to be exposed to elevated sound levels. Responses have been shown to vary by species – for example, smaller delphinids, including the bottlenose dolphin, have been shown to react to fixed-wing aircraft overflights either neutrally or with a startle response whereas more “cryptic” species (e.g., beaked whales) tend to react more overtly, often diving when overflown (**Wursig et al. ,1998**). It has also been reported that dolphins generally show no reaction to the overflight of aircraft unless the aircraft’s shadow passes directly over them (**Richardson et al., 1995**).

In consideration of the infrequent nature and short duration of helicopter flights, the limited distance offshore (approximately 2-3 km) at which they survey, and limited species behavioral responses documented in available research, it is expected that potential effects on marine mammals would be negligible. Likewise, when considering the high altitudes at which WFF’s contracted fixed wing aircraft fly during most of their operations, the same conclusion may be reached for this component of WFF’s surveillance operations as well.

The possibility also exists for a surveillance vessel to strike a marine mammal. However, several factors render this stressor highly unlikely. First, the species most susceptible to this stressor are large whales (**Jensen & Silber, 2003**; **Laist et al., 2001**), not the smaller pinnipeds or cetaceans that are considered in this Section (**Barco & Swingle, 2014**). Coupled with the infrequent nature of the action, the small number of vessels engaged in support of the activity, and the employment of vessel operating protocols (detailed in Section 5.2 of **NASA, 2015a**), the probability of striking a non-ESA listed marine mammal would be very low.

Proposed Action

Impacts of the Proposed Action on marine mammals would be the same as those under the No Action Alternative. Based upon this analysis, NASA has determined that the Proposed Action is highly unlikely to expose any marine mammal species to a stressor such that a “take” could occur. As such, no additional Marine Mammal Protection Act (16 U.S.C. § 1361 et seq.) coordination with NMFS is required (see Section 3.2.4.3 of this SEA for consultations initiated under the ESA).

3.2.4 Threatened and Endangered Species

3.2.4.1 Regulatory Context

Section 7 of the ESA requires Federal agencies to evaluate the effects of their actions on listed species and consult with the USFWS and NMFS if the agency determines that its action "may affect" an individual or critical habitat of the respective species.

During preparation of the *Final EA*, NASA consulted with both the USFWS and NMFS regarding the potential effects of launching the 100 Configuration Antares (among other actions) on listed species. In a July 8, 2009, letter, NMFS concurred with NASA's determinations that (among other activities) ELV launches from Pad 0-A were "not likely to adversely affect" in-water sea turtles or ESA-listed marine mammals. On May 10, 2010, USFWS issued a biological opinion (BO) for expanded ELV operations at WFF (Operational BO) (**USFWS, 2010a**). The Operational BO provides "take" authorization for piping plover and sea turtles and concluded that the effects of the proposed action were "not likely to adversely affect" either Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*) or seabeach amaranth (*Amaranthus pumilus*) (**USFWS, 2010a**). Subsequent to the May 10, 2010, BO, USFWS issued a Programmatic BO for the Wallops Shoreline Restoration and Infrastructure Protection Program (SRIPP BO), which incorporates by reference and is supplemental to the Operational BO and considers the effects of NASA's launch operations with the presence of a regularly-nourished beach (**USFWS, 2010b**). In addition to the determinations made in the Operational BO, the SRIPP BO concluded that the effects of the proposed action were "not likely to adversely affect" the North American subspecies of roseate tern (*Sterna dougallii dougallii*) (**USFWS, 2010b**).

3.2.4.2 Affected Environment

Section 3.2.3 of the *Final EA* describes in detail the federally listed species that inhabit Wallops Island, the estuarine waters and marshes between the island and the Mainland, and the Atlantic Ocean waters to the east. This section provides a both a summary and updated information obtained since the *Final EA*. Of note are the listings of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (**77 FR 5880**), rufa subspecies of red knot (*Calidris canutus rufa*) (**79 FR 73706**), and northern long-eared bat (*Myotis septentrionalis*) (**80 FR 17974**) as endangered or threatened (depending on the distinct population segment [DPS]), threatened, and threatened, respectively.

Additionally, in 2011 the loggerhead sea turtle (*Caretta caretta*) was divided into nine DPSs, listed as threatened or endangered under the ESA (**76 FR 58868**). This revision replaced the previous global listing of loggerheads with these nine new "species," of which the threatened Northwest Atlantic Ocean DPS occurs offshore of Wallops Island. A similar rule has recently been proposed for green sea turtles (*Chelonia mydas*) as well (**80 FR 15272**). Furthermore, in 2014, specific areas in the Atlantic ocean east of Wallops Island that contain *Sargassum* were designated as critical habitat for the loggerhead sea turtle (**79 FR 35896**).

Onshore

Wallops Island contains suitable habitats for the ESA-threatened seabeach amaranth; threatened piping plover (*Charadrius melodus*); threatened red knot; threatened northern long-eared bat, and several species of nesting sea turtles including loggerhead, leatherback (*Dermochelys coriacea*), Kemp's ridley (*Lepidechelys kempii*), and Atlantic green. Although there is suitable seabeach amaranth habitat present on the Wallops Island beach, recent biological surveys have not identified any of these listed plants (**NASA, 2012c, 2013c, 2014b**). Therefore, seabeach amaranth will not be discussed further, and this section will focus on piping plovers, red knots, northern long-eared bats, and sea turtles. Similarly, neither green, nor Kemp's ridley, nor leatherback sea turtles have been recorded nesting on Wallops Island, although suitable habitat for them is present on the beach and most species (with the exception of leatherbacks) have nested elsewhere in Virginia (i.e., the Virginia Beach area: VDGIF, unpubl. data). Accordingly, while the focus of this discussion will be on loggerheads, the assessment of potential effects can be applied to either species should it nest on Wallops Island in the future. Finally, this section limits of the discussion of each species to occurrence during the past four nesting seasons since this is the timeframe during which the Wallops Island beach has been renourished (**NASA, 2010**).

Piping Plover: NASA conducted piping plover surveys 3 to 4 times per week from March 2015 to August 2015, during which six nests were documented. Three nests were found on the recreational beach; two on north Wallops Island; and, for the first time since renourishing the beach, one nest was discovered between the two U.S. Navy facilities (V-010/ V-020 and V-024) on mid-Wallops Island (NASA, unpubl. data). Preliminary results indicate an overall success rate of 1.33 chicks fledged per nesting pair (NASA, unpubl. data).

In 2014, 5 nests were found on the recreational beach and the north end of Wallops Island. Nest success during 2014 ranged from 66 percent with two of three chicks fledging from one nest, to another being completely unsuccessful with none of three chicks fledging due to predation. The remaining three nests experienced fledge rates of 25 percent (n=2) and 50 percent (n=1) (**NASA, 2014b**). In 2013, NASA undertook a similar monitoring effort, during which three nests were again found on north Wallops Island and the recreational beach. Two nests had a 100 percent fledge rate, and the third had a 50 percent fledge rate (**NASA, 2013c**). The 2012 nesting season yielded six nests on north Wallops Island and the recreational beach; however, due to both predation and inundation from storm tides, only one of the nests resulted in fledged chicks (**NASA, 2012c**).

Red Knot: The numbers of rufa red knots on the Wallops Island beach peaked in late May of calendar year 2015, during which total counts exceeded 500 individuals (NASA, unpubl. data). In calendar year 2014, the fewest numbers of rufa red knots, 87 individuals, were observed on Wallops Island since NASA began its protected species monitoring in 2010 (**NASA, 2014b**). By contrast, during the month of May 2013, NASA observed flocks of red knots on Wallops Island ranging in size between approximately 20 to 1,160 individuals (**NASA, 2013c**). During 2012's monitoring effort observed flocks ranged in size from under 10 to approximately 675 individuals (**NASA, 2012c**). All observed knots were on the recreational beach and north end of Wallops Island (**NASA, 2012c, 2013c, 2014b**).

Sea Turtles: No evidence of sea turtle nesting was identified on Wallops Island in 2015 (NASA, unpubl. data) or 2014 (**NASA, 2014b**). In late July 2013, NASA located a false crawl and two loggerhead nests on the Wallops Island beach; the first nest was sited just north of launch Pad 0-A and the second was discovered north of Building X-079 (the HIF) (**NASA, 2013c**). The southernmost nest experienced an approximately 80 percent hatch rate, whereas the nest near the HIF was inundated during an October storm and, therefore, unsuccessful. In 2012, NASA identified two loggerhead nests, the first of which was located in June within the Recreational Beach area and was ultimately predated. In early July, two false crawls on different days led to a nest on the crest of the newly constructed dune just east of Navy Building V-010. After the closure of the hatch window, the nest was excavated revealing an approximately 78% success rate (**NASA, 2012c**).

Northern Long-eared Bat: The northern long-eared bat's (also known as northern myotis) range includes Accomack County. In 2015, the U.S. Geological Survey Cooperative Fish and Wildlife Research Unit deployed acoustic detectors at multiple locations in the state of Virginia. Through this effort, researchers obtained acoustic evidence suggesting the presence of northern long-eared bats on the Delmarva Peninsula, including Northampton County (W.M. Ford, pers. comm., 2015). Although northern long-eared bats were not detected in northern Accomack County in 2015, it does not disprove the potential for the species to occur there, especially within wooded areas (W.M. Ford, pers. comm., 2015). Furthermore, specific to WFF, in 2008, acoustic bat surveys were conducted in the marshes on Wallops Island, with 0.3 percent of the calls identified attributable to myotids (**Stantec Consulting, 2008**). While northern long-eared bats were not separated from the rest of the guild, based on the foregoing information it is reasonable to assume that this species could occur in the vicinity of WFF, even if in low numbers.

Northern long-eared bats likely do not spend the winter near WFF, as they prefer hibernating in caves and mines (**USFWS, 2015**). During the fall months, individuals enter hibernacula and remain there until spring or early summer (**Caceres & Barclay, 2000**). In summer, individuals disperse throughout their range, roosting in tree cavities, crevices, and under exfoliated bark (**Foster & Kurta, 1999**). The species is insectivorous, foraging nocturnally on prey both while in flight as well as gleaning prey items from surfaces (e.g., leaves, standing water) under the forest canopy (**Faure et al., 1993**). Breeding occurs prior to winter hibernation, and females give birth to a single pup the following summer (**Caceres & Barclay, 2000**).

Offshore

In preparing the *Final EA* and consulting with NMFS, NASA determined that project activities may affect several ESA-listed species including in-water sea turtles (species listed above under

Onshore) and several whale species, such as right (*Eubalaena glacialis*), fin (*Balaeanoptera physalus*), sperm (*Physeter macrocephalus*), sei (*Balaenoptera borealis*), and blue (*Balaenoptera musculus*).

Although Atlantic sturgeon was not discussed in the *Final EA*, NASA prepared a Supplemental Biological Assessment for its SRIPP (**NASA, 2011c**) that provides a detailed description of the species. In summary, the Atlantic sturgeon spawns in rivers distant from WFF and predominately utilizes the shallower waters (less than approximately 25 m in depth) offshore of WFF as a foraging ground while migrating between spawning and overwintering areas (**Dunton et al., 2010**; **Erickson et al., 2011; Stein et al., 2004**).

3.2.4.3 Environmental Consequences

No Action Alternative

Avifauna: Impacts on piping plover and rufa red knot from processing, static test fire, and launch of the 100 Configuration Antares ELV would be generally the same as those discussed for non-ESA-listed avian species in Section 3.2.2.2 of this SEA. In summary, these effects would include the potential for startle or disruption of foraging, and for plovers, the potential for disruption of courtship and nesting activities. However, the majority of both piping plover and red knot activity on Wallops Island has historically occurred on the north end of the island, well north of Pad 0-A (**Figure 3-3**; **NASA, 2012c, 2013c, 2014b**). Although the potential exists for piping plover nesting activity to occur within the beach area adjacent to the launch pad, and, therefore, exposing the species to more acute stressors including deafening or mortality from the rocket exhaust, their presence on the beach that is regularly nourished is unlikely due to the suppressed forage base (and resultant lower habitat value).

Sea Turtles: Impacts to nesting sea turtles could include avoided nesting attempts due to artificial lighting emanating from the launch complex (**Witherington, 1992**), disorientation of hatchlings during their subsequent path to the ocean (also due to project-related light sources; **Witherington & Bjorndal, 1991**), and changes to swimming patterns once in the ocean (**Witherington, 1991**). However, during times when Pad 0-A is inactive, the area is lit with amber LED and low-pressure sodium fixtures (i.e., "turtle friendly" lights: **Witherington & Martin, 2003**), reducing the potential for such effects to the least extent practicable.

During launch operations, bright, broad-spectrum area lighting is required and the potential effects on nesting sea turtles are unavoidable. The analysis in the *Final EA* and accompanying Biological Assessment (**NASA, 2009b**) considered that Pad 0-A would be lit with broad-spectrum lighting for up to several days prior to launch. However, observations of Pad operations have shown that broad spectrum night lighting can be required for up to several weeks on either side of the launch window; effectively resulting in up to approximately a month of lighting per launch event. As such, while the resultant effects described in these previous documents remain the same, in practice the duration and magnitude would be somewhat greater.

Then again, there is a relatively low level of sea turtle nesting activity in the region (i.e., the uninhabited Virginia Barrier Islands; VDGIF, unpubl. data), despite a lack of lighting at nearly all other islands in this contiguous chain, supporting the conclusion that nesting activity is limited in this area and, consequently, the effects from the lighting on Wallops Island would be minor on the broader scale. Moreover, as evidenced by the sea turtle nesting that occurred on the Wallops Island beach during and following the initial beach fill cycle (**NASA, 2012c, 2013c**), it is probable that the elevated beach would continue to provide suitable nesting habitat despite the fact that onshore lighting would have some unavoidable adverse effects.

Other more acute effects on sea turtles, including deafening or death due to intense noise or heat from rocket exhaust, while possible, would be highly unlikely due to the repelling nature of the launch site lighting and improbability of a sea turtle emerging onto the Wallops Island beach close enough to the launch pad to be exposed to such stressors.

The potential effects on in-water sea turtles would be interaction with jettisoned flight hardware, whether through direct strike or interaction with the item on the ocean floor; aircraft overflight; and ship strike; either of which would be highly unlikely. The potential effects on offshore *Sargassum* critical habitat would be limited to strike and/or displacement by jettisoned flight hardware or range surveillance vessels. This effect would be localized and would not substantially affect the potential for floating *Sargassum* to provide sheltering and foraging habitat for the post-hatchling and juvenile sea turtles it has been shown to support (**Witherington et al., 2012**). In fact, it is likely that the displacement or movement of *Sargassum* by jettisoned flight hardware would be indiscernible from its natural movement by currents, eddies, and waves (**Gower & King, 2008**).

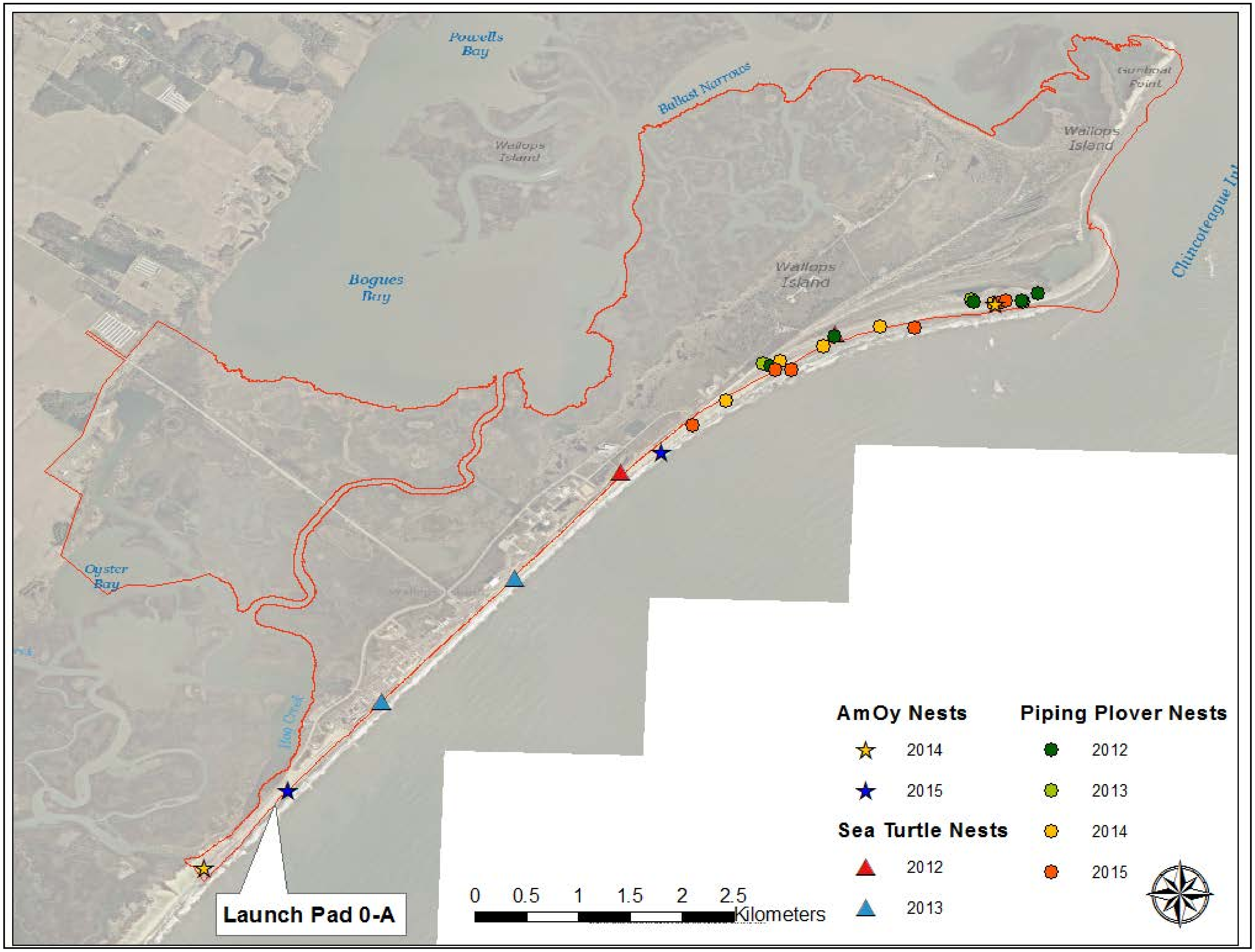

Figure 3-3: Recent (2012-2015) Avian and Sea Turtle Nesting Activity in Relation to Proposed Action

Northern Long-eared Bats: Potential effects on northern long-eared bats were not considered in the *Final EA* and, therefore, warrant discussion. While the majority of northern long-eared bat activity on Wallops Island would likely occur in the forested areas on the north end of the island, several km north of Pad 0-A, or the mainland, several km to the west, it is possible that the species forages in the marshes west of the launch pads (**Stantec Consulting, 2008**). Studies have shown bats to be susceptible to multiple forms of anthropogenic disturbance, including noise (e.g., **Jones, 2008, Schaub et al., 2008**) and lighting (e.g., **Stone et al., 2009, 2012**), but the greatest human-induced stressor of concern to the species is habitat loss and forest fragmentation (e.g., **Henderson et al., 2008**), which would not occur under the Proposed Action. Recent research by **Bunkley et al. (2015)** suggests that bats that produce low frequency sounds for echolocation may be more susceptible to adverse effects from anthropogenic noise. However, as a species that emits high frequency sounds for echolocation of prey (**Faure et al., 1993**), northern long-eared bats are less likely to be adversely affected by the infrequent, short duration noises (e.g., rocket launches, aircraft overflight) generated under the Proposed Action. Finally, when considering the distance between Launch Pad 0-A and the mature forest canopy (i.e., at least several km north or west of the Pad) that is the preferred roosting habitat for the species, it is unlikely that either stressor imparted by the Proposed Action would have more than a negligible adverse effect on northern long-eared bat. Supporting this conclusion is the 0.4 km hibernacula buffer proposed by USFWS to ensure protection of the species from direct adverse impacts, including noise, blasting, smoke, and other stressors (**80 FR 17974**).

Launch-induced fires could affect northern long-eared bats. In addition to *Phragmites*, small trees (e.g., *Prunus* spp., *Juniperus* spp.) west of Pad 0-A have been burned on several occasions following 100 Configuration Antares launches. The USFWS considers any tree greater than or equal to 7.62 centimeters diameter at breast height to be suitable northern long-eared bat roosting habitat. Therefore, potential roosting habitat could be burned in a launch-induced fire. Notwithstanding this fact, it is expected that beyond an initial startle reaction and likely relocation (upon detection of the fire), in the longer-term, the fires would have only minor effects on bats. In fact, **Lacki et al. (2009)** observed that bats in eastern Kentucky roosted more frequently in burned trees than those left unburned. Furthermore, the authors did not detect substantial deleterious effects on the bats' forage base.

Atlantic Sturgeon: Potential effects on Atlantic sturgeon were not considered in the *Final EA* and therefore warrant discussion. Effects from launches of the 100 Configuration Antares ELV would be limited to interaction with jettisoned flight hardware either as it descended to the ocean floor or once on the ocean floor. However, in consideration of the fact that jettisoned hardware would typically land in much deeper waters than those preferred by Atlantic sturgeon, the ability of the fish to maneuver away from a slowly descending item in the water column, and the dilute nature of any resultant release of rocket propellant (e.g., RP-1) once in the oceanic environment, the potential for adverse effects would be highly unlikely. Even if they were to occur, the behavioral and/or physiological effect would likely range from undetectable to a minor avoidance maneuver, which would not present a measurable reduction in an individual's fitness.

Furthermore, as a demersal (bottom dwelling) fish, it would not be susceptible to visual or acoustic stimuli induced by aircraft-based surveillance activities. Ship strike, while possible, would also be an unlikely occurrence.

Cetaceans: Similar to the discussion of impacts on non-ESA listed marine mammals discussed in Section 3.2.3.2 of this SEA, potential effects could include exposure to aircraft overflight, ship strike, low energy sonic booms, direct strike from jettisoned flight hardware, or general interaction with the item(s) once on the seafloor. The likelihood of interaction with a listed whale would likely occur between November and April. However, the project site is not in a concentration area, rather the site is expected to be only a migratory corridor; therefore, population numbers in the area would be low. This fact also supports the conclusion that, similar to the analysis of effects of surveillance aircraft flights and ship strike on non-ESA listed marine mammals, the potential for exposing an individual animal to a project-induced stressor would be very low.

Proposed Action

The potential effects of the Proposed Action on threatened and endangered wildlife would be the same as those under the No Action Alternative. Although there would be slightly greater sound pressure levels generated by the Antares 200 Configuration ELV, which could theoretically have a greater potential for disturbing avian species (i.e., rufa red knots and piping plovers), it is unlikely this would be the case. Birds and other non-human vertebrates typically can discriminate between sounds of different intensity provided the differences are at least in the range of 1-4 dB (**Dooling et al., 2000**). Since the additional sound pressure levels produced by the 200 Configuration Antares would be approximately 2 dBA, it is possible that piping plovers or rufa red knots would be able to discern the difference in sound pressure levels. However, the resultant behavioral response would likely be very similar to that under the No Action Alternative.

Updated Section 7 Consultations

NASA consulted with both NMFS and USFWS regarding the Proposed Action and its potential effects on listed species and critical habitat.

NMFS: In response to receiving NASA's supplemental Biological Evaluation for ELV launches from WFF (**NASA, 2015a**), on June 18, 2015, NMFS concurred with NASA's determination that the Proposed Action, "may affect," but is "not likely to adversely affect," all species and critical habitat under NMFS jurisdiction, including North Atlantic right, blue, fin, sei, humpback, and sperm whales; 5 DPSs of Atlantic sturgeon; loggerhead, Kemp's ridley, green, and leatherback sea turtles; and loggerhead sea turtle *Sargassum* critical habitat.

During the 2015 informal consultation, which was a re-initiation of the ESA consultation conducted in parallel with the 2009 *Final EA*, NASA worked with NMFS to develop the following conservation measures intended to reduce potential effects to listed species:

- To ensure that in-water species are not exposed to ship-induced stressors (e.g., ship strike), constant vigilance would be maintained for the presence of ESA-listed marine mammals and sea turtles. All vessel operators would conform to the regulations prohibiting the approach of right whales closer than 457 m (50 CFR 224.103 (c)). Any vessel finding itself within the 457 – m buffer zone around a right whale would depart the area immediately at a safe, slow speed, unless one of the exceptions applies (also at 50 CFR 224.103 (c));
- To the extent practicable, vessels would remain at least 100 m from all other marine mammals and sea turtles. Vessel speeds would be reduced to 10 knots (kt) or less when piloting in the proximity of marine mammals and further reduced to 5 kt or less when piloting in areas of known or suspected sea turtle activity. If marine mammals or sea turtles approach a vessel, activity would stop, allowing the animal to safety depart the immediate area, prior to resuming operation; and
- Should aircraft operators observe marine mammals or sea turtles, they would not undertake potentially harassing (e.g., repeated circling) patterns until the individuals are no longer under the aircraft's flight path.

USFWS: Based in the preceding analysis in this SEA, NASA has determined that the Proposed Action is essentially the same as that considered in the 2010 USFWS-issued BOs (**USFWS, 2010a**, **2010b**). However, due to 1) the listing of additional species since the 2010 BOs (i.e., northern long-eared bat and rufa red knot); 2) the need to update WFF's overarching ESA documentation to reflect the facility's current operations (including facets of which are unrelated to the action considered in this SEA); and 3) the intent to consolidate the two existing BOs; NASA has re-initiated formal ESA consultation with USFWS (**NASA, 2015c**). Supported by its Biological Evaluation (**NASA, 2015c**), NASA determined that its proposed action "may affect, and is likely to adversely affect," piping plover, rufa red knot, and loggerhead sea turtle; and "may affect, and is not likely to adversely affect," roseate tern, Delmarva Peninsula fox squirrel, northern long-eared bat, seabeach amaranth, and Kemp's ridley, leatherback, and green sea turtles.

NASA's ESA consultation with USFWS is ongoing, but would be completed prior to approving operations under the Proposed Action that could affect listed species or their habitat (e.g., launches). Any USFWS-issued terms and conditions or reasonable and prudent measures applicable to Antares operations at Pad 0-A would be incorporated into future revisions of WFF's Protected Species Management Plan (**NASA, 2015d**) for implementation by NASA or its designee (e.g., VCSFA or Orbital ATK).

3.3 Social Environment

3.3.1 Land and Water Uses

3.3.1.1 Affected Environment

Terrestrial

Section 3.1.1.4 of the *Final EA* describes in detail the land uses within and adjacent to WFF. Since completing the 2009 *Final EA*, NASA has participated with Accomack County and the Navy's Surface Combat Systems Center in the Accomack County/Wallops Island Joint Land Use Study (JLUS) (**Clark Nexsen, 2015**).[7] The primary objective of the JLUS was to identify land use issues that may impact the operational capabilities of WFF, and to identify actions participating agencies can pursue to ensure that incompatible development does not impact the facility's future mission requirements. Through the JLUS process, an action plan to guide future planning efforts was established. A primary input to the JLUS was WFF's range hazard areas within the County where special controls (e.g., temporary relocation of residents) could be necessary to ensure both public safety and NASA's ability to meet mandatory range safety criteria.

Maritime

To further enhance WFF's range safety program, at NASA's request the U.S. Army Corps of Engineers recently amended an existing permanent danger zone in the waters of the Atlantic Ocean off Wallops Island and Chincoteague Inlet that protects the public from hazards associated with rocket launching operations. The amendment increases the danger zone to a 56 km sector (**USACE, 2012**), which was not considered in the 2009 *Final EA*. During launch countdowns, enactment of the danger zone can temporarily restrict and/or re-direct maritime traffic in the Wallops area.

3.3.1.2 Environmental Consequences

No Action Alternative

Under the No Action Alternative, launching the 100 Configuration Antares ELV would be within the extent of (and consistent with) the hazard areas depicted in the Accomack County JLUS (**Clark Nexsen, 2015**). Similarly, although the extent of the maritime danger zone has increased, it would not be enacted any more frequently than as presented in the 2009 *Final EA*. Furthermore, NASA would continue to coordinate with the maritime community to ensure that its operations affect access to Chincoteague Inlet and the nearshore waterways to the least extent practicable.

[7] Accomack County JLUS (**Clark Nexsen, 2015**) information, including the final report, is available online at: http://accomackcojlus.com

Proposed Action

The Proposed Action would also be consistent with the Accomack County JLUS (**Clark Nexsen, 2015**) and would present the same potential effects resulting from the activation of the danger zone as the No Action Alternative.

3.3.2 Cultural Resources

3.3.2.1 Regulatory Context

The National Historic Preservation Act (NHPA) of 1966, as amended, outlines Federal policy to protect historic properties and promote historic preservation in cooperation with other nations, Tribal governments, States, and local governments. The NHPA defines historic properties as those that are either listed on the National Register of Historic Places (NRHP) or eligible for such listing.

Section 106 of the NHPA and its implementing regulations outline the procedures for Federal agencies to follow to take into account their actions on historic properties. Under Section 106, Federal agencies are responsible for identifying historic properties within the Area of Potential Effects for an undertaking, assessing the effects of the undertaking on those historic properties, if present, and considering ways to avoid, minimize, and mitigate any adverse effects.

3.3.2.2 Affected Environment

Section 3.3.6 of the *Final EA* describes in detail the cultural resources that were known to occur on Wallops Island as of the year 2009. Subsequent to preparing the *Final EA*, in 2011 NASA commissioned a supplemental historic context study and comprehensive architectural survey of 76 buildings and structures with dates of construction between 1956 and 1965 on WFF. The *Historic Resources Eligibility Survey, Wallops Flight Facility, Accomack County, Virginia* (**NASA, 2011b**) used the historic context of the 2004 survey referenced in the *Final EA* (**NASA, 2004**); however, the 2011 survey augmented the context with additional history pertinent to the period (1956 to 1965). In consultation with the Virginia Department of Historic Resources (VDHR), it was determined that there are no eligible historic districts within WFF and that the newly surveyed 76 buildings and structures are not individually eligible for NRHP listing.

In December 2014, a Programmatic Agreement (PA) among NASA, the Virginia State Historic Preservation Officer, and the Advisory Council on Historic Preservation, in consultation with Native American tribes, regarding the management of facilities, infrastructure, and sites at WFF, was executed. The PA set forth a streamlined process for NASA's compliance with Section 106 of the NHPA, when agreed upon criteria are met and procedures in the Agreement are followed. Appendix G of the PA defined activities with limited potential to affect historic resources including ground disturbance in areas modeled by the 2003 Cultural Resource Assessment to have low archaeological sensitivity, demolition of buildings determined not eligible during Historic Resource Eligibility Surveys, new construction that does not directly impact or alter identified archaeological sites, and launch/flight operations.

3.3.2.3 Environmental Consequences

Section 4.4.4 of the *Final EA* describes in detail the expected effects of ELV launches from Pad 0-A on cultural resources and the accompanying Section 106 consultation NASA conducted with the VDHR. VDHR concurred with NASA that there would be no historic properties affected.

However, neither the *Final EA* nor the accompanying Section 106 consultation considered the potential effects of launch failures on historic properties. As a result of the overpressures generated by the ORB-3 mishap, an NRHP-listed offsite property (Wharton Place) sustained damages to approximately 25 panes of glass and a window frame. In accordance with the laws, contracts, and agreements governing commercial launch activities at WFF, Orbital ATK ensured that the necessary repairs were made to the property owner's satisfaction. NASA reported the post-review discovery to VDHR and ACHP in accordance with 36 CFR 800.13(b)(3).

No Action Alternative

Under the No Action Alternative, continued launching of the 100 Configuration Antares ELV would be within the class of actions defined in Appendix G of the PA as having limited potential for affecting cultural resources.

In the unlikely case of a launch failure (e.g., ORB-3), it is possible that historic properties could be affected. The extent of the effect would be incident-specific but could include damage to architectural features including windows (as seen at the Wharton Place). If such an unlikely event were to occur, NASA would follow the reporting and/or mitigation protocols specified in the PA.

Proposed Action

Consistent with the No Action Alternative, nominal launch and flight operations are considered to have limited potential for affecting cultural resources. In the unlikely instance of a launch failure and resultant effects on a historic property, NASA would follow the reporting and/or mitigation protocols specified in its PA. Therefore, the Proposed Action would not require further analysis and/or consultation under Section 106 of the NHPA.

3.3.3 DOT Act Section 4(f) Resources

3.3.3.1 Regulatory Context

The DOT Act of 1966 (49 U.S.C., Subtitle I, Section 303(c)), as amended, includes a special provision—Section 4(f)—that stipulates that DOT agencies cannot approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites unless the following conditions apply:

1. There is no feasible and prudent alternative to the use of such land; and
2. The project includes all possible planning to minimize harm to the land resulting from such use.

Because the FAA is a DOT agency with regulatory jurisdiction over the Proposed Action, this SEA also includes an evaluation of DOT Section 4(f) lands.

3.3.3.2 Affected Environment

Several landholdings of the Chincoteague National Wildlife Refuge (CNWR) that are Section 4(f) lands are located within the vicinity of Wallops Island. Assawoman Island, which lies immediately south of Wallops Island, and the northern portion of Metompkin Island, which lies immediately south of Assawoman Island, are owned by the USFWS. Assawoman Island is closed year round except for seasonal boat and fishing access on the southern tip. The northern part of Metompkin Island is owned by the USFWS and the southern half is owned by the Nature Conservancy; both portions are open to the public for low impact, recreational daytime activities, such as hiking, bird watching, fishing, and photography. Approximately 8.5 km north of Pad 0-A is Assateague Island, also owned by USFWS and co-managed with the National Park Service's Assateague Island National Seashore. Assateague Island is open year-round and has been used in the past as a viewing site for Antares launches.

3.3.3.3 Environmental Consequences

No Action Alternative

Section 4.5.2.10 of the *Final EA* describes in detail the expected effects of Antares 100 Configuration ELV launches from Pad 0-A on Section 4(f) lands. In summary, pre-launch preparations could require the temporary closure of vehicular access from south Wallops Island onto Assawoman Island. Such closures would temporarily suspend USFWS's ability to access Assawoman Island for biological monitoring and other refuge management activities.

Launches would require temporary closure (i.e., up to 3 to 4 hours per launch attempt) of portions of the CNWR, including southern Assateague Island and Assawoman Island. To this end, NASA has an established agreement with CNWR for such closures and coordinates with CNWR personnel during mission planning to ensure that closures do not adversely affect CNWR activities any more so than necessary to maintain public safety. The value of CNWR in terms of its significance and enjoyment is not substantially reduced or lost due to launch activities at WFF. Instead, the southern portion of Assateague Island has become a popular observation location for viewing Antares launches. FAA-AST consulted directly with CNWR in parallel with the *Final EA* and received CNWR concurrence with this conclusion.

Proposed Action

The potential effects of the Proposed Action on Section 4(f) lands would be the same as those under the No Action Alternative. Because the Proposed Action is essentially the same as the No Action Alternative in terms of potential impacts on Section 4(f) properties, the FAA-AST has determined that 200 Configuration Antares launches under the Proposed Action would not result in a use of a Section 4(f) property. In December 2009, CNWR concurred that commercial space launches from MARS would not result in substantial impairment of CNWR.

3.4 Cumulative Effects

The CEQ regulations for implementing NEPA define cumulative effects as the "impact on the environment which results from the incremental impact of the action(s) 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" (40 CFR § 1508.7).

3.4.1 Evaluation Approach

Following CEQ's 1997 guidance (**CEQ, 1997**), the scope of the Cumulative Effects Analysis (CEA) should be related to the magnitude of the environmental impacts of the proposed action. Proposed actions of limited scope and impact typically do not require as comprehensive a CEA as proposed actions that have environmental impacts over a large area.

Therefore, similar to the methodology employed for deciding those resources to be considered in detail in the "direct and indirect effects" sections of this SEA, only those resource areas that 1) the Proposed Action would cause notably greater effects than those of the No Action Alternative or 2) have measurably changed since the 2009 *Final EA* are considered in detail in this CEA. **Table 3-5** provides a summary of those resources considered and whether they were included for detailed analysis in this CEA.

3.4.2 Analysis

Section 4.5 of the 2009 *Final EA* provides a detailed CEA for all resource areas potentially affected by ELV launches from Pad 0-A. Building upon that analysis was the CEA for the Shoreline Restoration and Infrastructure Protection Program (**NASA, 2010**), the CEA for the Wallops Island Post-Hurricane Sandy Shoreline Repair project (**NASA, 2013a**), and, most recently, the CEA for the U.S. Navy Hypervelocity Projectile and Electromagnetic Railgun project (**USN, 2014**). The aforementioned CEAs all included ELV launches from Pad 0-A as a primary impact-producing factor; therefore, they are deemed applicable to fulfilling the majority of NASA's obligations to consider cumulative effects in this SEA. These analyses are hereby incorporated by reference (as provided in CEQ Regulations at 40 CFR §§ 1500.4 (j) and 1502.21) with the focus of this SEA's CEA being the potential additive effect of processing and launching the 200 Configuration Antares ELV from Pad 0-A at WFF.

Table 3-5: Resources Considered for Cumulative Effects Only Those Analyzed in Detail in this SEA are Shown

Resource	Analyzed in Detail in this CEA?	If *Yes*, SEA Section If *No*, Rationale for Elimination
Physical Environment		
Soils	No	Proposed Action and No Action would have same localized effects.
Water Quality	No	Proposed Action and No Action would have same localized effects.
Coastal Zone Management	No	Proposed Action and No Action would have same localized effects.
Air Quality	No	Proposed Action would have lesser effects than No Action.
Noise	No	Minor difference in effects as identified in this SEA.
Biological Environment		
Vegetation	No	Proposed Action and No Action would have same localized effects.
Wildlife & Birds	Yes	3.4.2.1
Marine Mammals	No	Proposed Action and No Action would have same minor effects.
Threatened & Endangered Species	No	Minor difference in effects as identified in this SEA.
Social Environment		
Land & Water Uses	No	Proposed Action and No Action would have same minor effects.
Cultural Resources	No	Proposed Action and No Action would have same effects.
DOT Act Section 4(f) Resources	No	Proposed Action and No Action would have same effects.

It should be noted that NASA is currently preparing a twenty-year planning horizon "master plan" Site-wide Programmatic Environmental Impact Statement, and, accordingly, it considered the relevance of those actions to this CEA. However it was determined that those actions possibly presenting additive impacts to resources affected by the Proposed Action, either would not overlap temporally (i.e., they would occur well into the future) or are not well defined enough to be considered reasonably foreseeable for inclusion in this CEA.

In summary, the potential cumulative effects resulting from the Proposed Action would be nearly the same as the No Action Alternative, which has been evaluated as a component of multiple CEAs performed since the *Final EA*. As such, an additional detailed CEA in this SEA is not warranted. However, a summary CEA of the resource that has most notably changed since the *Final EA* (i.e., wildlife) is provided.

3.4.2.1 Wildlife

Since completing the *Final EA*, NASA has restored the Wallops Island beach, creating terrestrial wildlife and avian habitat where there previously was none. Additionally, the expansion of range surveillance activities (i.e., helicopter flights) would have the potential to induce stressors upon wildlife in the area.

To summarize, the wildlife on Wallops Island, particularly beach nesting and foraging birds, would continue to be exposed to a variety of potential stressors, of which many are frequent and recurring; including anthropogenic noise, lighting, aircraft overflight, recreational beach use, and a reduced forage base. Despite these potential adverse cumulative effects, at a time when the global availability of elevated beach habitat is declining, the continued renourishment of the Wallops Island beach would maintain several km of beach that would be suitable for nesting and limited foraging; therefore, providing a net benefit to these beach reliant species. Furthermore, it is expected that north Wallops Island would remain largely unaffected by cumulative effect producing actions due to its physical separation from the most active portion of the launch range as well as its general exclusion from beach renourishment activities. As such, while the potential cumulative effects on terrestrial wildlife and birds would be adverse, and largely unavoidable, they would not be substantial.

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