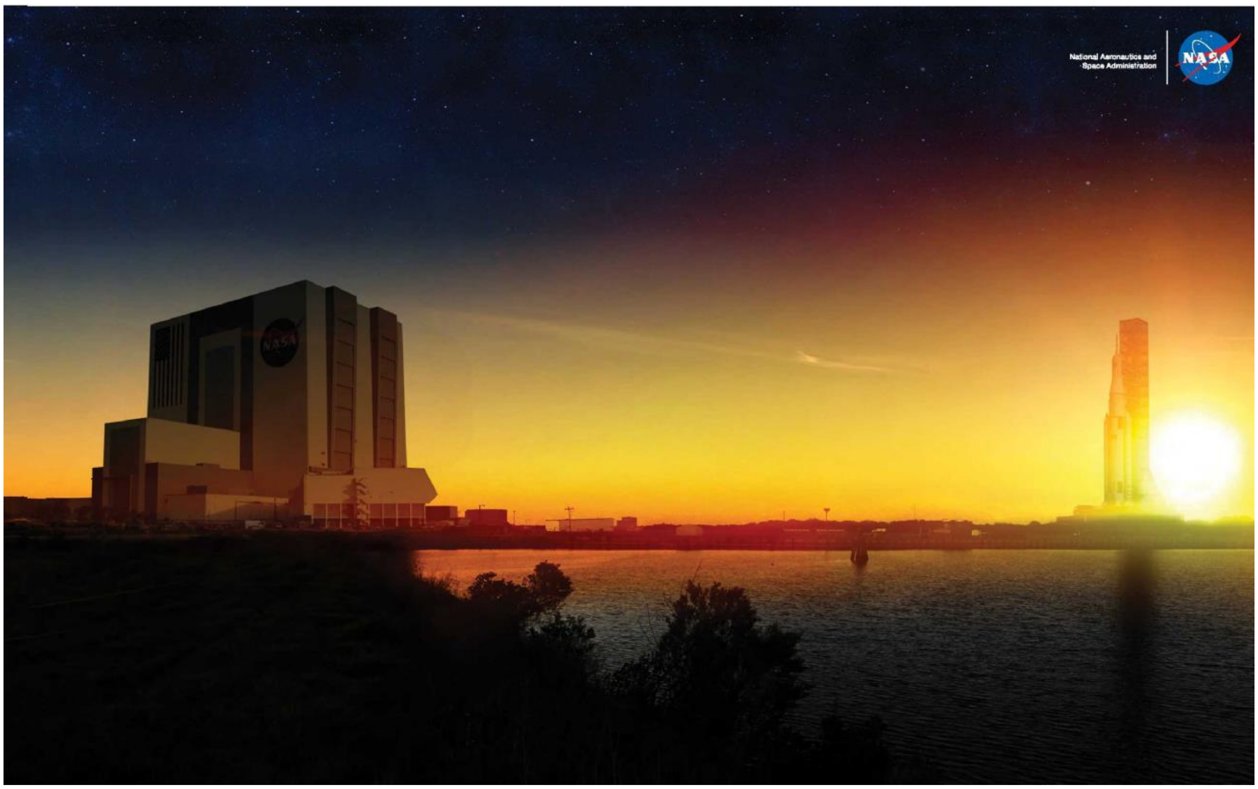
Final Environmental Assessment for Multi-Use of Launch Complexes 39A and 39B John F. Kennedy Space Center, FL



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FINAL ENVIRONMENTAL ASSESSMENT
FOR MULTI-USE OF LAUNCH PADS 39A AND 39B
JOHN F. KENNEDY SPACE CENTER, FLORIDA

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InoMedic HEALTH APPLICATIONS

EXECUTIVE SUMMARY

This Environmental Assessment (EA) has been prepared in compliance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. §§ 4321-4370d) and according to the Procedures of Implementation of NEPA for the National Aeronautics and Space Administration (NASA) (Title 14, Code of Federal Regulations, part 1216 subparts 1216.1 and 1216.3), the Council on Environmental Quality (CEQ) NEPA implementing regulations (40 Code of Federal Regulations [CFR] Parts 1500 to 1508), and Federal Aviation Administration (FAA) Order 1050.1E, *Environmental Impacts: Policies and Procedures*. Launch vehicles covered in this EA include Atlas V, Delta IV, Delta IV Heavy, Liberty, Falcon 9 and 9 v1.1, Falcon Heavy, Antares, Radially Segmented Launch Vehicle (RSLV-S), Athena IIc, Xaero, and the Space Launch System (SLS). The potential for up to two launches per month by NASA and/or commercial users would provide the ability to continue space exploration.

Purpose and Need

As established by the Office of the President and directed from Congress, it is NASA's mission to expand commercial uses of space and the space industry. This directive is detailed in the NASA Authorization Act of 2010 and the Space Act of 1958, as amended. The Proposed Action is consistent with both of these policy directives.

Under the Proposed Action, NASA would permit the establishment and operation of commercial venture capabilities at John F. Kennedy Space Center (KSC), under its jurisdiction for activities supporting both government and commercial civil space activities as described in this document. This would be accomplished through the execution of long-term land use leases and Space Act Agreements. The use and management of this property are described in Kennedy Contract Agreement KCA-1649 Rev. B, the Interagency Agreement between NASA and the United States Fish and Wildlife Service (USFWS). Under this agreement, the primary purpose of the land is NASA's utilization of it in partial fulfillment of its mission, with the secondary purpose being management by the USFWS as a national wildlife refuge. The purpose of this EA is to document potential environmental impacts from the construction of a Horizontal Integration Facility (HIF) at one or more of five possible locations, provide Rocket Propellant 1 (RP-1) Storage either at individual locations or a common area, and to allow multiple users to launch vehicles from Launch Complex (LC) 39A and LC 39B.

The purpose of NASA's Proposed Action is to allow multiple users to prepare and launch vehicles from LC 39A and LC 39B, located at KSC. The Proposed Action would provide the continued capability of space exploration which includes the processing and launch of rocket powered vehicles to 1) enable improved access to KSC's space launch and test operation capabilities by commercial and other non-NASA users; 2) advance NASA's mission by fostering a commercial space launch and services industry, and 3) improve the return on taxpayer investment of KSC Spaceport facilities through expanded use and improved utilization.

The Proposed Action would facilitate and support the launch operations of multiple users and various launch vehicles from LC 39A and LC 39B to meet the demand for lower cost access to space. In doing so, the Proposed Action enables the substantial federal investment in KSC, and particularly the LC 39 launch pads and related support facilities, to continue providing benefits to both the government and the private sector following the retirement of the Space Shuttle Program in 2011.

Proposed Action and Alternatives

One Proposed Action and the No Action Alternative were analyzed. The Proposed Action includes 1) construction of a HIF at one or more of five potential locations, 2) provide RP-1 Storage at individual locations or at a common location, and 3) allow multiple user launch capabilities at LC 39A and LC 39B.

Flight operations at LC 39A and LC 39B by multiple users would require construction of new RP-1 storage and transfer facilities. Options for these facilities include either individual storage locations at each launch pad or at a centrally located common storage facility. Delivery of RP-1 by railcar is being considered and, therefore, railroad connections to chosen storage location(s) would be necessary to provide a mode of transport for incoming fuel supplies. These railroad connections would be constructed within existing roadways. A HIF is proposed to provide housing for launch vehicle preparation prior to launch. Five location options for the HIF were reviewed in this EA. Launch vehicles covered in this EA include Atlas V, Delta IV, Delta IV Heavy, Liberty, Falcon 9 and 9 v1.1, Falcon Heavy, Antares, RSLV-S, Athena IIc, Xaero and the SLS. The potential for up to two launches per month by NASA and/or commercial users would provide the ability to continue space exploration.

Under the No Action Alternative, NASA would not allow multiple users to launch vehicles from either LC 39A or LC 39B. There would be no construction of a HIF or the need for additional RP-1 storage. The vehicles covered in this EA would not be launched from LC 39A or LC 39B.

Environmental Consequences

Potential environmental consequences are summarized in this section. An extensive discussion of impacts, including cumulative impacts, is provided in Section 4. Four classifications of environmental impacts were pre-determined, and the resources were evaluated in terms of these classifications:

- none (no impacts expected),
- minimal (impacts are not expected to be measurable, or are too small to cause any discernable degradation to the environment),
- moderate (impacts would be measureable, but not substantial, because the impacted system is capable of absorbing the change, or the impacts could be managed through conservation measures and/or mitigation), or

- major (impacts could individually or cumulatively be substantial).

This EA analyzed the following environmental resource areas in detail:

- Land Use
- Facilities and Infrastructure
- Health and Safety
- Water Quality
- Atmospheric Environment
- Noise and Vibration
- Biological Resources
- Geology and Soils
- Historic and Cultural Resources
- Hazardous Materials and Waste Management
- Global Environment
- Socioeconomics and Children's Environmental Health and Safety
- Orbital and Reentry Debris
- Aesthetics

Moderate impacts to land use are expected for proposed RP-1 Option 2 and HIF Options 2, 3, and 4 due to changes in land use classification necessary for establishment of safety zones. Management of these areas, currently administered by Merritt Island National Wildlife Refuge (MINWR) would be transferred back to NASA.

Impacts to electricity, natural gas, communications, and solid waste infrastructure at KSC would be minimal. These utilities and services are currently available in the vicinity of Proposed Action sites. Some utilities ducts would need to be laid and tie-ins established, but additional demands on these services would be readily absorbed. Water supply impacts during construction would also be minimal since potable water resources are available at or near proposed sites. Impacts to water supply and treatment during launch operations are classified as moderate due to the increased volume of water needed for sound suppression during launch, and the acquisition of industrial wastewater permits required for the launch deluge water. Construction of RP-1 and HIF facilities would require permitted stormwater management systems and impacts to stormwater is, therefore, considered moderate. Transportation impacts are classified as moderate due to railroad construction, and increased traffic and road closures during launch events.

Potential adverse effects to human health and safety are possible during construction and operational activities related to the Proposed Action. These are common to construction and space-related industrial activities. Compliance with Occupational Safety and Health Administration (OSHA) and hazardous materials regulations, adherence to health and safety plans, and participation in safety awareness training would mitigate the risks and result in moderate impacts to worker and public health and safety.

Direct moderate impacts to surface water would occur during construction of HIF Options 2, 3, 4, and 5. Depending on the sites chosen, these impacts include filling portions of Banana Creek, wetlands, and surface waters directly connected to the LC 39 Area Barge Canal. Dredge and fill permitting and mitigation for wetland impacts would constitute a moderate impact. Fallout from the launch exhaust cloud could result in short-term acidification of impounded surface waters near the launch pads. These waters are highly buffered and should return to pre-launch conditions within 72 hours of launch. Impacts to surface waters during launch are considered moderate.

Groundwater quality impacts from construction and operations are considered minimal. Surface water degradation would be absorbed by surface water management systems, preventing transfer of pollutants into the groundwater.

Impacts to air quality from construction or modification of any of the Proposed Action options would be minimal and of short duration. Potential emissions of any criteria pollutants are not expected to exceed air quality standards. Combustion emissions from launch vehicles would be of short duration and rapidly dispersed. Moderate impacts are expected to air quality from launch operations. There are no impacts anticipated to the local climate from implementation of the Proposed Action.

Moderate impacts due to noise are expected from construction of the HIF and RP-1 options and from increased noise levels during launch. Noise levels from launch are of short duration and diminish quickly as the vehicle rises. Adherence to OSHA safety practices would protect the KSC workforce from undue noise impacts during construction. Sonic boom levels would be less than those previously experienced during Space Shuttle launches and reentry.

Impacts to biological resources range from minimal to moderate. Vegetation clearing and filling of low-lying areas during construction of HIF and RP-1 options would result in moderate impacts due to alteration of land cover over entire sites or large portions of them. Effects of launch on vegetation near the pads include acute impacts from the acid ground cloud, which alters vegetation community structure and species composition. Impacts to wildlife are expected to be minimal due to loss of habitat from construction of Proposed Action HIF and RP-1 sites. Impacts to wildlife, including protected species, are also anticipated from noise during construction and launch events; and impacts to marine mammals from potential reentry debris. Mitigation would be required for the expected moderate impacts to protected wildlife due to loss of habitat. There are also operational impacts to nesting and hatchling marine turtles from facility lighting and night launches.

Impacts to soils from construction of HIF and RP-1 sites and associated infrastructure would be moderate from land clearing activities that would disturb the upper soil layers. Chemical characteristics of soils in the vicinity of the launch pads are altered by deposition from the launch ground cloud. These impacts are considered moderate, but the buffering capacity of the soil prevents long-term effects.

Historic facilities at LC 39 along with the Crawlerway would be moderately impacted by modifications related to the Proposed Action construction activities; and by future refurbishment or construction related to multiple use operations. There would be minimal impacts to archaeological sites and historic areas.

Compliance with hazardous material and waste management regulations and adherence to guidelines established by NASA would result in minimal impacts from construction activities related to the Proposed Action. Wastes generated by commercial entities must be properly containerized, stored, labeled, manifested, shipped, and disposed of in full regulatory compliance. Impacts due to use of large quantities of hazardous materials during processing of launch vehicles would be measurable, but can be reduced through appropriate management and conservation measures and are, therefore, considered moderate.

Greenhouse gas emissions during the construction phase are considered minimal and do not represent an addition to total regional emissions rates. Potential climate change impacts from the launch vehicles evaluated in this EA include their emission of black carbon "soot" into the stratosphere. The aerospace industry is addressing minimization of this impact by advancing propulsion system designs and innovative fuel mixtures. Increased energy use related to the Proposed Action results in an increased release of carbon dioxide (CO2). These impacts due to operations are considered moderate and can be mitigated by continued implementation of energy conservation programs at KSC.

The construction of HIF and RP-1 options would provide jobs for the local workforce and benefit the local economy. Operations associated with the Proposed Action would also be beneficial with the creation of full-time jobs.

With the exception of socioeconomics, there are no impacts to resources identified as a result of the No Action Alternative. There would be a moderate impact to socioeconomics due to loss of potential jobs for the local workforce. The potential for commercial launch operations at KSC would be severely decreased along with local economic opportunities.

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Tables

ACRONYMS

ac	acre
Al	aluminum
AST	Office of Commercial Space Transportation and Aboveground Storage Tank
Ba	Barium
B(a)P	benzo (a) pyrene
Bls	below land surface
BO	Biological Opinion
C	Centigrade
Ca	calcium
$CaCO_2$	calcium carbonate
CASI	Climate Science Adaptation Investigator
CBC	Common Booster Core
CCAFS	Cape Canaveral Air Force Station
CCM	Composite Crew Module
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Cl	chloride
cm	centimeters
CMS	Corrective Measures Study
CNS	Canaveral National Seashore
CO_2	carbon dioxide
COC	Chemicals of Concern
COPC	Chemicals of Potential Concern
Cr	chromium
CS	Confirmation Sampling

CSR	Confirmation Sampling Report
Cu	copper
CVOC	chlorinated volatile organic compounds
cy	cubic yard
CxP	Constellation Program
CZMA	Coastal Zone Management Act
dB	decibels
dBA	A-weighted decibels
DBA	Deluge Basin Area
DNL	day/night sound level
DO	Dissolved Oxygen
DoD	Department of Defense
DOT	Department of Transportation
DTP	Domestic Treatment Plant
EA	Environmental Assessment
ECS	Environmental Control System
EE	Engineering Evaluation
EELV	Evolved Expendable Launch Vehicle
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EO	Executive Order
ESA	Endangered Species Act
F	Fahrenheit
FAA	Federal Aviation Administration
FAC	Florida Administrative Code
FCMP	Florida Coastal Management Plan

Fe	iron
FEMA	Federal Emergency Management Agency
FDEP	Florida Department of Environmental Protection
FONSI	Finding of No Significant Impact
ft	feet
FPL	Florida Power and Light
gal	gallon
GCMs	global climate models
GCTL	Groundwater Cleanup Target Levels
GHG	Greenhouse Gas
GN2	gaseous nitrogen
GSDO	Ground Systems Development and Operations
ha	hectare
HAP	hazardous air pollutant
HAER	Historic American Engineering Record
HCl	hydrogen chloride
HEA	Health and Environmental Risk Assessment
Hg	mercury
HIF	Horizontal Integration Facility
HOF	Hypergol Oxidizer Facility
HO_X	Hydrogen Oxides
HTPB	hydroxyl-terminated polybutadiene
ICPS	Interim Cryogenic Propulsion Stage
IM	Interim Measure
in	inch
IPA	isopropyl alcohol
IPCC	International Panel on Climate Change
IRL	Indian River Lagoon

ISS	International Space Station
K	Potassium
KCA	Kennedy Contract Agreement
kg	Kilograms
km	kilometers
KSC	Kennedy Space Center
kV	kilovolts
kWh	kilowatt hours
l	liter
Lbs	pounds
LC	Launch Complex
LCC	Launch Control Center
LCH4	liquid methane
LH2	liquid hydrogen
LEO	low Earth orbit
LIDAR	Light Detection and Ranging
LOC	Location of Concern
LOX	liquid oxygen
LPS	Lightning Protection System
LUCIP	Land Use Controls Implementation Plan
m	meters
MCL	Maximum Contaminant Level
MDRPRA	Marine Debris Research, Prevention, and Reduction Act
mi	miles
Mg	magnesium
$MgCO_3$	magnesium carbonate
MINWR	Merritt Island National Wildlife Refuge
MLP	Mobile Launch Platform

MMH	monomethyl hydrazine
MMPA	Marine Mammal Protection Act
Mn	manganese
MPCV	Multipurpose Crew Vehicle
MPRSA	Marine Protection, Research, and Sanctuaries Act
mph	miles per hour
MSS	Mobile Service Structure
Na	sodium
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NDEL	Non-Destructive Evaluation Laboratory
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NHRP	National Register of Historic Places
Ni	nickel
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notices to Airmen
NPDES	National Pollutant Discharge Elimination System
NPR	NASA Procedural Requirement
NPS	National Park Service
OFW	Outstanding Florida Waters
OPF	Orbital Processing Facility
OSB	Operations Support Building
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
PAH	polycyclic aromatic hydrocarbon

PAMS	Permanent Air Monitoring Station
Pb	lead
PCB	polychlorinated biphenyl
PCC	Process Control Center
PEL	Permissible Exposure Limit
PM	Particulate Matter
POL	Paint, Oil, and Lubricant
ppm	Parts Per Million
PRL	Potential Release Location
PSBA	Propellants Support Building Area
PTCR	Pad Terminal Connection Room
PTE	Potential to Emit
QD	Quantity Distance
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RP-1	Rocket Propellant 1 (Kerosene)
ROD	Record of Decision
R-SCTL	Residential Soil Cleanup Target Level
RSLV-S	Radially Segmented Launch Vehicle
SA	SWMU Assessment
SAR	SWMU Assessment Report
SCTL	Soil Cleanup Target Level
SHPO	State Historic Preservation Officer
SJRWMD	St. Johns River Water Management District
SLF	Shuttle Landing Facility
SLS	Space Launch System
SPCC	Spill Prevention, Control, and Countermeasures
SPL	Sound Pressure Level

SR	State Road
SRB	Solid Rocket Booster
SRM	Solid Rocket Motor
SSP	Space Shuttle Program
SSRM	Strap-on Solid Rocket Motor
STP	Sewage Treatment Plant
STS	Space Transportation System
SVOC	Semi-volatile Organic Compounds
SWCTL	Surface Water Cleanup Target Level
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
TCE	trichloroethene
TDS	Total Dissolved Solids
TEA	tetraethyl aluminum
TEB	triethyl borane
Tl	thallium
TMDL	Total Maximum Daily Loading
TOC	Total Organic Carbon
TRPH	Total Recoverable Petroleum Hydrocarbons
TWA	Time Weighted Average
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VOC	Volatile Organic Compound
ZAP	Zone of Archaeological Potential
Zn	Zinc

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DRAFT ENVIRONMENTAL ASSESSMENT FOR MULTI-USE OF LAUNCH COMPLEXES 39A AND 39B KENNEDY SPACE CENTER, FL

1.0 PURPOSE AND NEED

1.1 Proposed Action

The National Aeronautics and Space Administration (NASA) in compliance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and NASA Procedural Requirements (NPR) 8580.1, has prepared this Environmental Assessment (EA) to increase Kennedy Space Center (KSC) spaceport capabilities and allow both commercial and governmental entities to utilize Launch Complex (LC) 39A and LC 39B for launch purposes. The intention is for the launch complexes to be modified to provide the capability for a variety of vertical launch vehicles to be processed and launched from either complex. While the two pads may have dissimilar configurations, together they would have the capability to accept various launch vehicles including, but not limited to, Atlas V, Delta IV, Delta IV Heavy, Liberty, Falcon 9 and 9 v1.1, Falcon Heavy, Antares, RSLV-S, Athena IIc, Xaero, and the Space Launch System (SLS). In addition, the complexes would be capable of supporting static engine testing for rocket engine certification and recertification, as well as housing necessary ground support equipment and various fuels.

NASA prepared an Environmental Impact Statement (EIS) for implementation of the Constellation Program (CxP), NASA's initial efforts to extend the human presence throughout the solar system. The CxP was cancelled in 2010 and NASA was directed to continue deep space human exploration with the Orion Multipurpose Crew Vehicle (MPCV) and the Space Launch System (SLS). The Record of Decision for the CxP EIS was modified to document NASA's consideration of environmental impacts resulting from the replacement of CxP with the SLS and the Orion crew capsule.

This EA also addresses the potential need to develop vehicle processing facilities within or around the launch complex perimeters. Each proposed facility would require up to four hectares (ha) [10 acres (ac)] of land and have the capability to be connected to the Crawlerway through either Crawlerway extensions or rail systems. A study of proposed Horizontal Integration Facility (HIF) locations was conducted and these potential locations are evaluated in this EA (NASA 2012a).

The actions addressed in this EA also include developing new Rocket Propellant 1 (RP-1) fuel storage systems and infrastructure necessary to supply fuel to LC 39A and LC 39B. A study was conducted which evaluated individual storage locations within each launch complex, and a single location for a common central storage (NASA 2012b). The proposed individual and common RP-1 sites and infrastructure are assessed in this document.

A vicinity map showing the location of LC 39 on KSC is provided in Figure 1-1, while Figure 1-2 depicts the perimeter boundary of LC 39A and LC 39B.

This EA will assist NASA decision makers (and other federal agencies) considering the environmental impacts associated with the Proposed Action and No Action alternatives. No final decisions will be made until NEPA compliance is complete.

Two federal agencies are directly involved in the EA for this proposed action: NASA, and the Federal Aviation Administration (FAA). As the landowner, NASA KSC is responsible for its real property assets and infrastructure in support of the Agency mission of human spaceflight and continued exploration of space. NASA's KSC is the only United States (U.S) launch complex utilized for human spaceflight. NASA is also responsible for managing KSC for space-related industry, development, and operations. KSC provides oversight for current commercial space and technology development-related uses, and will be responsible for establishing and coordinating activities outlined in the proposed action. NASA is the lead agency for the proposed action and is responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

The FAA Office of Commercial Space Transportation (AST) is a cooperating agency in the preparation of this EA because of its role in licensing the operation of commercial launch vehicles. The FAA/AST's mission is to ensure protection of the public, property, and the national security and foreign policy interests of the U.S. during commercial launch or reentry activities; and to encourage, facilitate, and promote U.S. commercial space transportation. The FAA would issue launch/reentry licenses, as appropriate, for commercial space transportation operators using LC 39. In addition, should NASA subsequently enter into any agreement with a non-federal entity to operate LC 39, the FAA would issue a launch site operator license and regulate the activities of the non-federal spaceport operator.

1.2 Purpose of the Proposed Action

As established by the Office of the President and directed from Congress, it is NASA's mission to expand commercial uses of space and the space industry. This directive is detailed in the NASA Authorization Act of 2010 and the Space Act of 1958, as amended.

The purpose of NASA's Proposed Action is to expand its spaceport capabilities to include the processing, launch, and recovery of various classes of vertically launched rocket-powered vehicles. This will 1) enable improved access to KSC's space launch and test operation capabilities by NASA, as well as commercial and other non-NASA users; 2) advance NASA's mission by fostering a commercial space launch and services industry, and 3) improve the return on taxpayer investment of KSC spaceport facilities through expanded use and improved utilization.

This EA will be subject to review periodically, to maintain currency with relevant rules, regulations, scientific findings, space technologies, available launch vehicles and sites, and the evolving requirements of NASA's space research program. In the event that a change in applicable laws, regulations or statutes occurs before an internal review, NASA will review the EA and determine if it is necessary to prepare a Supplemental EA or Environmental Impact Statement (EIS).

1.3 Need for the Proposed Action

NASA will be able to meet the specific objectives of U.S. space and Earth exploration by allowing for multiple users, both governmental and commercial, to process and launch space vehicles from LC 39. The Proposed Action of this EA, in conjunction with the Suborbital EA (NASA 2012c) and the Routine Payload EA (NASA 2011a), both prepared by NASA, will assure that the substantial federal investment in KSC, and particularly LC 39 and its related support facilities, will continue to provide benefits to both the government and the private sector.

The Proposed Action will require modifications to LC 39 infrastructure and facilities as needed to support the processing and launch of Atlas V, Delta IV, Delta IV Heavy, Liberty, Falcon 9 and 9 v1.1, Falcon Heavy, Antares, RSLV-S, Athena II, Xaero, and SLS vehicles. These vehicles will be responsible for transporting various spacecraft into orbit, including reusable manned and unmanned spacecraft such as Orion, Dream Chaser, CST-100, Liberty Composite Crew Module (CCM), and Dragon. For the purposes of this EA, the term "spacecraft" will be used to describe modules sent into orbit on the launch vehicle carrying payloads, supplies, or crew. The term "launch vehicle" will be used to describe the rocket and all of its components.

A vicinity map of LC 39 on KSC and a map of the perimeter boundary of LC 39A and LC 39B are shown below (Figure 1-1, Figure 1-2).

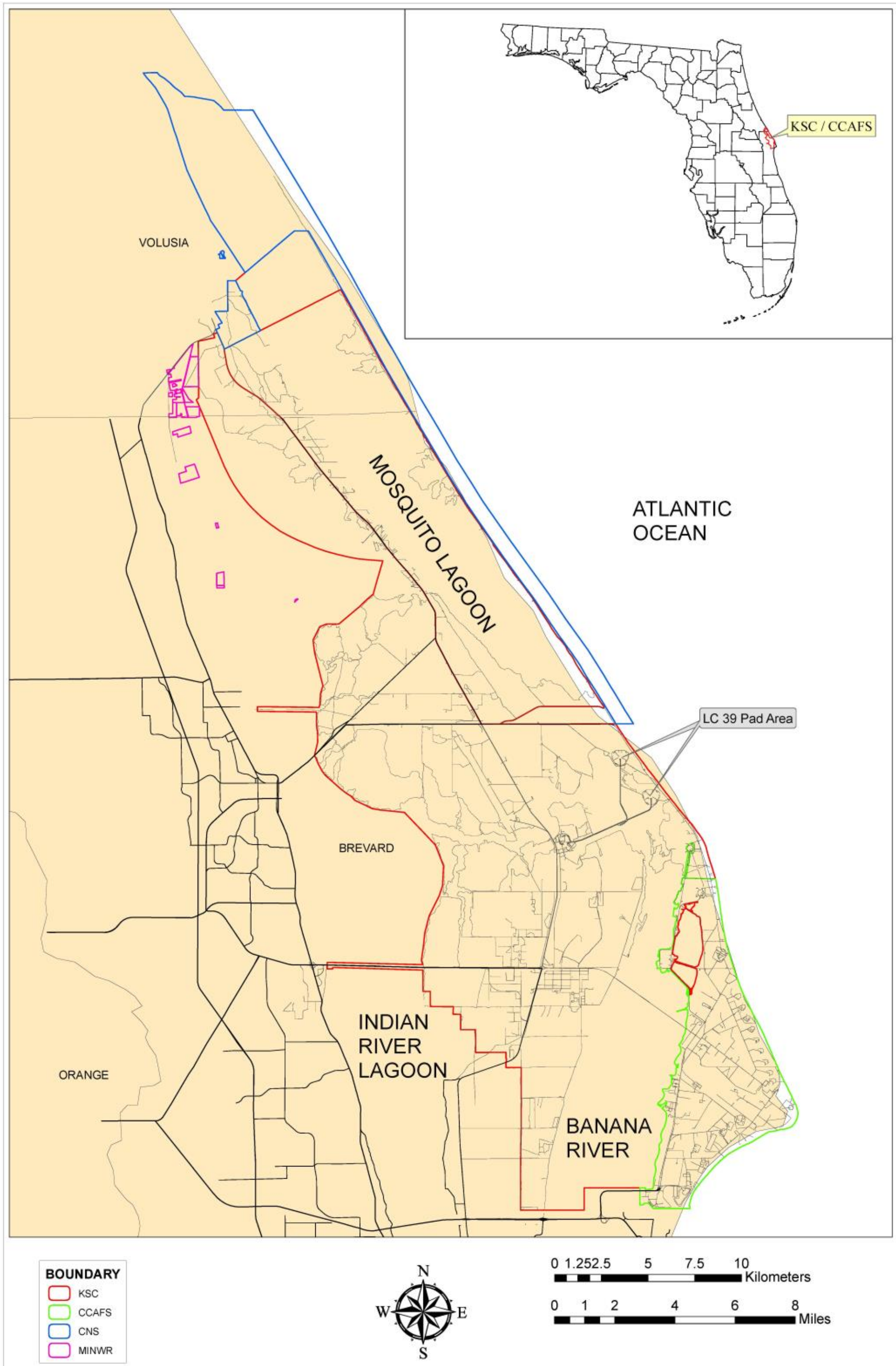


Figure 1-1. Vicinity map with location of Launch Complex 39 Area at KSC, FL.

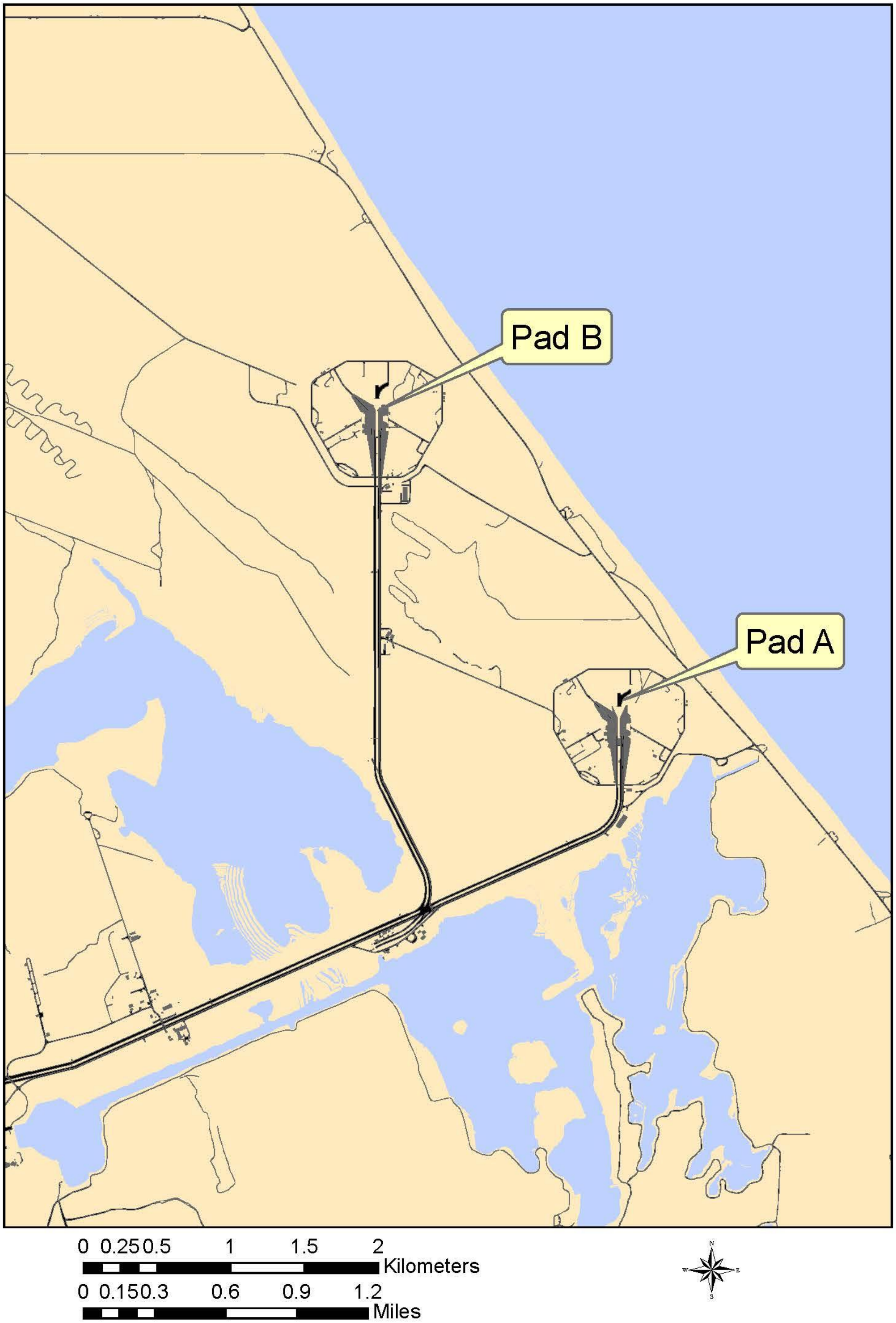


Figure 1-2. Launch Complex 39A (Pad A) and Launch Complex 39B (Pad B) at KSC, FL.

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

NASA would permit the establishment and operation of commercial venture capabilities at John F. Kennedy Space Center (KSC), under its jurisdiction for activities supporting both government and commercial civil space activities. As part of the effort to enable the commercial space industry, KSC endeavors to make available the excess capacity of its various assets, including facilities that may be of value to the industry. This is accomplished through an established partnership process whereby notice is made to the community through normal recognized pathways such as FedBiz. Responses to such notices are evaluated to determine if they are viable and which responses bring the best value to the Government. Then the use of those assets is established through various authorities such as the National Space Act and the Commercial Launch Space Act to execute appropriate agreements.

The modifications of LC 39A and LC 39B are proposed to provide vehicle processing and launch capabilities to multiple users. These modifications include the removal of the existing launch support structures on LC 39A. Most of the launch support structures have already been removed or modified at LC 39B and these actions were assessed in the Constellation EIS (NASA 2008). Other actions include the placement of new launch support structures, the addition of fuel storage at each launch complex or centrally located between them, development of associated fuel transfer systems between the pads, the addition of a new lightning protection system at LC 39A, and the development of ground support operations for up to ten vehicle types (described below). It is proposed that each launch complex will be able to process and launch one vehicle per month for a total of up to 12 annual launches at each pad, or 24 total annual launches at both pads combined. Launch scheduling will allow a three week preparation time at each complex prior to launch.

The two launch pads may have different configurations, however, they will both have the ability to allow for different ground support equipment and various fuel types depending on the launch vehicle being processed. The pads would be capable of supporting static engine testing for rocket certification and recertification. A HIF is proposed for processing of the multi-user launch vehicles (NASA 2012a). The HIF will require additional infrastructure to transfer processed vehicles to the launch pad. RP-1 fuel storage and transfer systems will be constructed to support multiple users. Construction and operation of the HIF and RP-1 areas are included in the Proposed Action.

RP-1 delivery by railcar is being considered and would require a serviceable railroad. The railroad inside the LC 39A fence and the one outside the LC 39B perimeter fence are non-serviceable and must be replaced. The railroad that runs along Phillips Parkway adjacent to the beach is washed out from storms and is impossible to maintain. The preferred location for construction of a new railroad to replace the existing beach side railroad is down the middle of

Phillips Parkway. This is the recommended railroad route for supply of RP-1 to both launch pads. The recommended route for the common RP-1 location is along Titusville Beach Road, across the Crawlerway, and down Pad B Road.

Both wheeled and rail launch vehicle transporters are being considered to move the launch vehicle from the HIF to the launch pad. Construction of a new road between the Crawlerways would be required for wheeled vehicle transportation of launch vehicle components. The extension of the existing railroad to the chosen HIF site(s) would be necessary for rail delivery of launch vehicle components.

Spacecraft planned for space exploration for the transport of crew, supplies, and payloads into orbit or to the International Space Station (ISS) are also covered in this EA as they are considered part of the complete vehicle at the launch phase. The Orion spacecraft has the capability of being mated with the Delta IV, Liberty or SLS. It is a potential manned spacecraft that can carry a crew of two to four. The Dream Chaser is a crewed suborbital and orbital spaceplane that is proposed to be mated with the Atlas V; it has the capability to transport seven crew members. The Dragon spacecraft is proposed for mating with the Falcon launch vehicles. Tables 2-1 and 2-2 provide details of launch vehicles and spacecraft included in this EA.

Table 2-1. Launch vehicles, stages, and fuels expected to be used for the Proposed Action.

Launch Vehicle	First Stage Primary	Ox / Fuel	Solid Rocket Motor	Second Stage Primary	Ox / Fuel	Payload	Additional Stages
Delta IV Heavy	RS-68 (3)	LOX / LH2	CBC	RL-10B2 (1)	LOX / LH2	Orion	
Atlas V	RD Amdros RD-180	LOX / RP-1	Aerojet (1-4)	Centaur RL-10A (2)	LOX / LH2	CTS-100	
Falcon 9 / Falcon 9 v1.1 / Heavy	Merlin (3)	LOX / RP-1	none	Merlin	LOX / RP-1 (TEA*/TEB pyrophorics for restart)	Dragon	
Liberty	Ares I, 5-segment solid	solid	no additional	Vulcain (2)	LOX / LH2	not selected	
SLS	RS-25 (4-5)	LOX / LH2	5 segment solid rocket booster (2)	J-2X (2)	LOX / LH2	Orion ICPS	
Antares	AJ26 (NK33)	LO2/LH2		30B	Solid		Optional 3rd Stage

Table 2-1. (Continued) Launch vehicles, stages, and fuels expected to be used for the Proposed Action.

Launch Vehicle	First Stage Primary	Ox / Fuel	Solid Rocket Motor	Second Stage Primary	Ox / Fuel	Payload	Additional Stages
RSLV-S	Annular Plug Nozzle	LO2/LCH4		Annular Plug Nozzle	LO2/LCH4		
Athena IIc	120	Solid (HTPB)		120	Solid HTPB		
Xaero	Unknown	LO2/IPA					

CBC = Common Booster Core, ICPS = Interim Cryogenic Propulsion Stage, TEA =Tetraethyl Aluminum, TEB =Triethyl Borane, LH_2 =Liquid Hydrogen, LOX = Liquid Oxygen, HTPB (Hydroxy-terminated polybutadiene, LCH4 = Liquid Methane , IPA = Isopropyl Alcohol.

Table 2-2. Payloads, engines, and propellants expected to be used for the Proposed Action.

Crew Capsule	Engine	Propellant
Liberty CCM	Rocket engine on service module	MMH*, N2O4
CST-100	RS-88	Ethanol, LOX
Dragon	18 Draco Thrusters	MMH, N2O4
Dream Chaser	Hybrid rocket engines/RCS thrusters	HTPB, nitrous oxide/ethanol based fuel
Orion ICPS	Rocket engine on service module Rocket engine on ICPS, RL10B-2 (1)	MMH, N2O4 LOX/LH_2

* MMH (monomethyl hydrazine)

The proposed approach for scheduling, operations, processing, and launch for any user will begin with the customer identifying shared resource requirements, hazards, and major milestones with periodic updates for the anticipated launch. A facility integration meeting between the customer and a NASA operations and maintenance point of contact would facilitate the process of vehicle launch operations. An integrated schedule between the customer and NASA would be utilized to track resources, assess major hazards associated with the proposed launch, and facilitate continued periodic reviews through launch day.

2.1.1 Delta IV Launch Vehicle

The Delta IV is designed to launch medium to heavy payloads and there are five vehicles within this suite of rockets, as shown in Figure 2-1. All five configurations of the Delta IV are based on a common booster core first stage that uses an RS-68 engine powered by liquid hydrogen (LH_2) and liquid oxygen (LOX). The gross weight at lift-off of the Delta IV is 737,994 kilograms (kg)

(1,626,998 pounds [lbs]) and its overall length is 70 meters (m) (230 feet [ft]). Refer to the NASA Routine Payloads EA and the Environmental Impact Statement (EIS) for the Evolved Expendable Launch Vehicle (EELV) Program for specific configurations and fuel requirements (NASA 2011a, USAF 1998).

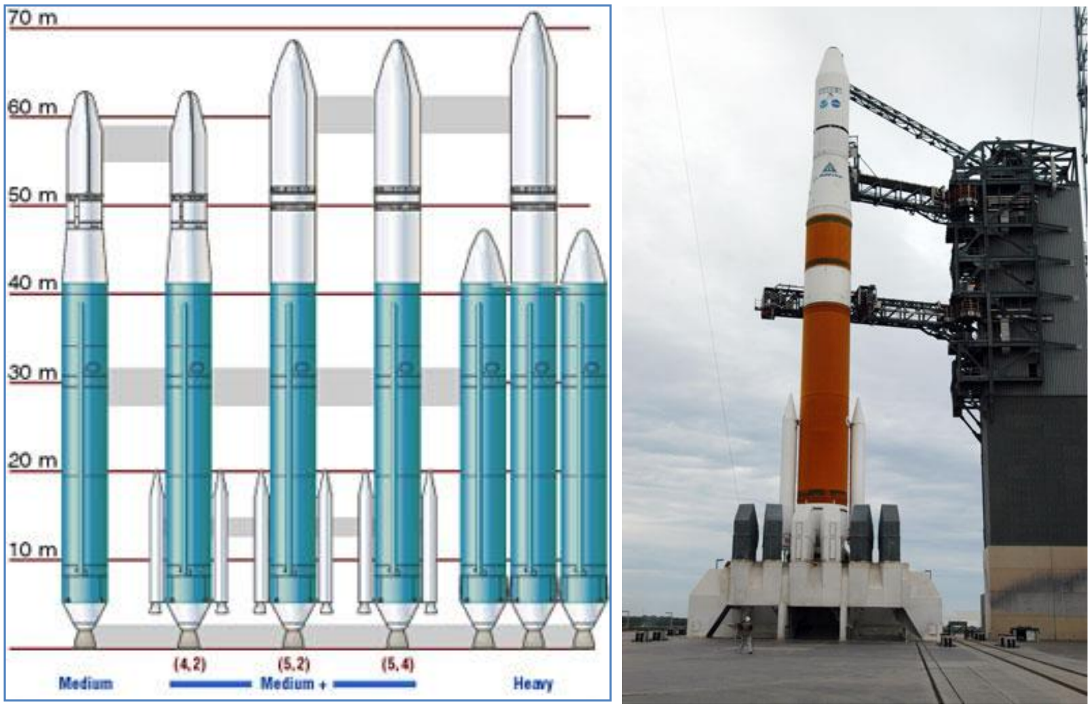


Figure 2-1. Suite of Delta IV rockets sized medium to heavy and photograph of the Delta IV.

2.1.2 Atlas V Launch Vehicle

The Atlas V is also based on the common core booster, however, it uses an RD-180 engine powered by LOX and RP-1, as shown in Figure 2-2. The lift-off weight of the Atlas V is 333,322 kg (734,850 lbs) for the Medium, 961,616 kg (2,120,000 lbs) for the Heavy, and the overall length is 60 m (196 ft). The EIS for the EELV Program describes specific configurations of the Atlas V launch vehicle (USAF 1998).

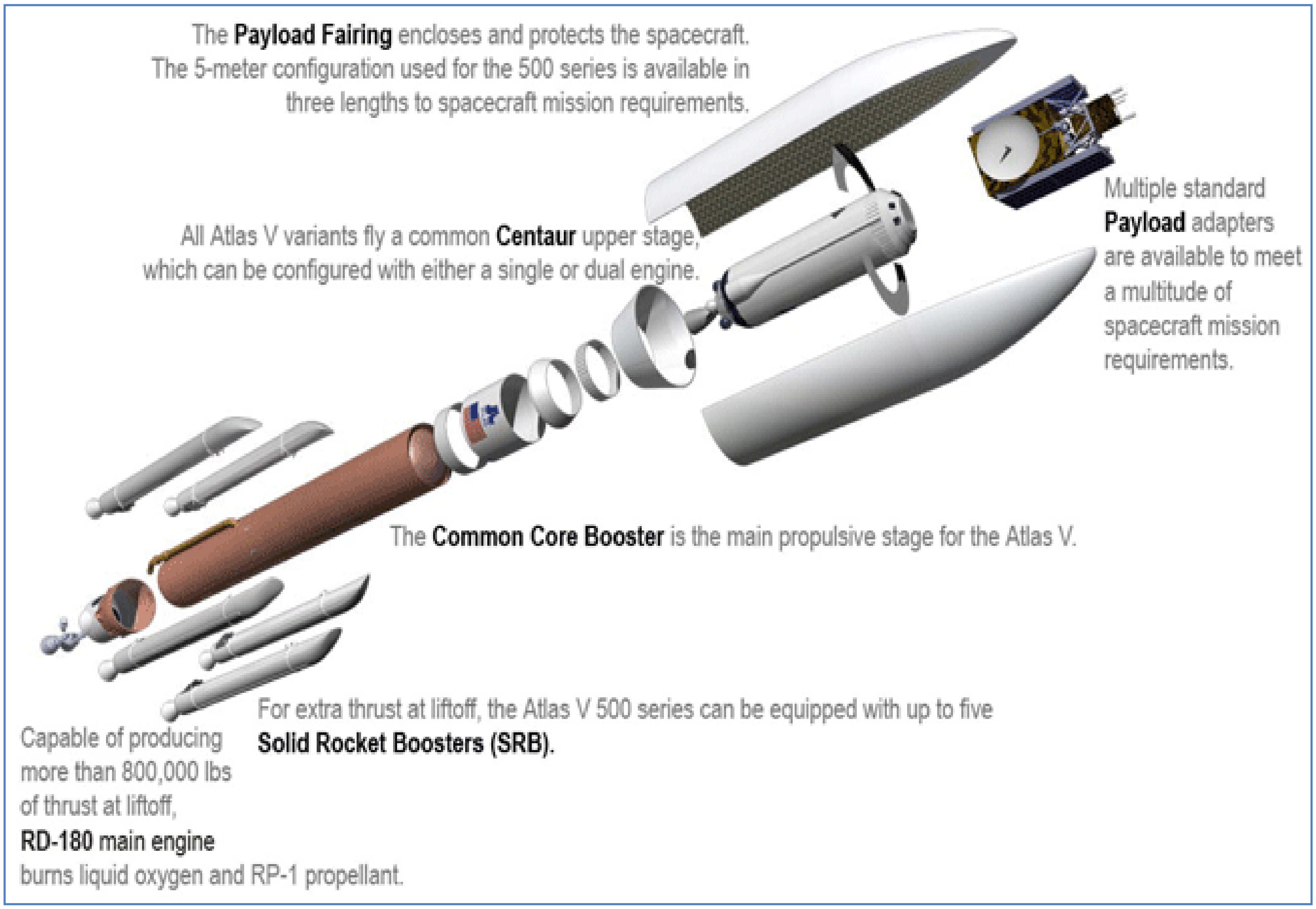


Figure 2-2. Diagram of the segmented Atlas V rocket.

2.1.3 Falcon 9 Launch Vehicle

The Falcon 9 is a medium class rocket with a gross lift-off weight of approximately 315,000 kg (694,456 lbs) and an overall length of 54 m (178 ft). Falcon 9 first stage is powered by nine Merlin engines using LOX and RP-1. The second stage is powered by a single Merlin engine. Refer to the EA for the Operation and Launch of the Falcon 1 and Falcon 9 Space Vehicles at Cape Canaveral Air Force Station (CCAFS) for specific configurations of the Falcon 9 launch vehicle (USAF 2007). A photograph of the Falcon 9 at Cape Canaveral is shown in Figure 2-3. The Falcon 9 v1.1 is a taller, heavier version of Falcon 9 Block 1 with added thrust due to a newer model of the Merlin engine (Figure 2-4). It has a gross lift-off weight of approximately 498,952 kg (1,100,000 lbs) and is 68 m (224 ft) tall.

Figure 2-3. Photograph of Falcon 9 located at CCAFS, Florida.

2.1.4 Falcon Heavy Launch Vehicle

The Falcon Heavy has a gross lift-off weight of 1,400,000 kg (36,864,717 lbs) and an overall length of 70 m (227 ft). Merlin engines are used on both stages of the Falcon Heavy and this is the first rocket in history to feature propellant cross-feed from the side boosters to the center core. Fuels needed for the Falcon Heavy are LOX and RP-1. Refer to the Final EA for the Falcon 9 and Falcon Heavy Launch Vehicle Programs from Space Launch Complex 4 East at Vandenberg Air Force Base (VAFB) (USAF 2011). An illustration of the Falcon Heavy launch vehicle is shown in Figure 2-4.

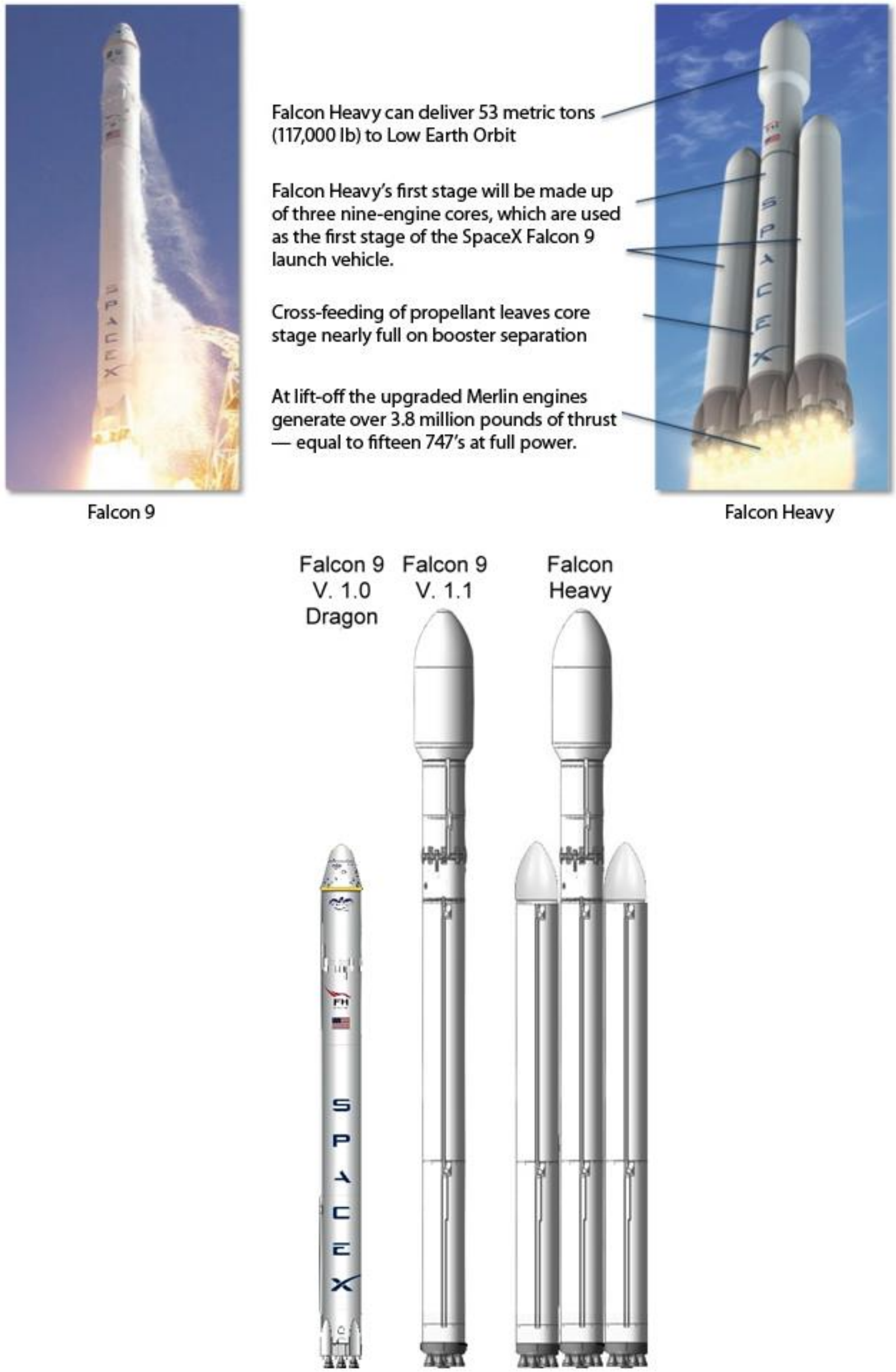


Figure 2-4. Falcon 9, Falcon 9 v1.1, and Falcon Heavy launch vehicles.

2.1.5 Liberty Launch Vehicle

The Liberty is a medium class vehicle that uses an existing stage (ARES 1) with an additional segment and the RS-25 engine, as shown in Figure 2-5. There is a second stage based on the liquid-fueled cryogenic core of the Ariane 5 vehicle powered by the Vulcain 2 engine. Fuels are LOX and LH2. The Liberty vehicle has a gross lift-off weight of 952,000 kg (2,098,801 lbs) and an overall length of 91 m (300 ft).

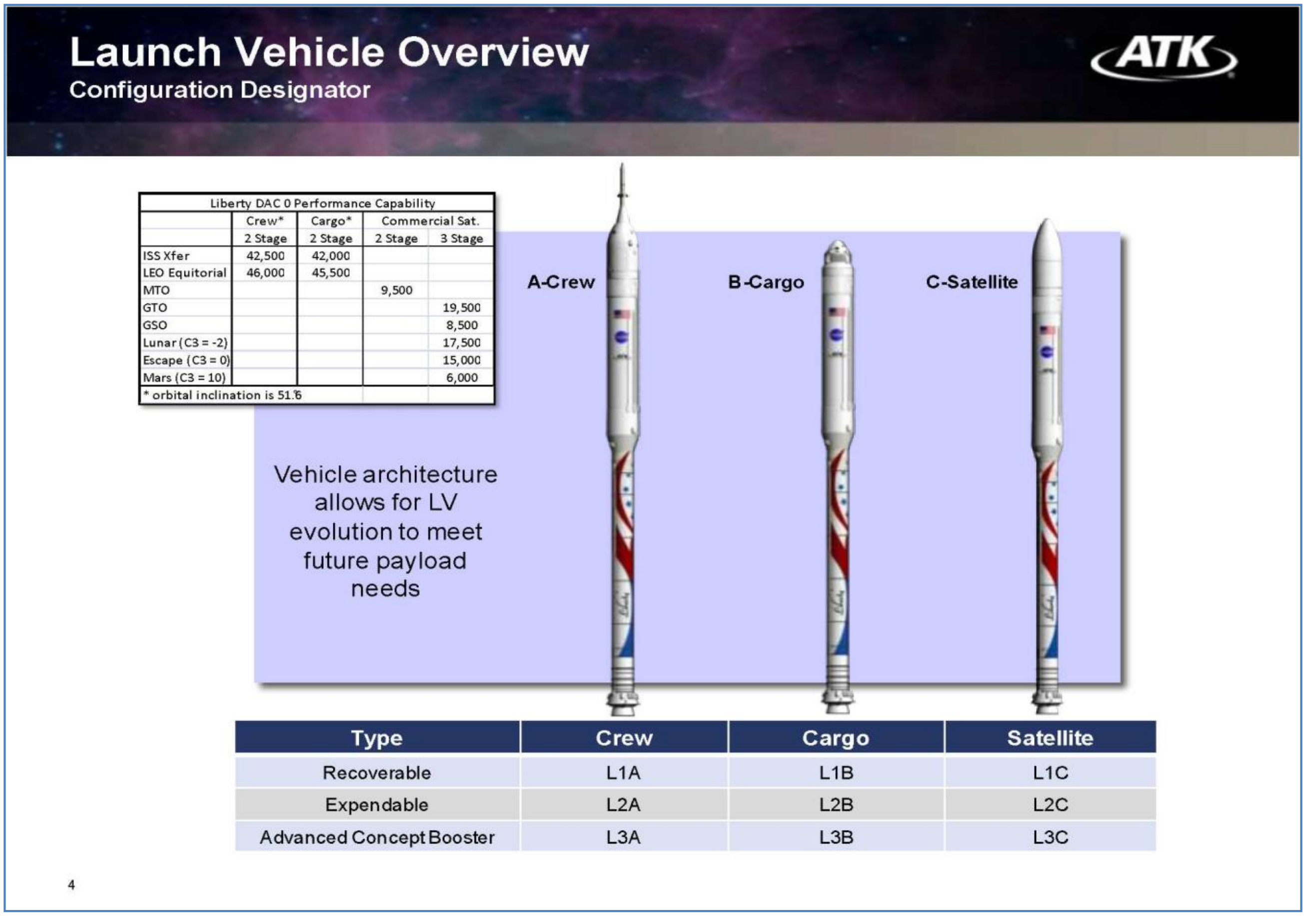


Figure 2-5. Liberty launch vehicle configurations.

2.1.6 Space Launch System Vehicle

The SLS is an advanced heavy lift launch vehicle providing a block upgrade evolvable architecture. The initial 70 metric ton SLS Block 1 configuration stands 97 m (321 ft) tall, provides 8.4 million pounds of thrust at lift-off, weighs 2.49 million kg (5.5 million lbs) and carries 69,850 kg (154,000 lbs) of payload. The Block 1 configuration includes two five-segment solid rocket boosters (SRBs) and a core stage that stores cryogenic liquid hydrogen and oxygen that will feed four RS-25 engines. The Block I configuration also includes the Interim Cryogenic Propulsion Stage (ICPS) which is an existing commercial LO_2/LH_2 upper stage modified to meet NASA human rating requirements. The Block 1A configuration will replace the SRBs with new advanced boosters which may be solid or liquid. The 130 metric ton SLS Block 2 configuration will add an upper stage with two J-2X engines and can incorporate a fifth RS-25 engine in the core stage increasing the thrust at liftoff to 4.17 million kg (9.2 million lbs) with the capability to carry payloads weighing 129,727 kg (286,000 lbs) to orbit. The Block 2 configuration will stand 117 m (384 ft) tall and weighs 2.94 million kg (6.5 million lbs). Figure 2-6 provides an illustration of the SLS launch vehicle configurations.

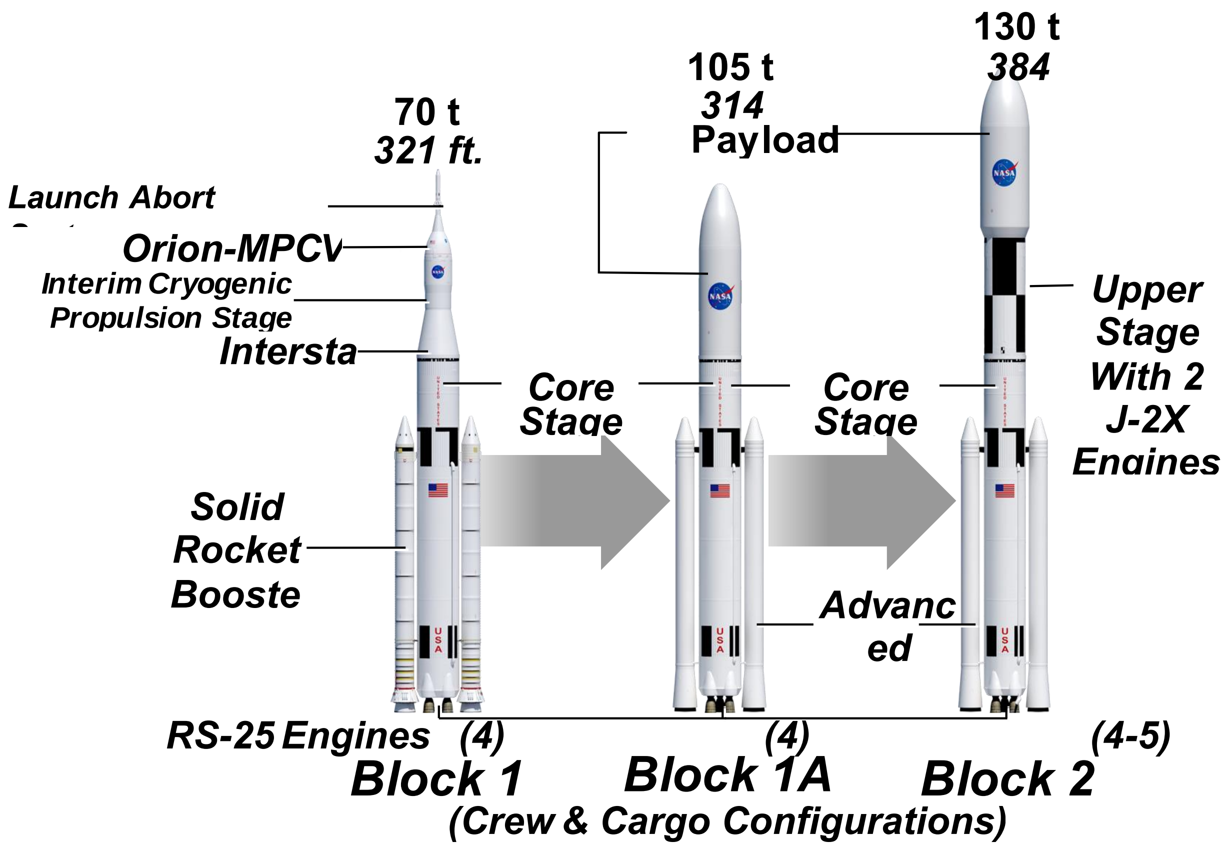


Figure 2-6. SLS launch vehicle configurations.

2.1.7 Antares

The Antares is a medium class launch vehicle built by Orbital Sciences and was formerly known as Taurus. This two staged vehicle with an optional third stage, as shown in Figure 2- 7, provides low earth orbit launch capability for payloads weighing over 5,000 kg (11,023 lbs).

Both liquid and solid stages are incorporated in the Antares which is capable of launching single and multiple payloads. A 3.9 m (13 ft) fairing accommodates large payloads.

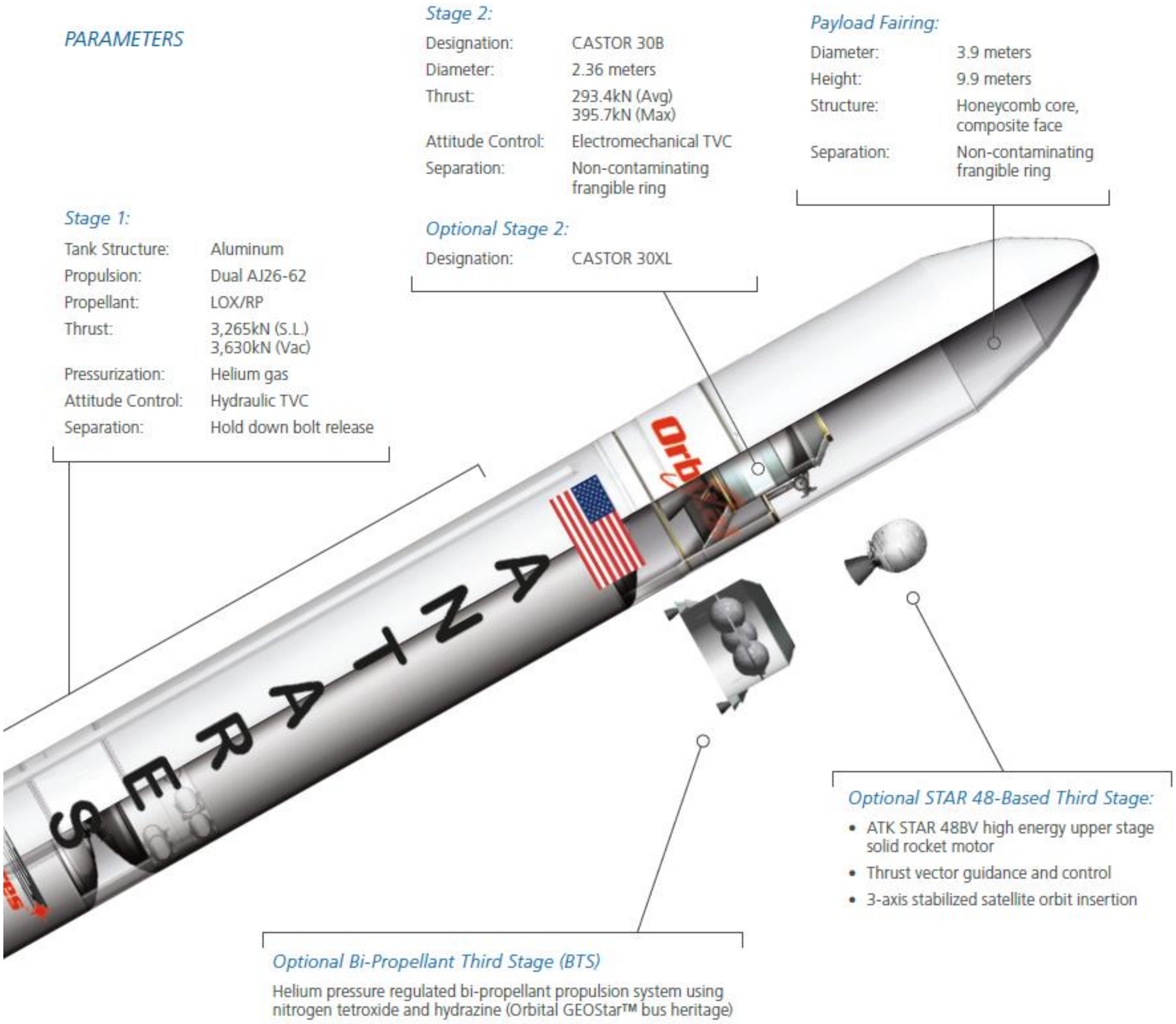
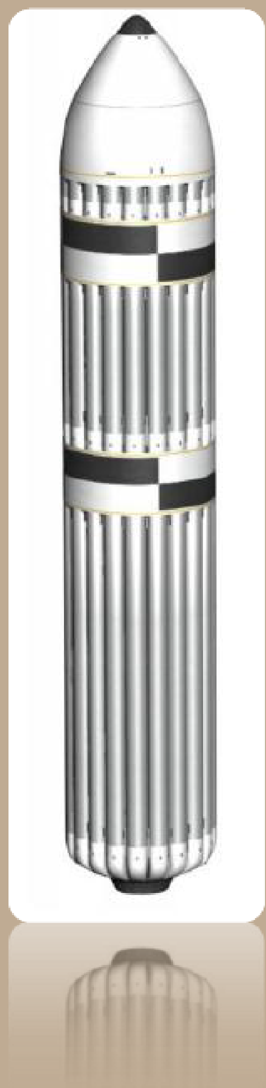


Figure 2-7. Antares launch vehicle.

2.1.8 Radially Segmented Launch Vehicle (RSLV-S)

The uniquely shaped RSLV-S (Figure 2-8) consists of elongated pie-slice shaped segments arranged in a radial configuration for each of its three stages. Individual fuel and oxidizer storage tanks make up each segment and supply individual nozzles at the base of the vehicle. This low cost modular design vehicle, manufactured by KT Engineering (KTE) is expected to significantly reduce the cost of transporting payloads to orbit.

RSLV-S



General	
Manufacturer	**KTE**
Height (ft)	107.4
Diameter (ft)	16
Launch Weight (lbs)	488,300
Thrust @ Sea Level (lbs)	1,000,000
T/W (SL)	2.05
First Stage	
Propellant Type	LO_2 /Liquid Methane (LCH_4)
Oxidizer (Qty)	LO_2 (252,336 lbs)
Fuel (Qty)	LCH_4 (93,385 lbs)
Engine	Annular Plug Nozzle
Engine Nozzle Diameter	72 in
Nozzles per Engine / Qty	1 / 1
Thrust/Engine	100,000 lbs
Second Stage	
Propellant Type	LO_2 / LCH_4
Oxidizer (Qty)	LO_2 (79,135 lbs)
Fuel (Qty)	LCH_4 (29,286 lbs)
Engine	Annular Plug Nozzle
Third Stage	
Propellant Type	LO_2 / LCH_4
Oxidizer (Qty)	LO_2 (50,336 lbs)
Fuel (Qty)	LCH_4 (18,628 lbs)
Engine	Annular Plug Nozzle
Commodities & Requirements	
Secondary Commodity	GN_2
Attachment Method	Launch Mount as Vehicle Base
Elevation of Commodity Connections	Vehicle Bottom Plane
Connection Requirements	Service mast with umbilical each stage, no stabilizers, all T-0
Erection Requirements	Horizontally assembled, roll out to pad in horizontal configuration. Rotate to vertical with transporter erector
Umbilical Requirements	Unknown
Access Requirements	Unknown
Support Structures/GSE	Unknown
Reference: NASA (Ref [2]) / KT Enginering (Ref [2])	

Figure 2-8. Radially Segmented Launch Vehicle (RSLV-S).

2.1.9 Athena IIc

The Athena IIc is a single core solid launch vehicle developed by Lockheed Martin. A 237 cm (92 in) fairing accommodates a wide range of spacecraft. The first and second solid stages are powered by CASTOR 120 engines while the third stage, also solid, incorporates the new CASTOR 30 (Figure 2-9). Athena IIc is capable of lifting up to 1,712 kg (3,775 lbs) to low earth orbit. Satellites weighing 5900 kg (13,000 lbs) can be launched from the east coast.

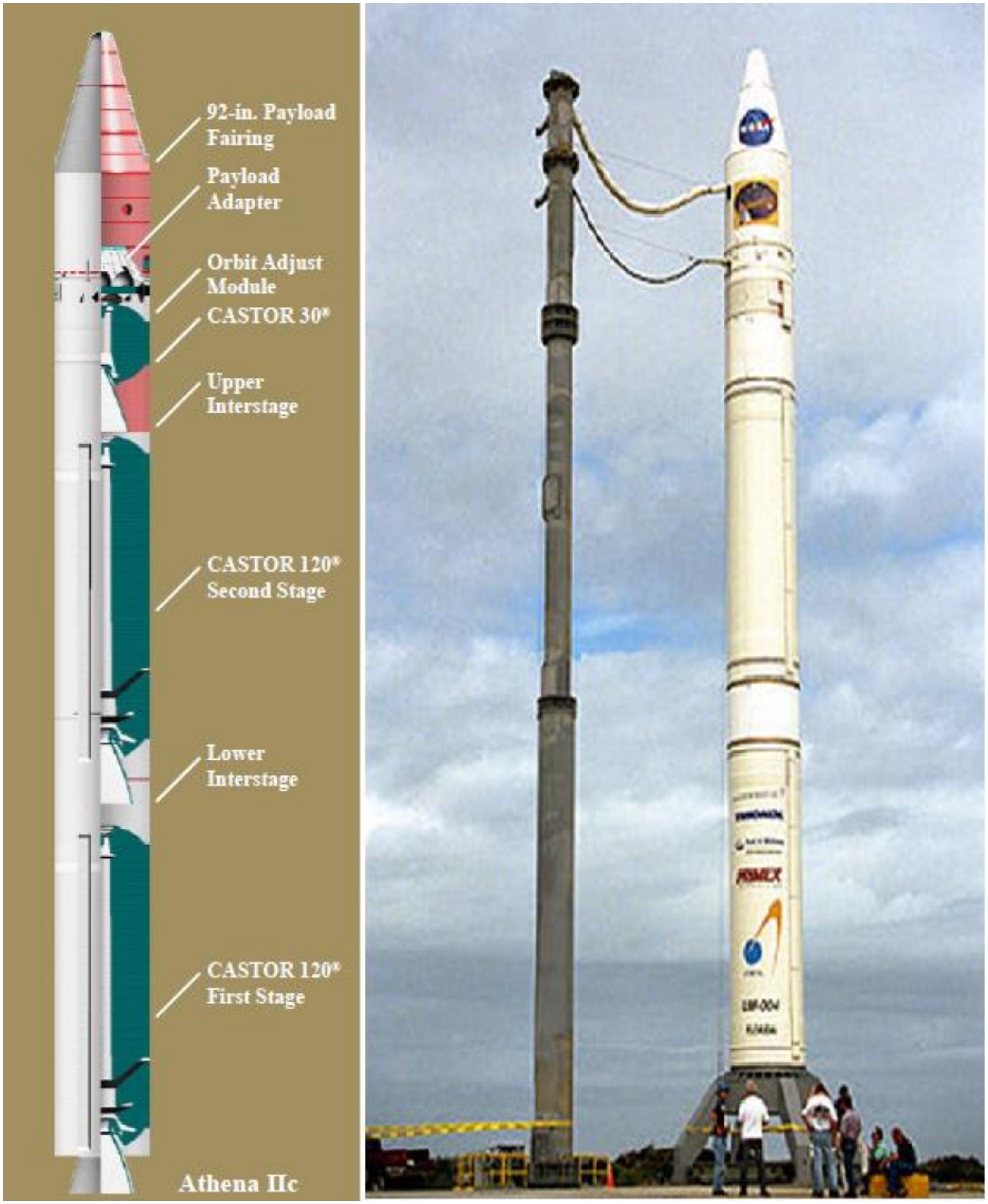


Figure 2-9. Athena IIc launch vehicle shown at LC-46 in CCAFS.

2.1.10 Xaero

Xaero is a small class vehicle under development by Masten Space Systems (Figure 2-10). This vertical takeoff vertical landing vehicle is expected to be capable of carrying a 10 kg (22 lbs) payload to approximately 30 kilometers (km) (100,000 ft). It uses aerodynamic “petals” to slow down on return to earth.

Figure 2-10. Xaero launch vehicle.

A size comparison of the various launch vehicles mentioned above is shown in Figure 2-11.

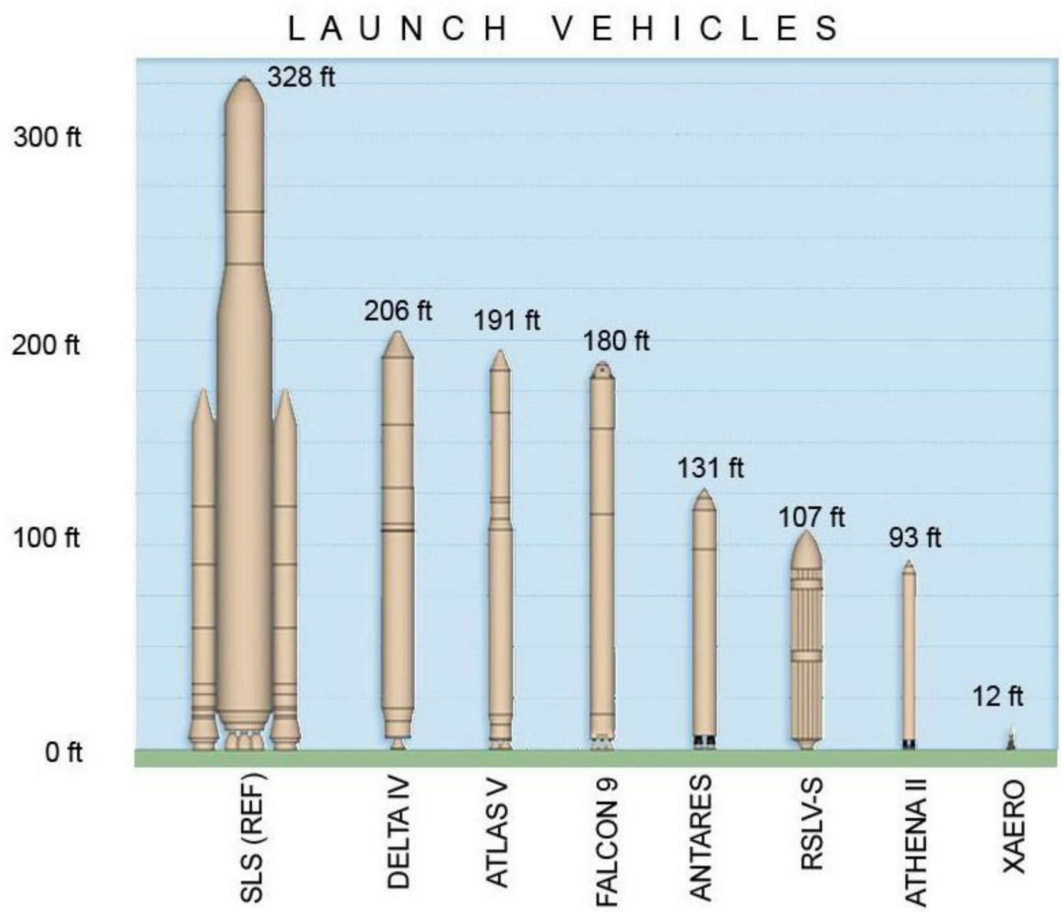


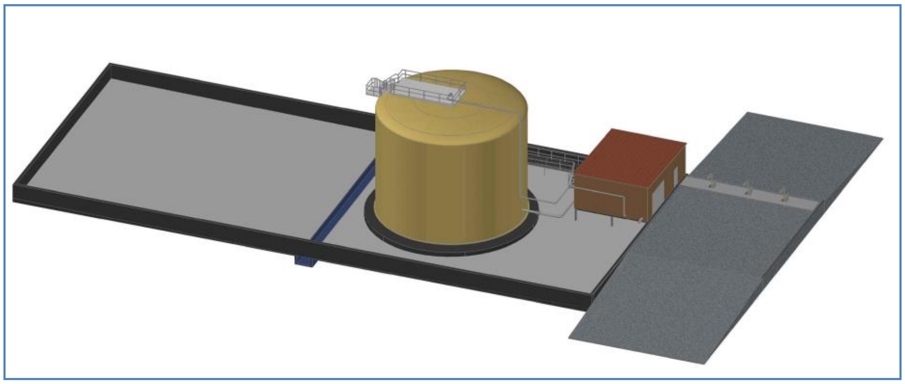
Figure 2-11. Small and Medium Class Launch Vehicle relative sizes.

2.2 RP-1 Storage and Transfer

Historically, both LC 39A and LC 39B had complete RP-1 storage and transfer systems within the complexes; these have been dismantled and removed. The portion that remains is a run of 20 cm (8 in) pipe at LC 39B. The RP-1 study addressed the addition of RP-1 storage and delivery systems to each complex (Option 1), or the addition of a common, centrally located storage facility (Option 2), which would deliver RP-1 to each complex (NASA 2012b).

The Proposed Action would include the installation of two 1,892,706 liters (l) (500,000 gal) RP-1 systems, one at each launch complex (Option 1) or a common storage tank (Option 2) of 378,541 l (100,000 gal) with the option to add four additional tanks, for a total of 1,892,706 l (500,000 gal) storage volume.

The recommended RP-1 locations at each launch complex (Option 1) are the former RP-1 storage and distribution areas. For the common storage location (Option 2), the recommendation is to use an area at the northeast corner of the Pad B Road and Pad A Emergency Road intersection. Selected renderings of the RP-1 common storage site are provided in Figure 2-12.



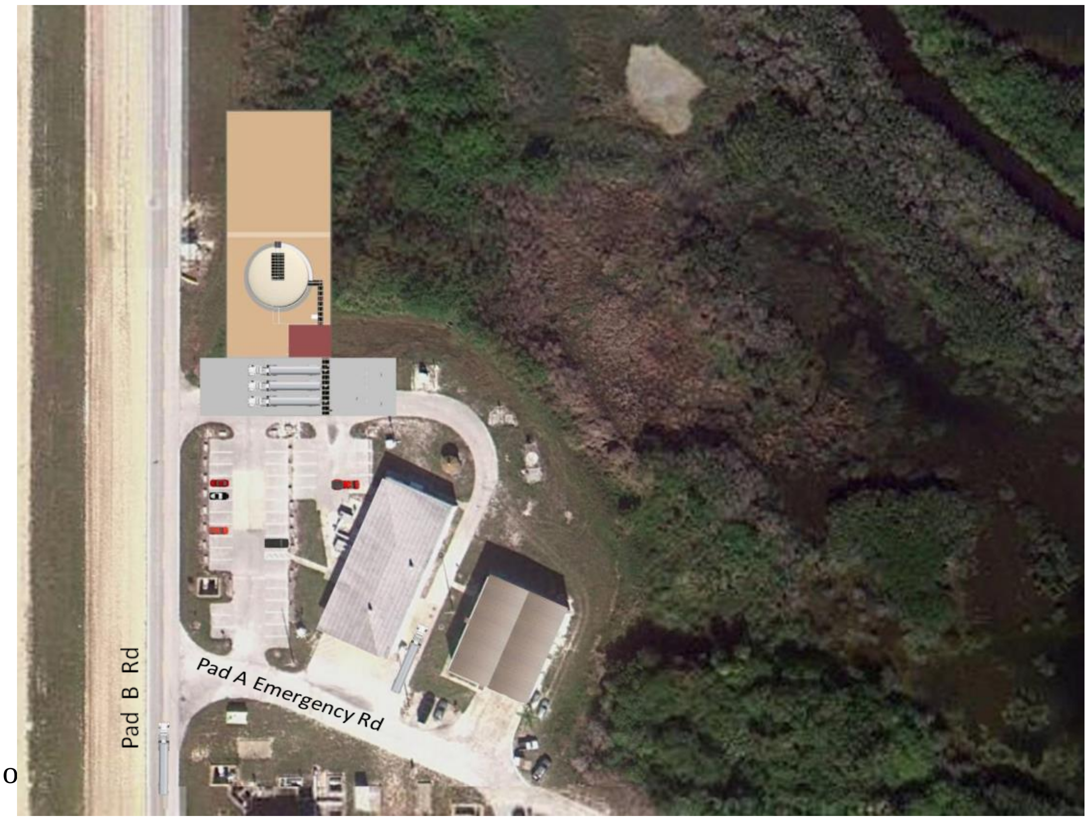


Figure 2-12.
intersection o

2.3 Horizontal Integration Facility

A study was conducted in 2012 to determine the need for a new HIF that would be used by customers to prepare launch vehicles in a horizontal configuration. The existing railway system would need additional tracks in order to receive the sections of the vehicle that would arrive via railway. Five proposed HIF sites (Options 1-5) are evaluated in this EA (including one at LC 39A) and are shown in Figure 2-13. The five HIF option locations are all accessible from State Road (SR) 3 and Saturn Causeway. HIF Option 1 is also accessible from Ordnance Road, Launcher Road, and Converter Compressor Road. HIF Options 2 and 3 are both located along the north side of Saturn Causeway, and most of HIF Option 1 and all of HIF Option 4 are located along the south side of Saturn Causeway. HIF Option 5 is located at the east end of Saturn Causeway along Pad A Perimeter Road.

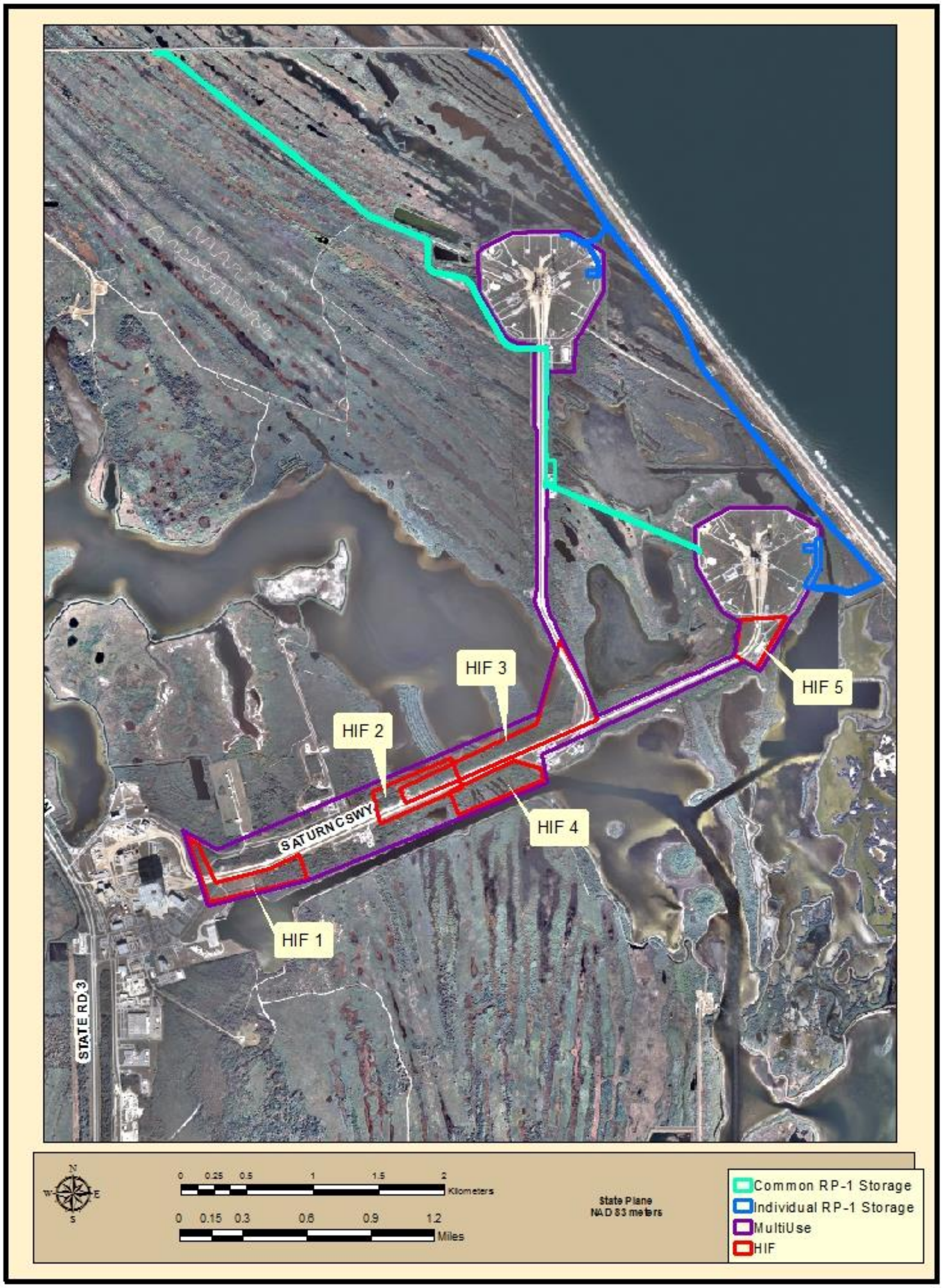


Figure 2-13. Location of proposed RP-1 storage and transfer areas, and five HIF sites.

2.4 Scope of the Environmental Assessment

Resources analyzed in detail were:

- Land Use
- Facilities and Infrastructure
- Health and Safety
- Water Quality
- Atmospheric Environment
- Noise and Vibration
- Biological Resources
- Geology and Soils
- Historic and Cultural Resources
- Hazardous Materials and Waste Management
- Global Environment
- Socioeconomics and Children's Environmental Health and Safety
- Orbital and Reentry Debris
- Aesthetics

This draft EA does not analyze potential impacts to the following environmental resource areas in detail, for the reasons explained below:

Wild and Scenic Rivers – There are no wild and scenic rivers (as designated by the Wild and Scenic Rivers Act) located within or near the proposed construction or operating areas. The nearest wild and scenic river, the Wekiva River, is approximately 85 km (53 miles [mi]) west of KSC.

Farmlands – There are no prime or unique farmlands as defined by the Farmland Protection Policy Act located at KSC.

2.5 No-Action Alternative

Under the No Action Alternative, NASA would not allow multiple users to launch vehicles from either LC 39A or LC 39B. There would be no construction of a HIF or the need for additional RP-1 storage. The vehicles covered in this EA would not be launched from LC 39A or LC 39B.

2.6 Alternatives to the Proposed Action

There were no additional alternatives considered for this EA that were carried forward.

3.0 Affected Environment

3.1 Introduction

This section provides a description of the current state of the environment and resources that would be affected by the Proposed Action.

3.2 Land Use

Land use can be defined as the human use of land resources for various purposes including economic production, natural resources protection, or institutional uses. Land uses are frequently regulated by mission objectives, program/project plans, policies, ordinances, and regulations that determine the types of uses that are allowable, or protect designated or environmentally sensitive land. LC 39A and LC 39B are bound by NASA's land use regulations.

Land and open water resources of KSC comprise 57,400 ha (142,000 ac) in Brevard County and Volusia County, and are located along the east coast of central Florida at approximately 28° 38'N, 80° 42'W (NASA 2010). The majority of the KSC land areas are located on the northern part of Merritt Island, which forms a barrier island complex adjacent to Cape Canaveral (NASA 1979). Undeveloped areas (uplands, wetlands, mosquito control impoundments, and open water) comprise approximately 95% of KSC. Nearly 40% are open water areas of the Indian River Lagoon system, including portions of the Indian River, Banana River, Mosquito Lagoon, and all of Banana Creek (NASA 2010).

KSC was established under NASA jurisdiction for the purpose of implementing the Nation's space program (National Space Act 1959). NASA maintains operational control over approximately 1,787 ha (4,415 ac) of KSC (NASA 2010). These are the operational areas, which are dedicated to NASA ground processing, launch, and landing activities, and include facilities and associated infrastructure such as roads, parking areas, and maintained right-of-ways. Undeveloped lands within the operational areas are dedicated safety zones or are reserved for planned and future expansion.

The overall land use and management objectives at KSC are to maintain the Nation's space mission operations while supporting alternative land uses that are in the Nation's best interest. This EA considers impacts under Section 4(f) of the Department of Transportation (DOT) Act, which has been recodified and renumbered as 49 U.S.C. Section 303(c). Any project that receives funding from or requires the approval of the DOT, including the FAA approval of a license or permit, must be analyzed for compliance with Section 4(f). In accordance with FAA Order 1050.1E, Change 1, the FAA will not approve any program or project that requires the use of any Section 4(f) property determined by the officials having jurisdiction thereof, unless no feasible and prudent alternative exists to the use of such land and such program, and the project includes all possible planning to minimize harm resulting from the use. Section 4(f) properties include publicly owned parks, recreation areas, and wildlife or waterfowl refuges, or any publicly or privately owned historic site listed or eligible for listing on the National Register of Historic Places (NRHP). When private institutions, organizations, or individuals own parks, recreational areas, or wildlife and waterfowl refuges, Section 4(f) does not apply to these properties, even if such areas are open to the public. However, a privately owned property may be protected under Section 4(f) when it is located on long-term leased public land or a public easement.

KSC LC 39A, LC 39B, the Crawlerway, and a portion of the KSC railroad track are listed on or eligible for listing on the NRHP, making them Section 4(f) properties. Section 4(f) properties located at KSC but further from the Launch Complex include the Vehicle Assembly Building, Launch Control Center, Press Site Clock and Flag Pole, Central Instrumentation Facility, Headquarters Building, and Operations and Checkout Building, all of which are listed on the NRHP. See Section 3.4.7 for a discussion of historic sites.

Section 4(f) properties directly adjacent to KSC include CCAFS (listed on NRHP), Merritt Island National Wildlife Refuge (MINWR), and Canaveral National Seashore (CNS). MINWR and CNS property within KSC boundaries are also considered Section 4(f) properties. Additional Section 4(f) properties are listed in Section 3.2.1. KSC land use is carefully planned and managed to provide required support for missions while maximizing protection of the environment. Land planning and management responsibilities for areas not directly utilized for NASA operations have been delegated to the USFWS at MINWR and the National Park Service (NPS) at CNS. This unique relationship between space flight and protection of natural resources is carefully orchestrated to ensure that both objectives are achieved with minimal conflict.

The designation of MINWR and CNS, in 1963 and 1975, respectively, on the 54,723 ha (135,225 ac) outside of NASA's operational control reflects this mutually beneficial objective. Both MINWR and CNS effectively provide a buffer zone between NASA operations and the surrounding communities. The NPS administers a 2,693 ha (6,655 ac) area of the CNS, while the USFWS administers the remaining 52,030 ha (128,570 ac) of the CNS and MINWR. The USFWS and NPS exercise management control over agricultural, recreational, and environmental programs within their respective jurisdictions at KSC, subject to operational requirements defined by NASA, such as temporary closures for launch and landing-related activities (NASA 2010). NASA remains the landowner and retains the authority to remove lands or construct facilities within MINWR or CNS as needed to support the space program.

LC 39A was constructed in 1965 and LC 39B in 1966 to support the Apollo Program; both complexes were later modified for the Shuttle Program. The launch complexes have been utilized for rocket and Shuttle launch purposes, including operations and maintenance support, since their construction. In 2011, LC 39B was deactivated and the launch tower removed. The pad hardstand itself and the remaining complex features are still present and would be modified to allow for the Proposed Action.

NASA has devised eleven land use categories to describe regions within which various types of operational or support activities at KSC are conducted. Most of the area within LC 39A and LC 39B perimeter fencing is given the land use designation of Launch (LA). Some areas within the complexes are set aside for Spaceport Management (SM). Land surrounding the launch complexes is designated as CO for conservation which includes undeveloped land, impoundments, and water bodies. The Crawlerway is in the Launch Support (LS) land use category. Most of the area on either side of the Crawlerway is part of MINWR (designated as CO). Other areas adjacent to the Crawlerway have been developed with facilities for launch support. Land within the LC 39 area that has been removed from MINWR, but is not yet developed, is considered Open Space (OS) (NASA 2010). Some of these designated land uses will change if the Proposed Action is taken, and these changes are described in Section 4.0, Environmental Consequences.

3.2.1 Surrounding Land Use

Major municipalities in the immediate vicinity of KSC include Titusville and Merritt Island. Titusville is located on the western shore of the Indian River, on the mainland, approximately 19 km (12 mi) from LC 39A and LC 39B. The unincorporated community of Merritt Island is south of KSC and its northern limit is approximately 17 km (10 mi) from the launch complexes. Land use is primarily agriculture and residential. Brevard County has zoned the SR 3 corridor as agriculture, rural, residential, and industrial. Agricultural areas are dominated by citrus groves, and industry in this area is limited to a gaseous nitrogen (GN_2) manufacturing plant adjacent to KSC property on the west side of SR 3. This plant is a strategic facility from which nitrogen is piped directly to KSC and CCAFS where it is used to support various payloads, Titan, and Atlas facilities. The GN_2 creates an inert environment and is used to purge the vehicles during fueling operations. In addition, the GN_2 is used with communication and camera boxes around the launch pads to prevent condensation and corrosion, and protects electrical components that must be made explosion-proof by rendering them inert.

In addition to the 4(f) properties identified above in Section 3.2, 4(f) properties located in the vicinity of KSC include local parks in Titusville and Merritt Island, St. John's NWR, and NRHP-listed sites in Titusville (Titusville commercial district, four houses, two churches, and a cemetery).

3.2.2 Coastal Zone Management

Because KSC is a federal facility, its activities are not subject to Florida's Coastal Zone Management Act (CZMA) of 1972. However, NASA and other federal agencies are required to review their activities with regard to direct effects on the coastal zone and are responsible for making the final coastal zone consistency determinations for these activities. Florida's state-wide coastal management program, executed by the Florida Department of Environmental Protection (FDEP), oversees activities occurring in or affecting the coastal zone and is based on a network of agencies implementing 24 statutes protecting coastal resources.

The CZMA provides for management of our Nation's coastal uses and resources by encouraging coastal states to develop and implement comprehensive management programs that balance the need for coastal resource protection with the need for economic growth and development in the coastal zone. Once a management program is developed and approved by the National Oceanic and Atmospheric Administration (NOAA), the state is authorized to review certain federal activities affecting the land, water uses, or natural resources of its coastal zone for consistency with the program. This authority is referred to as "federal consistency". The Florida Coastal Management Program (FCMP) was approved by NOAA in 1981 and is codified in Chapter 380, Part II, F.S.

3.3 Facilities and Infrastructure

Facilities located in the LC 39 Area include the Shuttle Landing Facility (SLF), Orbiter Processing Facilities (OPF) 1, 2, and 3, Vehicle Assembly Building (VAB), Launch Control Center (LCC), Transporter/Crawler, Mobile Launch Platform (MLP), Operations Support Buildings (OSB) 1 and 2, Processing Control Center (PCC), Logistics Facility, LC 39A, LC 39B, and the Press Site. These facilities and associated infrastructure have historically been used in support of rocket and Shuttle launches. They are maintained by KSC and will be available to support the Proposed Action.

There are approximately 563 active facilities located on KSC including space vehicle storage and testing facilities, chemical storage buildings, launch complexes, processing areas, laboratories, and offices. There are an additional 49 facilities used by NASA that are located on CCAFS. Equipment and personnel in all of these facilities provide a variety of functions in support of the KSC mission, including the following:

- Assemble, integrate, and validate payloads, including ISS elements and upper stage boosters
- Conduct launch, recovery, and landing operations
- Design, develop, construct, operate, and maintain each launch and landing facility and the associated support facilities
- Maintain ground support equipment required to process launch vehicle systems and their associated payloads
- Partner with DoD launch activities and provide logistics support to CCAFS, Patrick Air Force Base, VAFB, and various contingency and secondary landing sites around the world
- Research and develop new technologies to support space launch and ground processing activities
- Provide government oversight and approval authority for commercial expendable vehicle launch operations

LC 39A and LC 39B have historically been NASA-operated facilities. The area was undeveloped prior to the mid-1960s when construction for the Apollo Program began at LC 39A. Each launch complex is comprised of 65 fenced ha (160 ac). Retrofitted in 1975 to support the Shuttle Program, LC 39A encompasses 6,161 m^2 (66,211 ft^2). LC 39A is the southernmost of the two Shuttle launch sites situated along the eastern boundary of KSC. A concrete ramp, inclined at a 5% grade, leads from the end of the Crawlerway just inside the launch complex perimeter to the pad. The pad surface is raised 12.8 m (42 ft) above ground level and consists of the flame trench, a high-pressure gas storage enclosure, Pad Terminal Connection Room, and the Environmental Control System room. During the Shuttle era, when a Shuttle was on the pad there were several hundred low-pressure and high-pressure sodium, incandescent, and fluorescent lights on the structures and perimeter fence to assist security personnel in performing routine security checks. Many of the lights on the LC 39A launch structure have been removed or replaced with low intensity amber lights.

The structure of Pad B was retrofitted to support Shuttle operations in 1975. The northernmost of the two LC 39 sites, LC 39B encompasses 5,350 m^2 (57,589 ft^2) and its construction was similar to LC 39A. The launch tower was removed in 2010 in support of the Constellation Program, which was subsequently cancelled. Most of the lights on LC 39B were removed with the tower or turned off. The three 161 m (528 ft) lightning protection towers around the remaining concrete launch pad have FAA–required synchronous flashing lights (three high pressure sodium lights per level at two levels on each tower).

3.3.1 Water Supply and Treatment

KSC is a non-community, non-transient, subpart H public water system registered with FDEP as System 3054024. Potable water at KSC meets all Federal and State requirements for testing and quality. Water is supplied by the City of Cocoa, which obtains its water from artesian wells located west of the St. Johns River in Orange County, and surface water from the Taylor Creek Reservoir. Water enters KSC along SR 3 from a 60 cm (24 in) water main and extends north along SR 3 to the VAB Area. The average demand for water is 4.5 million l/day (1.2 million gallons [gal]/day). Various storage systems and secondary pump systems across KSC supply water necessary for fire suppression, launch activities, and potable water (NASA 2010). Some areas at KSC that are too distant from the distribution for cost effective connection have well water provided. Additionally, well water is used for some industrial purposes at KSC including service to the LOX spheres at LC 39A and LC 39B. Wells are registered with the State of Florida either through the St. Johns River Water Management District (SJRWMD) or the Florida Department of Health.

3.3.2 Wastewater Treatment

To manage domestic wastewater, KSC operates a collection and transmission system that transports wastewater to the Cape Canaveral Regional Waste Water Treatment Facility (RWWTF) located on CCAFS and operated by the Air Force under Permit FL0102920.

Domestic wastewater processed by the RWWTF meets all Federal and State requirements for testing and quality. There are also a number of septic tank systems throughout KSC that typically support small offices or temporary facilities (NASA 2010). Many of these systems were built prior to formal regulation of septic tanks and no permits exist. Other tanks are permitted by the Florida Department of Health as required. All systems are operated to meet State requirements.

Industrial wastewater at KSC is either managed under permit from FDEP; or is exempt from permitting as described in the Kennedy Industrial Wastewater Inventory. Two FDEP industrial wastewater permits for launch related deluge and washdown water were surrendered in 2012. These permits, one for each launch complex, detailed the collection, treatment, and disposal of acidic water resulting from the solid rocket exhaust. Water collected was neutralized to a prescribed pH, sampled for a variety of parameters, and then discharged to infiltration basins at the launch complex for disposal. Groundwater monitoring in the vicinity of the infiltration basins was also required to evaluate migration of treated water offsite. A study evaluating the cost and effectiveness of three treatment and/or disposal options for future industrial wastewater is being prepared. The three options for disposal include 1) renew permits for the systems as they were previously operated, 2) cleaning, storing, and reusing the water for future launches, and 3) constructing a new wastewater transmission system to connect the systems to the RWWTF. These three options are presented in order of increasing cost based on a review of the draft study.

3.3.3 Stormwater Collection

Impervious areas constructed after 1992 are subject to the rules of the SJRWMD to provide for the treatment of pollutants and the attenuation of potential flooding impacts. As facilities are improved, stormwater systems must be built or upgraded to be consistent with the requirements of SJRWMD Rule 40C-4, F.A.C. On KSC, roadways are drained to swale systems that remove potential floodwater from the road surfaces. There are over 100 surface water management systems controlling stormwater runoff at KSC. Regional systems serve the Industrial Area, VAB Area, and the SLF.

The deluge basin areas located in the northern sections of LC 39A and LC 39B are graded to divert surface runoff from the pads and flame trenches to the previously permitted industrial wastewater treatment system. Water collected by the industrial wastewater system is pumped to the same infiltration basins used by the system without treatment under agreement with FDEP.

There are numerous grassy swales around each launch complex through which water discharges via culverts to swales that run along the perimeter access roads. At LC 39A, the access road swale discharges to receiving waters located around the periphery of the complex, including marsh areas, impounded wetlands, Pintail Creek, and Broadaxe Creek.

Most of the drainage swales at LC 39B discharge to mosquito control impoundments, including T-27-D to the north, and T-33-A, B, and C to the south and southeast.

3.3.4 Electricity and Natural Gas

The electric power distribution system at KSC is a combination of a Florida Power and Light (FPL) transmission system and two NASA-owned distribution systems. FPL transmits 115 kilovolts (kV) to KSC, which are distributed to two major substations. The C-5 substation serves the LC 39 Area, providing 13.8 kV, and the Orsino substation serves the Industrial Area, providing 13.2 kV, for a total of 25% of the electricity currently allocated to KSC. A FPL solar site located in the Industrial Area has been providing approximately 1 megawatt of power directly to KSC since late 2009. In 2011, electricity consumption on KSC was 249,607,927 kilowatt hour (kWh) (E. Schoen pers. comm., August 2012).

In 1994, KSC began converting some facilities, equipment, and vehicles to natural gas. A 40 km (25 mi) pipeline was constructed by City Gas Company of Florida, and distributes the gas throughout KSC. In 2011, natural gas usage reached 2,916,703 therms (E. Schoen pers. comm., August 2012).

3.3.5 Communications

The KSC communications system provides a variety of services including conventional telephone services, transmission of voice data and video, and operation and maintenance of KSC's cable plant. There are three major distribution and switching stations located in the Industrial Area (First Switch) and in the VAB Area (Second and Third Switches). These three stations provide service for over 18,500 telephones on KSC.

3.3.6 Solid Waste

General solid refuse such as putrescible waste and office trash is collected by a private contractor at KSC and currently taken to the Brevard County Landfill, a 78 ha (192 ac) Class I landfill located near the City of Cocoa, for disposal. In 2009, the landfill received 1.3 million kg (1,400 tons) of waste per day, of which less than 1% came from KSC and CCAFS (http://ww3.brevardcounty.us/swr/landfilltour.cfm). The Brevard County landfill is expected to be able to accommodate needs until 2015. KSC has an unlined Class III landfill with permit restrictions that allow only certain types of waste and limit the capacity. Putrescible waste and general office trash are among the types of waste not permitted at the KSC Class III landfill. The life expectancy of the KSC landfill is 13 – 49 years. This is based on assumed disposal rate scenarios of 317,514 kg (350 tons) per day (13 years) or 81,647 kg (90 tons) per week (49 years) (NASA, 2010). Arrangements would need to be made for disposal of wastes not accepted at the KSC Class I landfill to an approved offsite waste disposal facility. A list of authorized solid wastes that can be disposed of at the KSC Class I landfill can be found in Section 13 of the NASA document KNPR 8500.1.

3.3.7 Transportation

KSC is serviced by over 340 km (211 mi) of roadways, with 263 km (163 mi) of paved roads and 77 km (48 mi) of unpaved roads. NASA Causeway is the primary entrance and exit for cargo, tourists, and personnel. The four-lane road originates on the mainland in Titusville as SR 405 and crosses the Indian River Lagoon onto KSC. After passing through the Industrial Area, the road reduces to two lanes of traffic, crosses the Banana River, and enters CCAFS. The major north-south artery for KSC is Kennedy Parkway (SR 3). It can be accessed from the north where it intersects with US 1 south of Oak Hill and from Titusville via SR 406/402. The southernmost entrance and exit for KSC is SR 3 on north Merritt Island. LC 39A may be accessed from SR3 and Saturn Causeway or via Phillips Parkway and Pad A By-Pass Road (Figure 3-1). LC 39B may be accessed from SR 3 to Saturn Causeway and Pad B Road, or via Phillips Parkway and Pad B By-pass Road. Pad A Emergency Road connects LC 39A to Pad B Road. LC 39B may also be accessed from the north via Patrol Road and Titusville Beach Road, which connect to an unnamed road that intersects the Crawlerway.

RP-1 individual storage and transfer facilities (Option1) are located within LC 39A and LC 39B perimeters. The combined RP-1 facility (Option 2) is proposed for an area east of the Crawlerway and north of the Industrial Water Pumping Station and Fire Station #3. This site would be accessed from SR 3 to Saturn Causeway and Pad B Road or Phillips Parkway and Pad B By-Pass Road to Pad B Road. The common RP-1 location may also be accessed from Pad A via Pad A Emergency Road to Pad B Road. The five HIF option locations are all accessible from SR 3 and Saturn Causeway. HIF Option 1 is also accessible from Ordnance Road, Launcher Road, and Converter Compressor Road. HIF Options 2 and 3 are both located along the north side of Saturn Causeway, and most of HIF Option 1 and all of HIF Option 4 are located along the south side of Saturn Causeway. HIF Option 5 is located at the east end of Saturn Causeway along Pad A Perimeter Road.

Construction of the KSC Railroad was completed in 1965. In 1983, NASA purchased the 7.5-mile spur west of Wilson's Corner, and undertook the complete operation and maintenance of the railroad, including the tracks, the Jay Jay Bridge, and crossings (ACI 2012). The west boundary of the railroad is the point where the track meets the Florida East Coast line in Titusville. The NASA Railroad crosses the Indian River via the Jay Jay Bridge. The track then extends east for approximately 11.3 km (7 mi) to Wilson's Corner (roughly the intersection of State Highway 402 and Kennedy Parkway North). The west branch of the railroad, with a length of 17.7 km (11 mi), extends from Wilson's Corner to the KSC Industrial Area.

The railroad splits into two branches at Wilson's Corner. The east branch extends 14.5 km (9 mi) to Playalinda Beach, and then curves southeast to parallel the Atlantic coastline. From this branch there are 0.32 km (0.2 mi) spurs that extend to Launch Pad 39A and 39B. The east branch of the NASA railroad ends at the boundary between KSC and CCAFS.

The portion of the railroad that runs parallel to Phillips Parkway on the beach side is often washed out by storms, making it nearly impossible to maintain. This section of railroad is no longer operational.

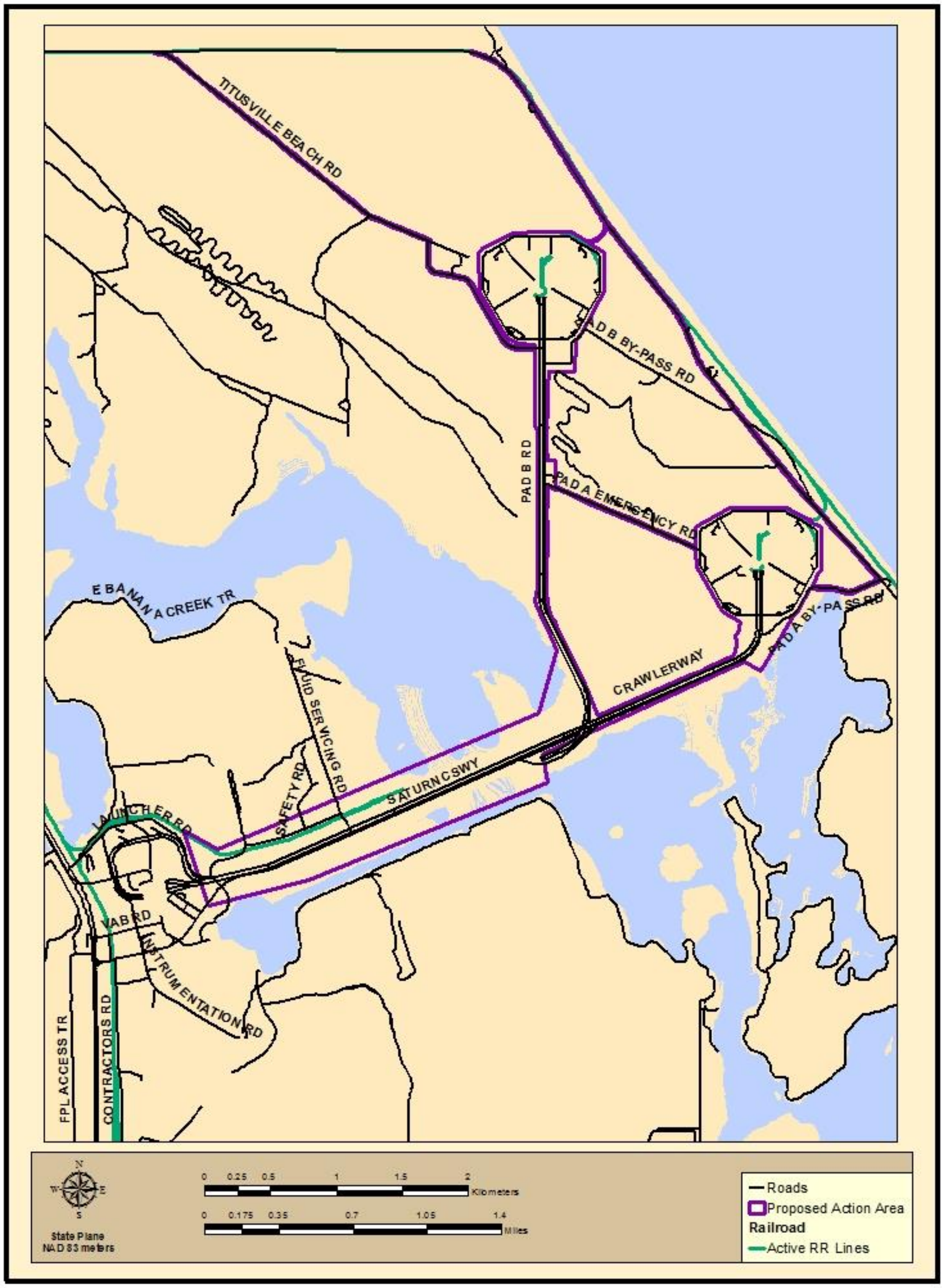


Figure 3-1. Roads and railroads in the vicinity of LC 39.

3.4 Environmental Resources

3.4.1 Health and Safety

It is KSC policy to provide a safe and healthy work environment for its workforce. KSC complies with applicable regulations of other federal agencies exercising regulatory authority over NASA in specific areas (e.g., the Department of Labor's Occupational Safety and Health Administration [OSHA]), and the DOT, as well as Agency safety policies and requirements. In the event of conflicting standards or regulations, the more stringent requirements apply.

The areas in and around KSC that could be affected by payload processing, transport, and launch are the subject of health and safety concerns. Range safety regulations for KSC are contained in NASA NPR 8715.5A and AFSPCMAN 91-710, which incorporate information that Range Safety organizations review, approve, and monitor; safety holds on all prelaunch and launch operations are imposed when necessary. The objective of the Range Safety Program is to ensure that the general public, launch area personnel, foreign landmasses, and launch area resources are provided an acceptable level of safety, and that all aspects of prelaunch and launch operations adhere to public laws. Hazardous materials such as propellants, ordnance, chemicals, and booster/payload components are transported in accordance with U.S. DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199).

KSC, CCAFS, the City of Cape Canaveral, and Brevard County have a mutual-aid agreement in the event of an emergency. During launch activities, CCAFS maintains communication with KSC, Brevard County Emergency Management, the Florida Marine Patrol, the U.S. Coast Guard (USCG), and the State coordinating agency, the Division of Emergency Management. Range Safety monitors launch surveillance areas to ensure that the risk to people, aircraft, and surface vessels is within acceptable limits. Control areas and airspace are closed to the public as required (USAF 1998).

Emergency medical services for KSC and CCAFS personnel are provided by the KSC Occupational Health Facility staff. Additional health care services are available at nearby public hospitals in Titusville, Rockledge, and Cocoa Beach. Fire and police protection on KSC are provided by private contractors.

In addition to hosting the NASA Range Safety staff, KSC has its own Center Range Safety team led by the KSC Range Safety representative. The KSC Range Safety representative is tasked with implementing NASA policy and keeping the NASA Range Safety manager informed of all KSC activities related to range safety. KSC Range Safety supports a multitude of activities including design, development, test, and evaluation support to new programs, and support to launch operations.

The advent of the Ground Systems Development and Operations (GSDO) Program, formerly 21st Century Space Launch Program, and the Range Interface and Control Services product line, in particular, provides a unique opportunity for NASA and the USAF to work together to increase the flexibility, responsiveness, affordability, and capacity to support launches with the frequency and turnaround times necessary to meet customer needs. KSC Range Safety provided technical support and leadership to the GSDO Range Interface and Control Services product line in 2011 and 2012.

3.4.2 Water Quality

3.4.2.1 Surface Water

The inland surface waters in and surrounding KSC are shallow estuarine lagoons and include portions of the Indian River, Banana River, Mosquito Lagoon, and Banana Creek. The area of Mosquito Lagoon within the KSC boundary and the northernmost portion of the Indian River Lagoon (IRL), north of the Jay Jay Railway spur crossing (north of SR 406), are designated by the State as Class II, Shellfish Propagation and Harvesting areas. All other surface waters at KSC have been designated as Class III, Recreation and Fish and Wildlife Propagation areas. All surface waters within MINWR are designated as Outstanding Florida Waters (OFW) as required by Florida Statutes for waters within national wildlife refuges. Surface water quality at KSC is generally good, with the best water quality being found adjacent to undeveloped areas of the IRL, such as Mosquito Lagoon and the northernmost portions of the Indian and Banana Rivers (NASA 2010).

Several agencies (e.g. NASA, USFWS, and Brevard County) maintain water quality monitoring stations at surface water sites within and around KSC. The data collected are used for long-term trend analysis to support land use planning and resource management. Surface water quality has been monitored at 11 sites within the boundary of KSC since 1984, with quarterly monitoring until 2000, and then biannually to present. The purpose of this monitoring program is to maintain an ecological database of basic surface water quality parameters. Parameters collected include nutrients, phenols, grease and oil, color, total suspended solids, total dissolved solids, chlorophyll, turbidity, and metals. Most of the basic surface water parameters, such as salinity, dissolved oxygen (DO), pH, temperature, and conductivity, follow seasonal and diurnal patterns typical of the IRL. During post Shuttle launch sampling events, of all the water quality parameters tested, only zinc has been consistently above baseline levels. Typically this pattern returns to normal baseline levels within 24 hours (D. Scheidt pers. comm., 28 Sept. 2008).

Since 2011, the overall water quality of the waters surrounding KSC has been markedly impacted. The likely cause for the dramatic decrease is related to the presence of two large and persistent algal blooms in the area. The first bloom consisted mostly of an unidentified chloro-microflagellate, which occurred from early spring through late fall of 2011 (SJRWMD 2012). This bloom covered a large portion of the northern Indian River Lagoon basin, mainly the IRL proper and Banana River, including the waters surrounding KSC. The second large bloom, consisting mostly of a brown tide pelagophyte species, occurred during the summer of 2012 (T. Rice pers. comm. Sept. 2012). Unlike the bloom of 2011, which began in the Banana River Lagoon before spreading to the northern IRL and Mosquito Lagoon, the 2012 bloom started in the southern Mosquito Lagoon in July, then spread into the northern IRL. These blooms decreased water clarity and overall quality, which negatively impacted seagrass growth and distribution. The blooms appear to have been precipitated by an extreme cold winter that killed some of the submerged aquatic vegetation species; this was followed by nutrient loading from the decaying materials. In addition, the area experienced relatively dry weather patterns that contributed to an increase in salinity that supported the blooms. The blooms are characteristically dense and create a significant loss of light penetration in the water column. The light loss then effectively kills the seagrasses. The marked decline of seagrass (approximately 90%) during this bloom has been documented for much of the central Indian River, and the majority of the Banana River, including the KSC long-term monitoring sites and the SJRWMD long-term seagrass sites (L. Morris pers. comm., 2011 and 2012).

FDEP, in compliance with the Environmental Protection Agency (EPA) Numeric Criteria Standards for pollutants, has set Total Maximum Daily Loadings (TMDLs) for many impaired waters in the State. The following waters within the boundary or adjoining KSC are identified as impaired:

- Atlantic Ocean (Brevard County, Volusia County): mercury in fish tissue
- Indian River (Brevard County): mercury in fish tissue, copper, nickel, and nutrients
- Banana River (Brevard County): mercury in fish tissue, and nutrients
- Mosquito Lagoon (Brevard County, Volusia County): mercury in fish tissue.

Basin Management Action Plans (BMAPs) addressing the first five years of a 15 year restoration period, for the Banana River Lagoon, and the North Indian River Lagoon have been developed and adopted These BMAPs only address nutrient impairment. A comprehensive statewide TMDL for mercury is also under development.

Fresh surface waters within KSC are primarily derived from the surficial groundwater, which is recharged by rainfall. Shallow groundwater supports numerous freshwater wetlands. Groundwater discharge to surrounding estuarine systems helps maintain lagoon salinity levels. Groundwater underflow is also a major factor in establishing the equilibrium of the freshwater-saltwater interface in the Surficial Aquifer system (Edward E. Clark 1987) prohibiting saltwater from intruding into surface waters. During most of the year, shallow groundwater discharges to swales and canals (Schmalzer and Hinkle 1990). Many of the larger canals are excavated below the groundwater table and, as a result, always contain water.

Most of the coastal dune systems on KSC lack naturally occurring freshwater bodies. Many estuarine wetlands were impounded for mosquito control and have been isolated from the estuary since the late 1950s and 1960s. The water quality of these impoundments varies, depending on the amount of exchange that exists between them and the lagoon via culverts. Dissolved oxygen may periodically become too low to sustain most aquatic life. Likewise, salinities may fluctuate substantially during the course of a year depending on the amount of rainfall. During the early

1990s, a significant effort was made by MINWR and SJRWMD to reestablish connection between many impoundments and the estuary in order to return the impoundments to more natural conditions. Many improvements were made to the culvert systems (i.e., more and larger culverts) and in some cases, impoundment dikes were removed completely.

3.4.2.2 Floodplain

Executive Order (EO) 11988 directs agencies to consider alternatives to avoid adverse effects and incompatible development in floodplains. The Proposed Action alternative sites are located across four different Federal Emergency Management Agency (FEMA) flood zone categories including AE, AO, X, and X500 (Figure 3-2). Zone AE involves areas inundated by 100-year flooding with base flood elevations determined. Sites in Zone AO are river or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth of 0.3-0.9 m (1-3 ft). Zone X lands are outside of the 100-year and 500-year floodplains. And finally, Zone X500 represents areas between the limits of the 100-year and 500-year flood, or certain areas subject to 100-year flood with average depths less than 0.3 m (1 ft), or where the contributing drainage area is less than 2.6 km^2 (1 mi^2).

LC 39A is in Zone X, while LC 39B is primarily in X except the eastern edge, which is designated Zone X500. Proposed HIF and common RP-1 storage sites include flood zones AE, X, and X500 along with portions of Phillips Parkway which are in Zone AO.

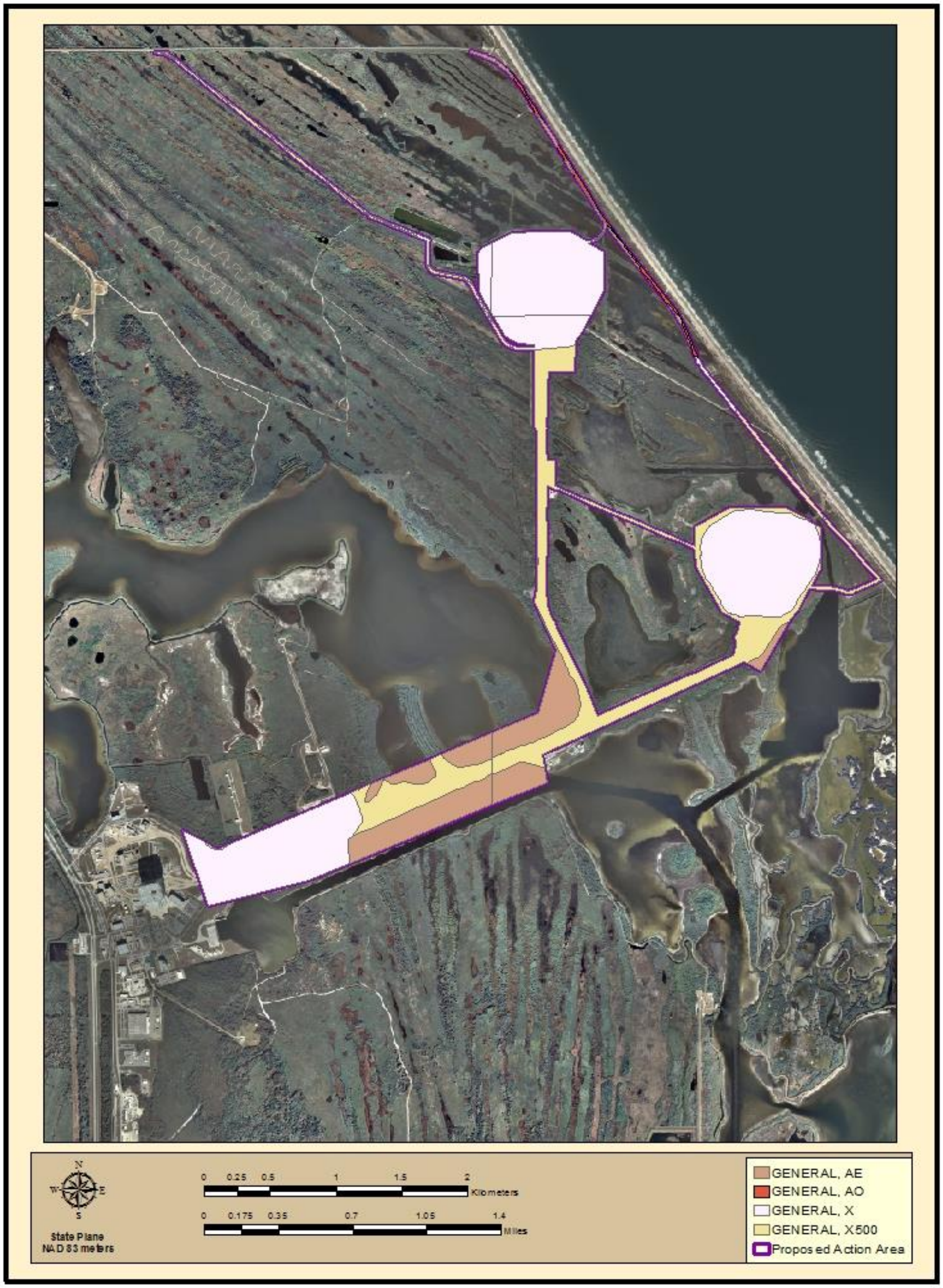


Figure 3-2. Floodplain map for the Proposed Action area at KSC, FL.

3.4.2.3 Coastal Erosion and Sea Level Rise

Because of the close proximity of the LC 39 area to the IRL and the Atlantic coast, the dynamics of erosion and rising sea level are important. Both launch complexes are located 300 m (1,000 ft) or less from the coastline and within 150 m (500 ft) of the estuary (Banana River). The following section summarizes current and future beach erosion scenarios and potential impacts of rising water levels from the ocean and estuary.

3.4.2.3.1 Erosion

Erosion described herein relates to recent dune losses. The causes of erosion are varied and include both natural processes and anthropogenic activities. In Florida, of the 1,328 km (825 mi) of coastline, at least 629 km (391 mi) of beaches are critically eroded (FDEP 2008). Beaches are declared critically eroded if they pose a threat to homes and other buildings, wildlife habitat, or important cultural resources.

Much of the 116 km (72 mi) coastline of Brevard County is eroding. With the exception of Cape Canaveral, Brevard County beaches are part of a long, narrow barrier island. The beaches are backed by a 3 m (10 ft) dune, which runs along much of the island. Erosion rates in Brevard County have accelerated since the late 1960s. From 1875 to 1993, erosion rates averaged 0.4 m/yr (1.2 ft/yr), while between 1969 and 1993, erosion rates increased to an average of 4.6 m/yr (15.2 ft/yr) (Bush et al. 2004). Since 1972, over 24 beach renourishment projects have been undertaken countywide to mitigate these losses, utilizing over 11 million m^3 (14 million yd^3) of sand (K. Bodge pers. comm., 2011). At Cape Canaveral, the average tidal range is 1 m (3.5 ft) with a spring tide range of 1.2 m (4.1 ft). During major hurricanes, water levels can peak 2.7 to 3.3 m (9 to 11 ft) above mean low water.

Several sections of KSC's coastline have been gradually eroding during the past few decades, including areas in the vicinity of LC 39. Following several years of high erosion beginning in 2004, NASA requested the U.S. Geological Survey (USGS) to conduct a study to determine the current and potential future status of its protective dune system. A KSC coastal vulnerability study was initiated in early 2008 (USGS 2008). Initial USGS findings showed that several areas north of Cape Canaveral are experiencing moderate to severe erosion (1-2 m/yr [3-6 ft/yr]) and inland migration of the dune face (Figure 3-3). In addition, the study developed coastal vulnerability models that showed the chances for extreme erosion events (dune overwash) increased substantially between 1999 and 2006. Generally, along eroding coastlines, dunes tend to migrate landward if unobstructed by human infrastructure (Bush et al. 2004). Dunes in the vicinity of the LC 39 Area can be expected to experience a coastline retreat of more than 25 m (82 ft) during the next decade.

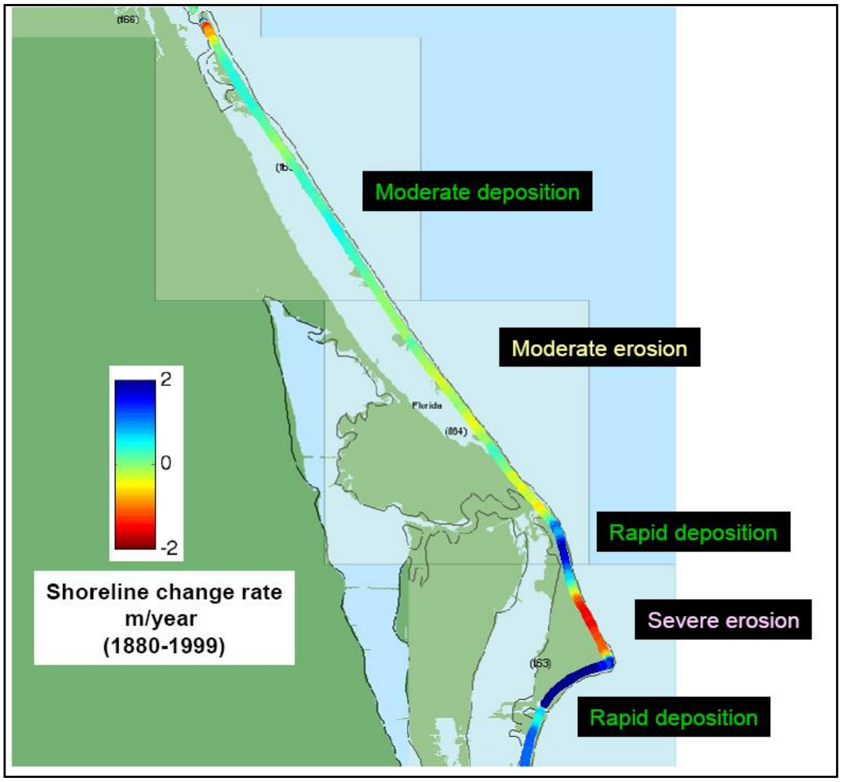


Figure 3-3. Shoreline erosion and deposition rates along KSC and CCAFS (USGS 2008).

3.4.2.3.2 Sea Level Rise

At the coast, mean sea level is defined as the height of the sea with respect to a local land benchmark, averaged over a period of time long enough to eliminate the effects of wave and tidal fluctuations. Changes in mean sea level as measured by coastal tide gauges are called "relative sea level changes," because they can come about either by movement of the land on which the tide gauge is situated or by changes in the height of the adjacent sea surface. Relative sea level changes are not an indication of sea level rise. A eustatic sea level change is that which is caused by an alteration to the volume of water in the world ocean (i.e., true sea level rise).

According to the International Panel on Climate Change (IPCC), global mean sea level continues to rise due to thermal expansion of the oceans and the loss of mass from glaciers, ice caps, and the Greenland and Antarctic ice sheets (Church et al. 2001, Bindoff et al. 2007, IPCC 2007). There is high confidence that the rate of sea level rise has increased between the mid-19th and the mid-20th centuries (Bindoff et al. 2007). For the 20th century, the average rate was 1.7 ± 0.5 mm/yr (0.07 ± 0.2 in/yr), consistent with the 2001 IPCC estimate of 1 to 2 mm/yr (0.04 to 0.08 in/yr) (Church et al. 2001). However, satellite observations available since the early 1990s provide more accurate sea level data with nearly global coverage. This decade-long satellite altimetry dataset shows that since 1993, sea level has been rising at a rate of around 3 mm/yr (0.12 in/yr). It is important to note that the change in sea level is variable. The rate of sea level rise experienced in the vicinity of the LC 39 Area might be greater or less than this global average.

Several recent studies are predicting higher rates of sea level rise than what has been reported in IPCC Fourth Assessment Report (IPCC 2007). The projected increased rates of sea level rise have been attributed to a greater contribution of melting glaciers and increased ice-sheet flow. According to Meier et al. (2007), sea level is likely to rise at rates ranging between 2.2 to 5.1 mm/yr (0.09 to 0.20 in/yr), while another study estimates rates of 3.1 to 6.1 mm/yr (0.12 to 0.24 in/yr) (Carlson et al. 2008).

In the region of Cape Canaveral and KSC, mean sea level is considered to be -0.26 m (-0.8 ft) NAVD88, while mean water level of the IRL in the vicinity is estimated at -0.21 m (-0.7 ft) NAVD88, based on analyses of data from historic and current NOAA tide gauges. Monthly water levels in the IRL and Atlantic Ocean fluctuate annually on a cyclic basis with maximum heights generally in October, falling rapidly as the ocean cools and contracts through the winter with minimal elevations in February and March. This cycle is shown in Figure 3-4 for the USGS tide station at Haulover Canal on northern KSC.

Projected sea level rise scenarios for KSC have been provided by the NASA Climate Adaptation Science Investigation team (Table 3-1). These projections are based on results of the analysis of 16 global climate models and include the more current information on rapid ice melt. At KSC, the rise in sea level will produce a similar rise in lagoon level as a result of their connection through inlets and groundwater. An analysis of the potential for land inundation by rising lagoon and sea level is summarized graphically in Figure 3-5. This analysis is based on land surface elevations derived from the 2007 Light Detection and Ranging (LIDAR) mission conducted by the Florida Division of Emergency Management. The analysis shows which areas of KSC land will have the same or lower elevation than the lagoon and be subject to flooding during the fall high water period. The analyses do not take into account a rising surficial aquifer or storm conditions.

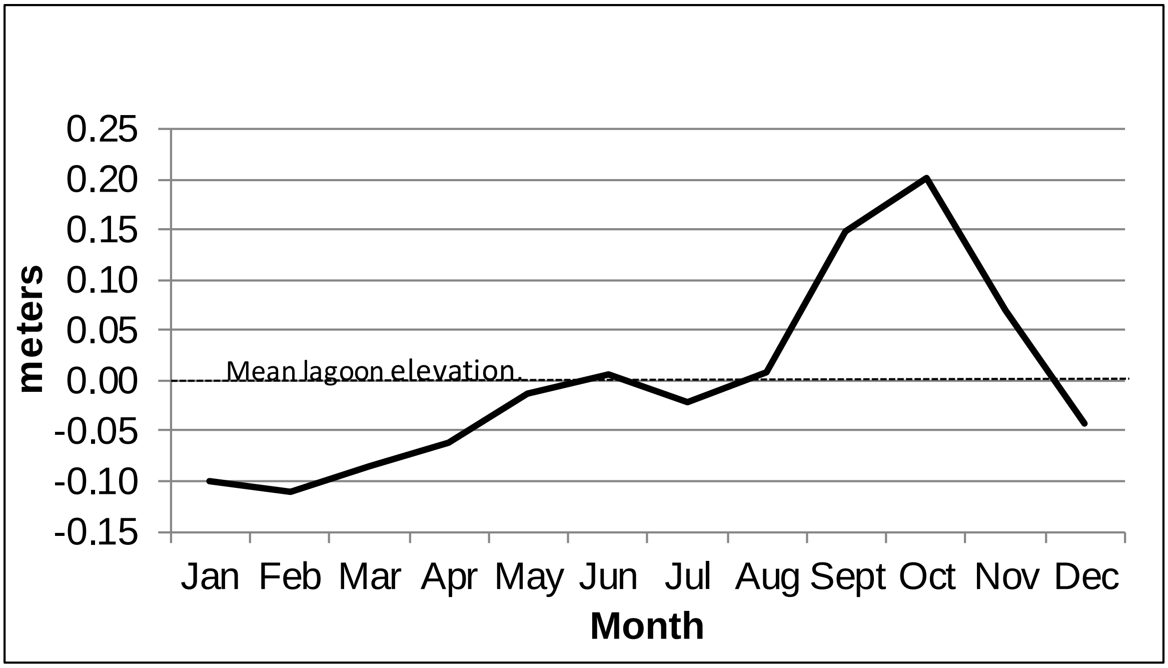


Figure 3-4. Annual average cycle of water level in the Indian River Lagoon measured at the USGS water level recording station in Haulover Canal between the Indian River Lagoon and Mosquito Lagoon.

Table 3-1. Projected sea level rise in the vicinity of KSC through the late part of the 21st Century.

	2020s	2050s	2080s
Sea level rise[1] Central rise	+ 5.1 to 7.6 cm (+ 2 to 3 in)	+ 12.7 to 20.3 cm (+ 5 to 8 in)	+ 22.9 to 38.1 cm (+ 9 to 15 in)
Rapid ice-melt[2] Sea level rise	~ 15.2 to 20.3 cm (~ 6 to 8 in)	~ 53.3 to 61 cm (~ 21 to 24 in)	~ 109.2 to 124.5 (~ 43 to 49 in)

[1] The model-based sea level rise projections may represent the range of possible outcomes less completely than the temperature and precipitation projections.
[2] "Rapid ice-melt scenario" is based on acceleration of recent rates of ice melt in the Greenland and West Antarctic ice sheets and paleoclimate studies.

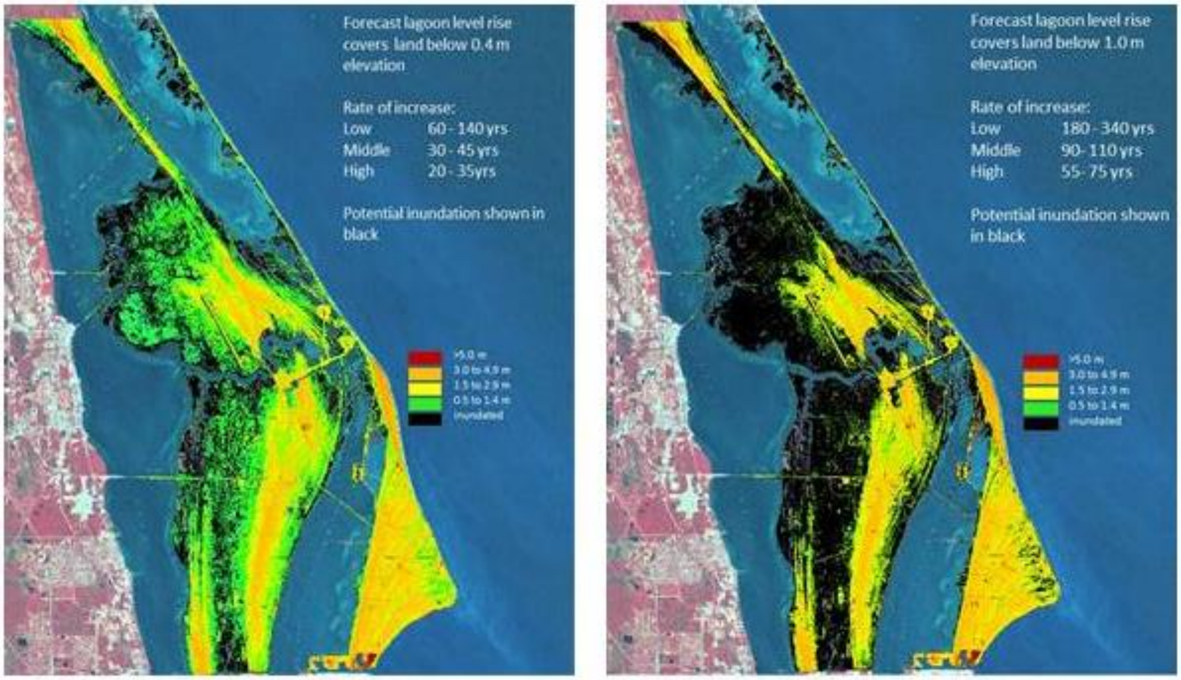


Figure 3-5. Potential land surface inundation estimates at KSC for areas below 0.4 m and 1.0 m elevation (NAVD88) assuming three different sea level rise rates (C. Hall, unpublished data). The Low scenario assumes a rate of approximately 3-5 mm/year (0.1-0.2 in/year),), the Middle scenario assumes a rate of 9-11 mm/year (0.3-0.4 in/year), and the High scenario assumes a rate of 13-15 mm/year (0.5-0.6 in/year). Sea level rise rates and times are generalized to accommodate the high degree of uncertainty associated with current global climate change model projections and estimates in the peer reviewed literature.

3.4.2.4 Groundwater Sources

The State of Florida has created four categories used to rate the quality of groundwater in a particular area. The criteria for these categories are based on the degree of protection that should be afforded to that groundwater source, with Class G-I being the most stringent and Class G-IV being the least. The groundwater at KSC is classified as Class G-II, which means that it is a potential potable water source and generally has a total dissolved solids content of less than 10,000 mg/l (parts per million [ppm]). The groundwater at the LC 39 pads has been classified as Class G-III, because of their proximity to the ocean. Any future long-term pumping would allow saltwater to encroach into the aquifer, rendering it non-potable (NASA 2003). The subsurface of KSC is comprised of the Surficial Aquifer, the Intermediate Aquifer, and the Floridian Aquifer. Recharge to the Surficial Aquifer system is primarily due to precipitation. Of the approximately 140 cm (55 inches (in)) of precipitation occurring annually, approximately 75% returns to the atmosphere through evapotranspiration. The remainder is accounted for by runoff, base flow, and recharge of the Surficial Aquifer. However, the quality of water in the KSC aquifer is influenced by the intrusion of saline and brackish surface waters from the Atlantic Ocean and the IRL. This is evident by the high mineral content, principally chlorides, that has been measured in groundwater samples from various KSC surveys.

3.4.2.5 Groundwater Quality

The quality of water in an aquifer is dependent upon the characteristics of the underlying rocks, the proximity of the aquifer to highly mineralized waters, the presence of residual saline waters, and the presence of chemical constituents in the aquifer and overlying soils.

Surficial Aquifer Systems

Unconsolidated, surficial aquifers are subject to contamination from point sources and from general land use. Contaminants may include trace elements, pesticides, herbicides, and other organics. Urban and agricultural land uses have affected some Florida Aquifers (Rutledge 1987, Barbash and Resek 1996). Point source contamination to the KSC Surficial Aquifer has occurred at certain facilities (NASA 2010).

Baseline conditions of the KSC Surficial Aquifer have been studied in some detail (Schmalzer et al. 2000, Schmalzer and Hensley 2001). In the 2001 study, six sample sites were located in each subsystem of the Surficial Aquifer for a total of 24 sites. Shallow and deep groundwater samples were analyzed for organochlorine pesticides, aroclors, chlorinated herbicides, polycyclic aromatic hydrocarbons (PAH), total metals, DO, turbidity, pH, specific conductivity, temperature, total dissolved solids (TDS), and total organic carbon (TOC).

These data suggested that widespread contamination of the Surficial Aquifer on KSC has not occurred (Schmalzer and Hensley 2001). No organochlorine pesticides, aroclors, or chlorinated herbicides were found above laboratory detection limits. Although pesticide residues or degradation products and chlorinated herbicides occurred in some soils, those concentrations were low and migration into the aquifer either has not occurred or has not been widespread. Some PAHs were found in the shallow wells. PAHs occur in a variety of KSC soils at relatively low concentrations, which is not surprising since PAHs have both natural and anthropogenic sources (e.g., Douben 2003).

Most trace metals were in low concentrations in KSC groundwater, if they occurred above detection levels. These findings are consistent with the low concentrations of most trace metals in KSC soils and the primarily quartz composition of the terrigenous deposits comprising the surficial sediments of Merritt Island (Brown et al. 1962, Milliman 1972, Field and Duane 1974). Aluminum (Al), iron (Fe), and manganese (Mn) occurred above detection limits more frequently than other trace metals. Al and Fe are abundant components in the Earth’s crust and are present in KSC soils. Intense leaching, particularly in acid scrub and flatwoods soils, mobilizes Al and Fe (Paton et al. 1995). Iron is a typical constituent of groundwater in the Surficial Aquifer in Florida (Miller 1997). Mn is one of the most abundant trace elements (Kabata-Pendias and Pendias 1984); it is present in KSC soils but the concentrations are relatively low. Solution and precipitation of Fe and Mn are affected by pH and oxidation-reduction conditions.

The chemical parameters varying most with subaquifer and depth were calcium (Ca), chloride (Cl), magnesium (Mg), potassium (K), and sodium (Na), as well as conductivity and TDS that are related to these cations and anions. The trends were generally consistent among these; the shallow wells in the Dune-Swale subaquifer had the lowest values. Concentrations increased with depth within a subaquifer. At a given depth, concentrations in the Dune-Swale and West Plain subaquifers were lower than in the Dune and Marsh subaquifers. These trends reflect increased mineralization with depth and differences between the freshwater Dune-Swale and West Plain subaquifers and the more saline Dune and Marsh systems. The Dune and Marsh subaquifers interact with saline water of the Atlantic Ocean and IRL system, respectively (Edward E. Clark 1987).

Intermediate Aquifer System

The groundwater quality in the Intermediate Aquifer system varies from moderately brackish to brackish due to its recharge by upward leakage from the highly mineralized and artesian Floridan Aquifer system, and in some cases from lateral intrusion from the Atlantic Ocean. Groundwater in the semi-artesian Sand and Shell Aquifer is brackish. Groundwater in the Shallow Rock Aquifer is brackish with some sites receiving seawater intrusion. The limited data for the thin Hawthorn Limestone Aquifer indicate that it is moderately brackish (Edward E. Clark 1987).

Floridan Aquifer System

The Floridan Aquifer system underlying KSC contains highly mineralized water with high concentrations of chlorides as a result of seawater that was trapped in the aquifer when it formed. The high concentrations of chlorides can also be explained to a lesser degree by induced lateral intrusion (due to inland pumping) and a lack of flushing due to a low proximity to freshwater recharge areas (Edward E. Clark 1987).

3.4.3 Atmospheric Environment

3.4.3.1 Climate

The climate at KSC is characterized as maritime-tropical with humid summers and mild winters. The area experiences moderate seasonal and daily temperature variations. Average annual temperature is 22° Centigrade (C) [71° Fahrenheit (F)] with a minimum monthly average of 13° C (60° F) in January and a maximum of 28° C (81° F) in July. During the summer, the average daily humidity range is 70 to 90% and the winter is drier with humidity ranges of 55 to 65% (Mailander 1990).

Prevailing winds during the winter are steered by the jet stream aloft and are typically from the north and west. As the jet stream retreats northward during the spring, the prevailing winds shift and come from the south. During the summer and early fall, as the land-sea temperature difference increases and the Bermuda high-pressure region strengthens, the winds originate predominantly from the south and east.

The central Florida region has the highest number of thunderstorms in the U.S. during the summer months (May to September), and over 70% of the annual 122 cm (48 in) of rain occurs in the summer. During thunderstorms, wind gusts of more than 97 km/hr (60 mi/hr) and rainfall of over 2.5 cm (1.0 in) often occur in a one-hour period, and there are numerous cloud-to-ground lightning strikes. Hurricane season extends from June through November. The most active hurricane season in KSC's history was 2004, when damages to facilities exceeded $100 million. Additionally, many habitats, such as marshes, shoreline, and dunes were affected, at least temporarily, due to the storm surge and beach erosion (NASA 2004).

3.4.3.2 Air Quality

Air quality at KSC is regulated under Federal Clean Air Act regulations (Title 40 CFR Parts 50 through 99) and Florida Administrative Code (FAC) Chapters 62-200 through 62-299. NASA activities at KSC and CCAFS are a major source of air pollution. NASA holds a Title V Air Operation Permit which governs the air emissions from those activities. Table 3-2 shows state and federal ambient air quality standards.

The ambient air quality at KSC is predominantly influenced by daily operations such as vehicle traffic, utilities, fuel combustion, and standard refurbishment and maintenance operations. Other operations occurring infrequently throughout the year, including launches and prescribed fires, also play a role in the quality of air as episodic events. Air quality has historically been influenced to some extent by two off-site regional oil-fired power plants located within a 18.5 km (10 mi) radius of KSC. Both plants are currently offline however, one new generation plant is under construction scheduled to go online in 2013.

Table 3-2. State and Federal Ambient Air Quality Standards.

Pollutant	Average Time	State of Florida Standard	Federal Primary NAAQS	Federal Secondary NAAQS
Carbon Monoxide	8-hour[a] 1-hour[a]	9 ppm 35 ppm	9 ppm 35 ppm	N/A N/A
Lead	Quarterly 3-Month	1.5 µg/m3 1.5 µg/m3	1.5 µg/m3 0.15 µg/m3[b]	1.5 µg/m3 0.15 µg/m3
Nitrogen Dioxide	Annual 1-hour[d]	0.053 ppm 0.10 ppm	0.053 ppm 0.10 ppm	0.053 ppm 0.10 ppm
Ozone	8-hour[h] 1-hour[i]	0.075 ppm N/A	0.075 ppm 0.12 ppm	0.075 ppm 0.12 ppm
Particulate Matter (PM10)	24-hour[e]	15 µg/m3	150 µg/m3	150 µg/m3

Pollutant	Average Time	State of Florida Standard	Federal Primary NAAQS	Federal Secondary NAAQS
Particulate Matter (PM2.5)	Annual[f] 24-hour[g]	15 µg/m3 N/A	15 µg/m3 35 µg/m3	15 µg/m3 35 µg/m3
Sulfur Dioxide	Annual 24-hour[a] 1-hour[j] 3-hour	0.02 ppm 0.10 ppm N/A 0.5 ppm	0.03 ppm 0.14 ppm 0.075 ppm N/A	0.5 ppm 0.14 ppm N/A 0.5 ppm

a. Not to be exceeded more than once per year. b. Final rule signed October 15, 2008. c. Annual mean. d. 98th percentile-averaged over three years. e. Annual 4th highest daily maximum 8-hour concentration averaged over three years. f. Not to be exceeded more than once per year on average over three years. g. Annual mean averaged over three years. h. 99 th percentile of 1-hour daily maximum concentrations averaged over three years. i. EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding"); the standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is <1. j. The 3-year average of 99th percentile of daily maximum 1-hour average must not exceed 75 ppb. Source: NASA 2010, NASA 2011a.

Ambient air quality is monitored by the Permanent Air Monitoring Station (PAMS) located north of the Industrial Area. The PAMS continuously monitors concentrations of sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone, as well as meteorological data. KSC is currently located within an area classified as attainment with respect to the NAAQS established by the EPA and FDEP for all criteria pollutants (Drese 2011). Total inhalable 10-micron particulates (PM-10) were monitored historically (1983 to 1989, 1992 to 1999) at the PAMS and two other sites on KSC. During those times, there was only one exceedance in PM-10; this occurred in 2006 during the ground clearing for the Space Station Processing Facility (J. Drese pers. comm.).

3.4.4 Noise and Vibration

Noise is an undesirable sound that may interfere with communication or if of sufficient intensity over time, results in decreased hearing acuity. In the natural world, noise can be defined as any sound that occurs above a tolerance level of a species in question, and alters its normal behavioral patterns. Given certain intensities, frequencies, and duration, noise can change the behavior of humans and wildlife. Noise is usually associated with human activity although some natural sounds may be considered noise. Noise is measured in decibels (dB) and an A-weighted sound pressure level (dBA) is commonly applied. Noise at KSC was described in detail in the EA for Expanded Use of the SLF (NASA 2007a) and typical sound levels are summarized below in Table 3-3.

Noise levels around facilities at CCAFS and KSC approximate those of any urban industrial area, reaching levels of 60 to 80 dBA. Additional on-site sources of noise are the aircraft landing facilities at the CCAFS Skid Strip and the KSC SLF. Other less frequent but more intense sources of noise in the region are launches from CCAFS and KSC. Sonic booms produced during vehicle ascent over the Atlantic Ocean are directed in front of the vehicle and do not impact land areas.

KSC is a large controlled access area and the noise environment is isolated to the activities within this area where launch vehicle and spacecraft processing and launch represent a primary mission. Aircraft and launches at both KSC and CCAFS do present sound levels that extend beyond the respective boundaries. KSC is bounded by the Atlantic Ocean and CCAFS to the east and the Indian River on the west. The nearest city is Titusville, approximately 9.7 km (6 mi) to the west, across the Indian River. Open space lies to the north. Land just to the south of KSC is largely undeveloped with low density housing located approximately 14.5 km (9 mi) from LC 39. The beach cities of Cape Canaveral and Cocoa Beach are also to the southeast and immediately south of Port Canaveral, approximately 24 km (15 mi) from the LC 39 area. The sound produced by current rocket launches is noticed in all these areas and these perimeter locations are commonly visited by the public for launch viewing.

Noise generated at KSC originates from: 1) traffic, 2) industrial operations, 3) construction, 4) aircraft, and 5) launches. Traffic noise is generated by employees traveling to and from their workplace and the local movement of a mix of trucks and passenger vehicles. Road surfaces are mostly asphalt with a maximum speed limit of 89 km per hour (55 miles per hour [mph]) on the major roadways and commonly 56 km per hour (35 mph) or less on local roads. Typical noise levels from passenger vehicles are 72 to 74 dBA at 89 km per hour (55 mph) at a distance of 15.2 m (50 ft). Heavy trucks (e.g., semi-trucks with exhaust located 1.8 to 2.4 m (6 to 8 ft) above the roadway) can produce 84 to 86 dBA at 89 km per hour (55 mph) at 15.2 m (50 ft). Overall noise from these sources is dependent on many factors including traffic volume, speed, vehicle type, roadway geometry, and local structures. Most of the vehicular activity is during the daylight hours, commonly between 0630 and 1630. There are both second and third work shifts at KSC, yet the population and traffic is greatly reduced. Rail operations are extremely infrequent, low speed, and limited to local movement of flight vehicle elements.

Table 3-3. Examples of typical sound levels.

Common Sounds	**Sound Level** *(dBA)*
Threshold of hearing	0 - 10
Quiet rural nighttime	20
Quiet suburban nighttime	20 - 25
Quiet urban nighttime	40
Business office	50
Heavy traffic at 90 m (300 ft)	60
Gas lawn mower at 30 m (100 ft)	70
Noisy urban daytime	80
Gas lawn mower at 0.9 m (3 ft)	95
Inside subway train	100
Jet flyover at 300 m (1,000 ft)	110

Construction noise is largely limited to the site, yet noise can carry to surrounding areas. Some typical values for noise levels from construction and associated vehicles were shown in the Expanded Use of the SLF EA (NASA 2007a) with examples summarized below in Table 3-4.

Table 3-4. Examples of construction noise sources.

Source	**Sound Level** (max. dBA)	**Estimated Sound Level at 120 m (400 ft)** (est. dBA)
Dump truck	108	70
Concrete mixer	105	67
Dozer	107	69 - 84
Loader	104	5 - 68
Generator	96	58
Crane	104	55 - 70

Noise from aircraft at and near KSC is associated with operations at the SLF with runways 15 and 33 and the nearby Skid Strip at CCAFS runways 12 and 30.

KSC was the launch site for the Space Shuttle Program and has experienced Shuttle launch-related noise as well as noise from four rocket launch pads located on CCAFS (e.g., Delta, Atlas, and Titan). The Space Shuttle was NASA's reusable, heavy lift vehicle beginning in 1981, with launches reaching as many as nine in one year in 1985. At the pad launch noise can reach 160 dBA with sound diminishing with distance. Noise from the February 2008 Space Shuttle launch (STS-122) was measured by the KSC Environmental Health Office with a logging noise dosimeter at a fall-back position (approximately 4.5 km (2. 8 mi), or 4,500 m (14,700 ft). Pre- and post-launch event data indicated sound levels ≤70 dBA at the fall-back position. At launch time there was a short-term increase to a peak of 99 dBA with a gradual decrease to ambient conditions. The entire cycle, as seen in Figure 3-6, was less than one minute. In considering the magnitude and short duration of the noise, personnel exposures do not reach the OSHA permissible exposure limit (PEL) of 90 dBA 8-hr time weighted average (TWA), or even the action level (85 dBA 8-hr TWA) for hearing conservation program concerns. Nor do they present sound pressure levels (SPL) that exceed the 115 dBA upper limit for unprotected personnel. NASA has a significantly more protective exposure limit than OSHA, and noise exposure from the short duration launch noise is similarly well below hearing conservation concerns when that policy is applied.

Figure 3-6 shows sound pressure level at fall-back (4.5 km [2.8 mi] from LC 39A). Sound levels (dBA and dBC shown) are 1-second averages. The criterion level of a potential noise hazard is 85 dBA and was exceeded for 28 seconds. The much higher C-weighed SPLs reflect the strong low frequency sound component of the overall spectrum.

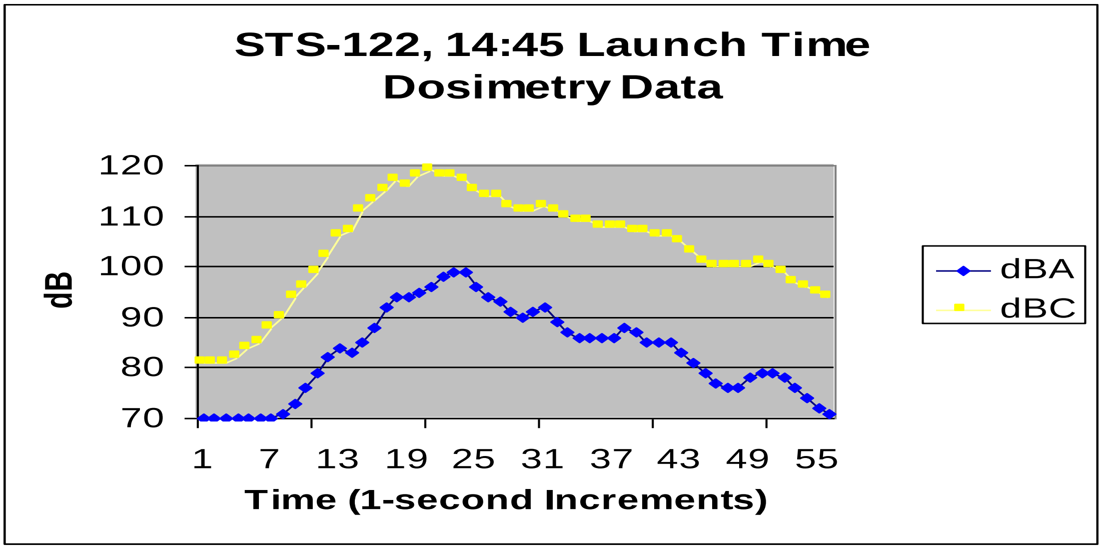


Figure 3-6. Sound Pressure Level at fall-back (2.8 mi from LC39A) shown in 1-second averages in dBA and dBC.

Sonic booms are created by aircraft and rocket activity when they exceed the speed of sound. The duration is brief, measuring in milliseconds. The closer the source is to the receiver, the greater the intensity; thus in general, the greater the altitude the less the intensity on land. The returning orbiter produced this occurrence and local experience of other aircraft is not common. Test flights to include supersonic flights of commercial endeavors have taken place from the SLF. Supersonic test flights in 2007 by F-104 aircraft were assessed to determine experienced noise levels at several locations. Logged SPL data, including peak values, did not indicate levels above normal background during times of sonic activity. Similarly, observers positioned at selected monitoring stations did not detect sonic boom activity during those tests.

Permissible noise exposure limits for humans are established by OSHA. The 8-hour time weighted average noise level on KSC is appreciably lower than the OSHA recommended level of 85 decibels, A weighted (dBA) (OSHA 2006). SLF flight operations include conventional fixed wing aircraft and helicopters. There has been air show activity as well with flights by military pilots and fighters. Noise from this activity is dependent on aircraft type and flight characteristics. Additionally, the effects of the noise are dependent on the hours of operation. Few operations take place in the evening (i.e., 2200 to 0700 hrs) when humans are more sensitive to noise. Flight activity is commonly cargo delivery (e.g., flight hardware and support equipment), limited commercial test flights (e.g., F-104), official business travel (e.g., Gulfstream), astronaut flight training and activity preceding launch day, and helicopter flights. Since 2004, flights have increased to 5,521 in 2009, and then decreased in 2010 to 4,753. The Proposed Action site (LC 39A and LC 39B) was used during the Apollo Program for Saturn V launches and most recently for the Space Shuttle Program. The noise environment there is influenced by local traffic, launch systems maintenance, launch preparation work, and launches from nearby launch complexes over a background noise of nearby coastline and natural areas. When not influenced by work activities, the area is anticipated to have sound levels in the range of 34 to 51 dBA, as found at a site on Playalinda Road north of LC 39A during an earlier assessment of the SLF. Light traffic can result in short-term increases to above 70 dBA. An example of the noise produced by a Space Shuttle launch (i.e., 160 dBA) and its effects almost three miles (5 km) to the west (maximum 99 dBA, with influence of less than one minute) was described above. Launches from nearby pads can result in sound levels that could exceed 130 dBA for a short duration following a similar pattern or curve shape as shown above in Figure 3-6. Other launch pads are more distant and result in short-term elevated sound levels. The current environment is also influenced by noise levels from traffic along Phillips Parkway.

3.4.5 Biological Resources

The footprint of the proposed LC 39 Area Multi-use Project occupies a total of 362.4 ha (895.5 ac) of habitat on a barrier island complex that parallels Florida's mid-Atlantic coast. The KSC region has several terrestrial and aquatic conservation and special designation wildlife management areas and aquatic preserves (NASA 2010). The area of interest consists of KSC, the adjoining Atlantic Ocean, and the IRL system.

Any federal action that may affect federally protected species or designated critical habitats requires consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA) of 1973, and/or with the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (MMPA) of 1972, as amended. In addition, potential effects on Essential Fish Habitat in offshore waters require consultation and analysis by NMFS under the Magnuson-Stevens Fisheries Conservation and Management Act of 1996.

The Biological Resources section addresses the plants and animals within the project area that are potentially affected by the Proposed Action. There are three categories: vegetation and habitats (further broken down into terrestrial and oceanographic), wildlife (further broken down into terrestrial and oceanographic), and threatened and endangered species.

Because the Proposed Action has the potential to impact the adjacent Atlantic Ocean from the proposed multi-users (e.g. falling debris, launch noise, etc.), the MMPA applies. It prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. The term "take" means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal.

Much of the land of KSC is undeveloped and in a semi-natural state. Topography is generally flat, with elevations ranging from sea level to approximately 6 m (20 ft) above sea level. More than 50% of KSC is classified as wetlands. These areas host a variety of plant communities that support many resident and transient animal species. The aquatic environment surrounding KSC provides diverse fish habitat, which supports many shorebird species, and sport, commercial, and recreational fishes. The Atlantic beaches are important to nesting sea turtles. In addition, the Mosquito Lagoon is primary habitat for juvenile green turtles (*Chelonia mydas*) and loggerheads (*Caretta caretta*), and the IRL is considered among the best oyster and clam harvesting areas on the east coast (NASA 2010).

3.4.5.1 Habitats and Vegetation

As detailed in Section 3.2, all KSC zoning and land use planning is under NASA directive for implementation of the U.S. Space Program, with the primary objectives to provide required support for missions and to maximize protection of the environment. NASA maintains operational control over approximately 1,704 ha (4,212 ac) of KSC. This comprises the functional area that is dedicated to NASA operations. Approximately 70% of that is developed as facility sites, roads, lawns, and maintained right-of-ways. The remaining undeveloped operational areas are dedicated safety zones around existing facilities, or are being held in reserve for planned and future expansion. The NPS and the USFWS manage the 54,745 ha (135,278 ac) that are outside of NASA operational control.

Terrestrial Habitats and Vegetation

The LC 39 Area Multi-use Project site supports several upland and wetland plant communities (Figure 3-7). Table 3-5 lists the dominant land cover as ruderal (54%). Ruderal plant species thrive in disturbed areas including sites along roads, railways, and facilities. Ruderal herbaceous vegetation (44%) is dominated by plants such as Bahia grass (*Paspalum notatum*) and beggarticks (*Bidens alba*). Ruderal woody vegetation (10%) is typically dominated by Brazilian pepper (*Schinus terebinthifolius*), wax myrtle (*Myrica cerifera*), and groundsel (*Baccharis halimifolia*).

Oak scrub is a fire maintained community found on well-drained soils associated with Pleistocene and Holocene dunes. It comprises 2.4% of the project area. The similar palmetto scrub land cover is found in locations having soils not as well-drained as oak scrub (0.1%). Typical species include the following oaks: sand-live oak (*Quercus geminata*), myrtle oak (*Q. myrtifolia*), and Chapman oak (*Q. chapmanii*). Saw palmetto (*Serenoa repens*) is also common. Brazilian pepper has invaded some areas.

Hardwood hammock, upland mixed forest, and upland hardwood forest are found on moderately drained soils, covering 2.3% of the project location. Typical canopy species include live oak (*Quercus virginiana*), laurel oak (*Q.* laurifolia), red maple (*Acer rubrum*), elm (*Ulmus americana*), and red mulberry (*Morus rubra*). Near lagoons, southern red cedar (*Juniperus virginiana*) becomes significant. Understory vegetation is comprised of saw palmetto and various shrubs, including yaupon (*Ilex vomitoria*) and tropical species including nakedwood (*Myrcianthes fragrans*), lancewood (*Ocotea coriacea*), myrsine (*Myrsine cubana*), and wild coffee (*Psychotria* spp.). Cabbage palm (*Sabal palmetto*) hammocks cover less than 0.1% of the project location.

Coastal strand covers approximately 0.1% of the project location. Vegetation is primarily composed of shrubs, including saw palmetto, sea grape (*Coccoloba uvifera*), wax myrtle (*Myrica cerifera*), and nakedwood; live oak becomes more abundant as distance to the primary dune increases. Two species of cacti, prickly-pear (*Opuntia humifusa*) and shell mound prickly-pear (*Opuntia stricta*) are also found in this habitat.

Flooded and wet areas include saltwater wetland scrub-shrub (5.1%), freshwater wetland scrub-shrub (2.7%), mangrove (1.4%), saltmarsh (0.3%), and freshwater marsh (<0.1%). The saltwater wetland scrub-shrub community contains a mix of mangroves, groundsel (*Baccharis halimifolia*), buttonwood, (*Conocarpus erectus*), and sea oxeye daisy (*Borrichia frutescens*). Mangroves include red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). Saltwater marshes are dominated by saltmarsh cordgrass (*Spartina alterniflora*), black rush (*Juncus roemerianus*), salt grasses (*Distichlis spicata* and *Paspalum vaginatum*), and succulent species such as saltwort (*Batis maritima*) and glasswort (*Sarcocornia ambigua*).

Examples of plants found in the freshwater wetland scrub-shrub community are Carolina willow (*Salix caroliniana*) and elderberry (*Sambucus nigra* subsp. *canadensis*). Understory plants include cinnamon fern (*Osmunda cinnamomea*) and royal fern (*O. regalis*). Freshwater marshes include emergent species such as maidencane (*Panicum hemitomon*), pink red stem (*Ammannia latifolia*), herb of grace (*Bacopa monnieri*), sawgrass (*Cladium jamaicense*), spikerush (*Eleocharis* spp.), softstem bulrush (*Schoenoplectus tabernaemontani*), marsh pennywort, (*Hydrocotyle* spp.), southern cattail (*Typha domingensis*), and arrowhead (*Sagittaria lancifolia*). Various sedges are common in wet areas. Common grasses include seashore paspalum (*Paspalum vaginatum*), sand cordgrass (*Spartina bakeri*), and the non-native torpedo grass (*Panicum repens*). Primrose willow (*Ludwigia* spp.) and Virginia saltmarsh mallow (*Kosteletzkya pentacarpos*) can be locally abundant.

Figure 3-7. Land cover of the Proposed Action area.

Table 3-5. Land cover areas and the percentage of total land cover found within the footprint of the Proposed Action.

Habitat Type	ha (ac)	Percentage
Ruderal – herbaceous	159.5 (394.1)	44.0
Ruderal – woody	36.5 (90.2)	10.1
Wetland scrub-shrub - saltwater	18.4 (45.5)	5.1
Estuary	14.6 (36.0)	4.0
Wetland scrub-shrub – freshwater	9.8 (24.2)	2.7
Oak scrub	8.5 (21.1)	2.4
Hardwood hammock	6.1 (15.0)	1.7
Mangrove	5.2 (12.9)	1.4
Ditch	5.0 (12.4)	1.4
Marsh – saltwater	1.3 (3.1)	0.3
Upland mixed forest	1.1 (2.7)	0.3
Upland hardwood forest	0.8 (2.1)	0.3
Water – interior – fresh	0.7 (1.8)	0.2
Coastal strand	0.5 (1.2)	0.1
Palmetto scrub	0.4 (0.9)	0.1
Water – interior - salt	0.2 (0.6)	0.1
Cabbage palm	0.2 (0.5)	0.1
Marsh – freshwater	0.1 (0.3)	<0.1
Total Area	362.4 (895.5)	100.00

Oceanographic Habitats

Although direct impacts are not expected to affect the ocean from the development of Multi-use Project facilities, there is potential for operations to have an effect via reentry components from launch vehicles. Components would include non-recoverable items (debris) such as jettisoned vehicle stages, as well as recoverable solid rocket boosters and manned spacecraft. Non-recoverable stages from launch activities are intended to land in ocean areas cleared of shipping or air traffic, and sink to the bottom.

The Magnuson-Stevens Fishery Conservation and Management Act, Public Law 104-208, provides for the protection of Essential Fish Habitat (EFH). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and specifies that each federal agency shall consult with NOAA with respect to any action that may adversely affect any EFH identified under the Act. Ocean waters off KSC have several areas designated as EFH that are of particular importance to sharks and other game fish, as well as several species of lobsters, shrimp, and crabs. These habitats include: sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, and from the Gulf Stream shoreward, including *Sargassum* sp. In addition, the northern boundary of Oculina Bank, a unique strip of coral reefs not duplicated elsewhere on Earth, is located approximately 37 km (20 nautical mi) off of Cape Canaveral. The entire reef is 145 km (90 mi) long. There are restrictions on many types of fishing in most of the area and fishing for snapper and grouper species is prohibited in part of the area (per South Atlantic Fishery Management Council 2012).

3.4.5.2 Terrestrial Wildlife

Four hundred thirty species of amphibians, reptiles, birds, and mammals have been documented on KSC. Of these, ten are federally protected and one is a Candidate species for federal protection (see Section 3.4.5.4, Threatened and Endangered Species and Table 3-7 for further information). Fourteen additional species are protected by the State of Florida as either Threatened or Species of Special Concern (Table 3-6).

Table 3-6. Wildlife species documented on KSC, which are not federally listed, but are protected by the State of Florida.

SCIENTIFIC NAME	COMMON NAME	PROTECTION LEVEL
Lithobates capito	Gopher frog	SSC
Pituophis melanoleucus mugitus	Florida pine snake	SSC
Gopherus polyphemus	Gopher tortoise	Threatened
Pelecanus occidentalis	Brown pelican	SSC
Egretta thula	Snowy egret	SSC
Egretta caerulea	Little blue heron	SSC
Egretta tricolor	Tricolored heron	SSC
Egretta rufescens	Reddish egret	SSC
Eudocimus albus	White ibis	SSC
Ajaia ajaja	Roseate spoonbill	SSC
Falco sparverius paulus	Southeastern American kestrel	Threatened
Grus canadensis pratensis	Florida sandhill crane	Threatened
Sterna antillarum	Least tern	Threatened
Rynchops niger	Black skimmer	SSC
Podomys floridanus	Florida mouse	SSC

SSC= Species of Special Concern

Herpetofauna

Fifty species of reptiles and 19 species of amphibians have been documented to occur on KSC (Seigel et al. 2002). Six of these are federally protected as either Threatened or Endangered and are discussed in Section 3.4.5.4 (Threatened and Endangered Species).

Three of the 69 species are not federally listed, but are protected by the State of Florida. These include the Florida gopher frog (*Lithobates capito*), the gopher tortoise (*Gopherus polyphemus*), and the Florida pine snake (*Pituophis melanoleucus mugitis*). The Florida gopher frog and Florida pine snake are uncommon on KSC and little is known about their numbers or distribution. The gopher frog is associated with two habitat types. On KSC, it inhabits uplands (scrub and scrubby flatwoods) and lives in gopher tortoise burrows most of the year, but must go to the freshwater swales to breed (Blihovde 2006). The Florida pine snake also inhabits the uplands on KSC, but is rarely observed. They will use gopher tortoise burrows as den sites, but seem to prefer pocket gopher (*Geomys pinetis*) burrows (Franz 1992); pocket gophers do not occur on KSC.

The gopher tortoise is listed by the State of Florida as a Threatened species and has been classified as a Candidate species for federal listing. The gopher tortoise is discussed further in Section 3.4.5.4 (Threatened and Endangered Species) of this document.

Birds

KSC provides habitats for 331 bird species (U.S. Geological Service 2007; updated R. Bolt pers. comm.); nearly 90 species nest on KSC, many of which are year-round residents (Breininger et al. 1994). There are over 100 species that reside in the area only during the winter, including many species of waterfowl. The remaining birds regularly use KSC lands and waters for brief periods of time, usually during migration. The wood stork (*Mycteria americana*) and Florida scrub-jay (*Aphelocoma coerulescens)* are federally protected and discussed in Section 3.4.5.4 (Threatened and Endangered Species) of this document. In addition, there are 11 species that are protected by the State of Florida (Table 3-6). Six of these belong to a group of birds commonly called waders (*Order Ciconiiformes*). They are typically associated with wetlands and aquatic habitats and include the storks, egrets, herons, ibises, and spoonbills. The wading bird population on KSC is very large, and it is estimated that between 5,000 and 15,000 birds are present at any given time, depending on the season (Smith and Breininger 1995). The largest numbers occur during the spring and the fewest birds are present in the winter.

Mammals

Thirty species of mammals inhabit KSC lands and waters (Ehrhart 1976). Typical terrestrial species include the opossum (*Didelphis virginiana*), hispid cotton rat (*Sigmodon hispidus*), cotton mouse (*Peromyscus gossypinus*), raccoon (*Procyon lotor*), river otter (*Lutra canadensis*), and bobcat (*Lynx rufus*). Due to the regional loss of large carnivores such as the Florida panther (*Puma concolor coryi*) and red wolf (*Canis rufus*), the bobcat and otter now hold the position of top mammalian predators on KSC. The gray fox (*Urocyon cinereoargenteus*) and red fox (*Vulpes vulpes*) also occur on KSC, and there has been an increase in sightings of coyotes (*Canis latrans*) since the mid-2000s (R. Bolt pers. comm.).

A proliferation of mid-level predators, such as the raccoon and opossum, has resulted from an imbalance of predator/prey ratios and human-induced habitat changes. Opportunistic species such as the cotton rat and eastern cottontail rabbit (*Sylvilagus floridanus*) account for a large portion of the small mammal biomass, rather than habitat-specific species such as the State-listed Florida mouse (*Podomys floridanus*) and the federally protected southeastern beach mouse (*Peromyscus polionotus niveiventris*). Other small mammals include the least shrew (*Cryptotis parva*), eastern mole (*Scalopus aquaticus*), round-tailed muskrat (*Neofiber alleni*), and the eastern spotted skunk (*Spilogale putorius*). At least three species of bats have been documented. They occasionally use facilities as roost sites, and when conflicts occur due to facility renovations or demolition, or human health concerns, the bats must be excluded from those facilities. Several bat houses have been erected on KSC to help mitigate impacts. A large bat roost and maternity colony is located in the NASA Causeway/SR 3 overpass. Even though it is the busiest intersection on KSC, several thousand bats, mostly Brazilian free-tailed (*Tadarida brasiliensis*), have used this site for at least 25 years (R. Bolt pers. obs., 2012).

3.4.5.3 Oceanographic Resources and Wildlife

The benthic habitat of the nearshore off KSC consists primarily of topographically elevated sand ridges. This high energy environment drives the food availability, larval recruitment, and habitat structure for benthic organisms along the Florida coast. Benthic communities provide an important food or energy resource for higher trophic levels, including fish and larger organisms.

Soft bottom fish communities offshore from KSC have never been the subject of rigorous sampling. A brief Minerals Management Service survey (September 2000 and June 2001) of nine sand shoal sites off of Brevard County and several counties to the south produced 63 fish taxa with dusky anchovy (*Anchoa lyolepis*) and silver seatrout (*Cynoscion nothus*) comprising 69% of all fish caught (Hammer et al., 2005). Macroinvertebrate catches included 32 taxa of stomatopods, decapod crustaceans, echinoderms, and squid.

Data on surf zone fish abundance are unavailable but density of several economically valuable fish species including red drum (*Sciaenops ocellatus*), black drum (*Pogonius cromis*), pompano (*Trachinotus carolinus*), sheepshead (*Archosargus probatocephalus)*, and whiting (*Menticirrhus* sp.) appears quite high (E. Reyier pers. comm.). Most notably, the open surf zone and longshore troughs serve as a high value nursery for juvenile lemon sharks (*Negaprion brevirostris*), which are present year round but gather in aggregations of up to several hundred individuals each winter from November through March (Reyier et al., 2008). KSC and collaborating fisheries research groups are currently funding acoustic telemetry studies to assess site fidelity, habitat preferences, and migrations of several nearshore fish species including lemon sharks, red drum, black drum, pompano, and whiting.

Fisheries data from the Florida Fish and Wildlife Research Institute (FWRI) documents commercial landings and the Marine Recreational Fishery Statistics Survey documents recreational fisheries landings. Commercial and recreational landings data for the northeast Florida region (including Brevard County) are available for 54 individual species of fish and 19 mixed-species categories (e.g., sharks, flounders, triggerfish, and mixed grouper). The dominant commercial finfish species in terms of pounds landed regionally are sharks, kingfish (whiting), Spanish mackerel (*Scomberomorus maculatus*), striped mullet (*Mugil cephalus*), and king mackerel (*Scomberomorus cavalla*). Recreational catches are numerically dominated by spotted seatrout (*Cynoscion nebulosus*), crevalle jack (*Caranx hippos*), kingfish (*whiting*), gray snapper (*Lutjanus griseus*), and red drum. Pinfish (*Lagodon rhomboides*) are also recorded as a large component of the recreational fishery; however, this small species is utilized largely as bait. Decapod crustaceans sustain the largest commercial and recreational fisheries by weight in east Florida with landings dominated by white shrimp (*Litopenaeus sp.*) and blue crabs (*Callinectes sapidus*).

3.4.5.4 Threatened and Endangered Species

No federally listed plant species have been found on KSC. KSC supports 39 plant species that are protected by the State of Florida as endangered, threatened, or species of special concern (Schmalzer et al. 2002; NASA 2010).

Nineteen federally listed wildlife species have been documented on or in the near vicinity of KSC, more than on any other national wildlife refuge in the continental U.S. The smalltooth sawfish (*Pristis microdon)* has been documented in the ocean waters near KSC, but they are extremely rare. Six other species are only incidentally present and do not make important contributions to the area's biota: hawksbill sea turtle (*Eretmochelys imbricata*), Kemp’s ridley sea turtle (*Lepidochelys kempi*), snail kite (*Rosthrhramus sociabilis*), Audubon’s crested caracara (*Polyborus plancus audubonii*), piping plover (*Charadrius melodus*), and roseate tern (*Sterna dougallii*). The Atlantic saltmarsh snake (*Nerodia clarkii taeniata*) historically occurred along the coastline from Volusia County through Brevard County south into Indian River County. It is now believed to be restricted to a limited coastal strip in Volusia County (USFWS 2005) and is no longer expected to be found on KSC.

The remaining 11 species regularly occur on KSC (Table 3-7). The American alligator (*Alligator mississippiensis*) was once on the brink of extinction, but recovery efforts enabled populations throughout its range to rebound strongly. However, because the alligator is similar in appearance to another listed species, the American crocodile (*Crocodylus acutus*), it remains on the federally protected list. Alligators are abundant on KSC and can sometimes cause problems related to traffic safety and encounters with people around and within facilities. Eight federally listed species occur on KSC either commonly or occasionally: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), eastern indigo snake (*Drymarchon couperi*), wood stork (*Mycteria americana*), Florida scrub-jay (*Aphelocoma coerulescens*), southeastern beach mouse (*Peromyscus polionotus niveiventris*), and the West Indian manatee (*Trichechus manatus*). The bald eagle (*Haliaeetus leucocephalus*) was removed from the ESA list in 2007, but continues to receive federal protection via the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act. The gopher tortoise is listed as threatened by the State of Florida, but its status was elevated in 2011 to Candidate species for federal listing, and it is included in this section. Legally designated critical habitat for the northern right whale (*Eubalaena glacialis*) is located along the KSC coast and extends east for 9.3 km (5 nautical mi); right whales are occasionally observed between December and March.

Table 3-7. Federally protected wildlife species documented to occur on KSC.

SCIENTIFIC NAME	COMMON NAME	PROTECTION LEVEL

Alligator mississippiensis	American alligator	Threatened (S/A)*
Caretta caretta	Loggerhead	Threatened
Chelonia mydas	Atlantic green turtle	Endangered
Dermochelys coriacea	Leatherback sea turtle	Endangered
Gopherus polyphemus	Gopher tortoise	Candidate for listing
Drymarchon couperi	Eastern indigo snake	Threatened
Mycteria americana	Wood stork	Endangered
Haliaeetus leucocephalus	Bald eagle	P*
Aphelocoma coerulescens	Florida scrub-jay	Threatened
Peromyscus polionotus niveiventris	Southeastern beach mouse	Threatened
Eubalaena glacialis	Northern right whale	Endangered
Trichechus manatus	West Indian manatee	Endangered

*Key: S/A = similarity of appearance; P = protected under the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act.

Marine Turtles

Three species of marine turtles have been documented using KSC beaches for nesting. The loggerhead, currently listed as threatened (under review for uplisting to endangered, FR 2010), and green sea turtle, listed as endangered, are abundant during their nesting season (May through October). The numbers of leatherbacks, listed as endangered, nesting on KSC have increased over the past 20+ years; they are no longer considered rare. The loggerhead and green sea turtle are also found in many portions of the estuary, which is occupied primarily by juveniles as a nursery habitat before they return to the Atlantic Ocean to spend their adult lives.

The KSC nesting beach is 10 km (6.2 mi) long (Figure 3-8). Some disorientation of marine turtles related to lighting from nighttime space operations has occurred along the KSC beach over the last decade. The USFWS Endangered Species Office issued an interim Biological Opinion (BO) in 2009 that was applicable for the 2009 - 2011 nesting seasons. This BO was based upon the review of lighting impacts and management activities on nesting marine turtles and emerging hatchlings. The resulting rate of take (i.e., hatchling disorientation) allowed by the BO was 3% (USFWS 2009).

Table 3-8 shows the number of nests, by species, deposited on the KSC beach from 2008 through 2011. Nesting “hot spots” have remained similar over the last 30 years and are typically kilometers 26-27 and 32-33 (Figure 3-8) (Gann 2011). The area between kilometers 30-31 has the highest percentage of false crawls (emergences that do not result in a nest); in the past few years this location has experienced high erosion and multiple wash overs (Coastal Planning & Engineering, Inc. 2011).

Table 3-8. Marine turtle nesting data from the KSC/MINWR beach, 2008 – 2011.

SPECIES & TYPE	ANNUAL NUMBER			
	2008	2009	2010	2011
Loggerheads				
nests	1,072	789	1,163	1,089
false crawls	826	734	869	776
total emergences	1,898	1,523	2,032	1,865
Green Turtles				
nests	104	53	142	176
false crawls	136	71	219	302
total emergences	240	124	361	478
Leatherbacks				
nests	1	2	6	3
false crawls	0	0	0	1
total emergences	1	2	6	4

Figure 3-8. Marine turtle nesting beach on KSC/MINWR. Labels indicate the general locations of kilometer markers used for recording marine turtle nesting data for the Florida statewide Index Nesting Beach Survey.

Disorientation surveys for adults and hatchlings are performed every season. Adult disorientations for 2008, 2009, and 2010 were 0.3%, 0.4%, and 0.6%, respectively. Hatchling disorientation rates vary tremendously from year to year (Figure 3-9), depending on light pollution from facilities and the condition of the dunes between light sources and the nesting beach. The average rate for 2000 – 2009 is 5%, which is above the 3% take allowed by the interim BO issued in 2009. However, hatchling disorientation rates for 2008, 2009, and 2010 were 2.4%, 3.5%, and 2.4%, respectively, and it appears that the numerous activities and efforts being made to reduce impacts from lighting are improving conditions (Gann 2011).

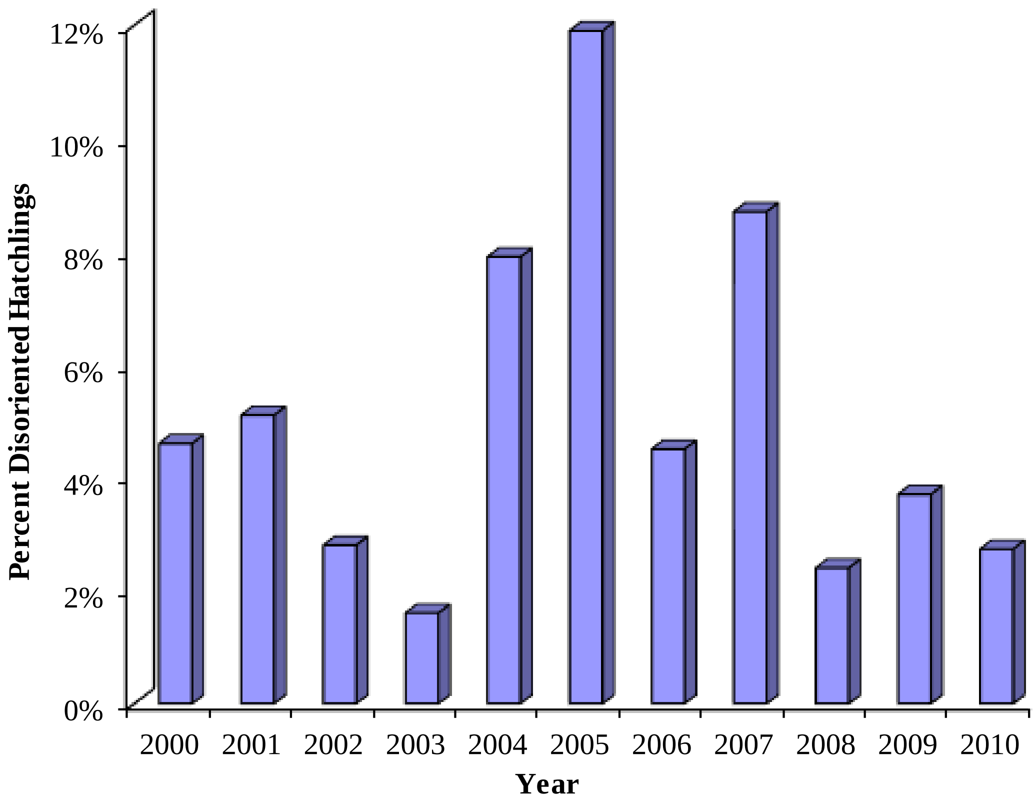


Figure 3-9. Disorientation rates of marine turtle hatchlings on the KSC beach for 2000 through 2010 nesting seasons.

Gopher Tortoise

The gopher tortoise is listed by the State of Florida as a Threatened species. It is already federally protected in the westernmost portion of its range (Louisiana, Mississippi, and western Alabama). In a 12-month finding in 2011, the USFWS stated that although available data indicate that listing the gopher tortoise as federally threatened is warranted, other higher priority species preclude the USFWS from taking that action at this time. As a result, the tortoise has been classified as a Candidate species for listing. Candidate species receive no official legal protection, but the USFWS encourages cooperative conservation efforts, a practice that KSC has been following since the mid-1980s.

The gopher tortoise is common, widespread, and well-studied on KSC. Several thousand tortoises have been permanently marked for identification, and research has been conducted related to life history, habitat use, disease, reproduction, and survival. Tortoises on KSC are typically found in oak scrub, scrubby flatwoods, and coastal dune habitats, and also commonly use disturbed areas such as open fields, road shoulders, and man-made dikes and berms. Because gopher tortoises dig burrows, and over 300 species of vertebrates and invertebrates have been documented using tortoise burrows, they are an incredibly important component of the ecological community wherever they occur (Ashton and Ashton 2008).

Studies to determine home range sizes were done with radio tagged tortoises on KSC. Males' home ranges were between 0.3 and 5.3 ha (0.7 – 13.1 ac); the average size was 1.9 ha (4.7 ac) (Smith et al. 1997). Females' home ranges were smaller and they used between 0.3 and 1.1 ha (0.7 – 2.7 ac) with an average of 0.6 ha (1.5 ac). These studies were from scrub and scrubby flatwoods habitats where conditions are much different than those in coastal dune. KSC scrub and scrubby flatwoods have a dense shrub layer that tends to reduce the amount of light reaching the ground, which in turn reduces the herbaceous plant growth used as food by tortoises (Schmalzer and Hinkle 1992; Breininger et al. 1994). Tortoises in those less suitable habitats need larger home ranges in order to have sufficient resources (Ashton and Ashton 2008). The coastal dune is more open and the vegetation is primarily grasses and herbs, with plenty of documented species of tortoise food available (Ashton and Ashton 2008). Also, the soil of the coastal dune habitat is sandy and very suitable for burrowing. Because of these habitat characteristics, the dune habitats along the shoreline support the most dense tortoise populations on KSC.

Because gopher tortoises tend to occupy drier habitats or disturbed areas, they often come into conflict with development or operational requirements. When this happens, the official KSC Gopher Tortoise Policy is to 1) avoid disturbing gopher tortoises or their burrows whenever possible by working with managers to reconfigure projects; 2) remove tortoises from harm's way when temporary impacts cannot be avoided so they can remain on-site or be returned to their original home range once the project is completed; or 3) relocate tortoises away from the project site to nearby suitable areas if the impacts are widespread and permanent. Cooperative efforts with project managers are typically successful, and relocations are very rare.

Eastern Indigo Snake

Eastern indigo snakes (*Drymarchon couperi*) have been listed as a Threatened species since 1978. They have large home ranges, eat a wide variety of prey, and use many different habitat types and den sites (Stevenson et al. 2010, Breininger et al. 2011). Radio tagged indigos in Brevard County tracked between 1998 and 2002 had average home range sizes of 201.7 ha (498.4 ac) for males and 75.6 ha (186.8 ac) for females.

Habitat fragmentation was found to be a critical factor impacting indigo snake population persistence (Breininger et al. 2012). Snakes that occupied areas that were intact (i.e., less fragmented by roads and other features) had significantly higher survival rates than snakes living in places that were more highly fragmented (Breininger et al. 2004). Road mortality was found to be the most prevalent cause of death in the radio tagged indigos studied in Brevard County (Breininger et al. 2012). The status of the eastern indigo snake population on KSC is unknown, but it is believed to be more secure than populations that occur outside of protected lands.

Bald Eagle

Although removed from the federal Endangered Species list in 2007, the bald eagle continues to receive federal protection via the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Lacey Act. KSC supports an annual average of 11 breeding pairs; see Figure 3-10 for 2011/2012 nest sites. Average annual production for the last nine seasons (through 2011 – 2012) was 13 fledglings (Bolt 2012). Eagles use mature live pines and pine snags, but will occasionally build nests on man-made towers. KSC offers an ideal situation for bald eagle nesting due to the wide expanse of relatively undisturbed pine habitat, and the freshwater and estuarine wetland complex that provides a diversity of excellent foraging habitats (Hardesty and Collopy 1991).

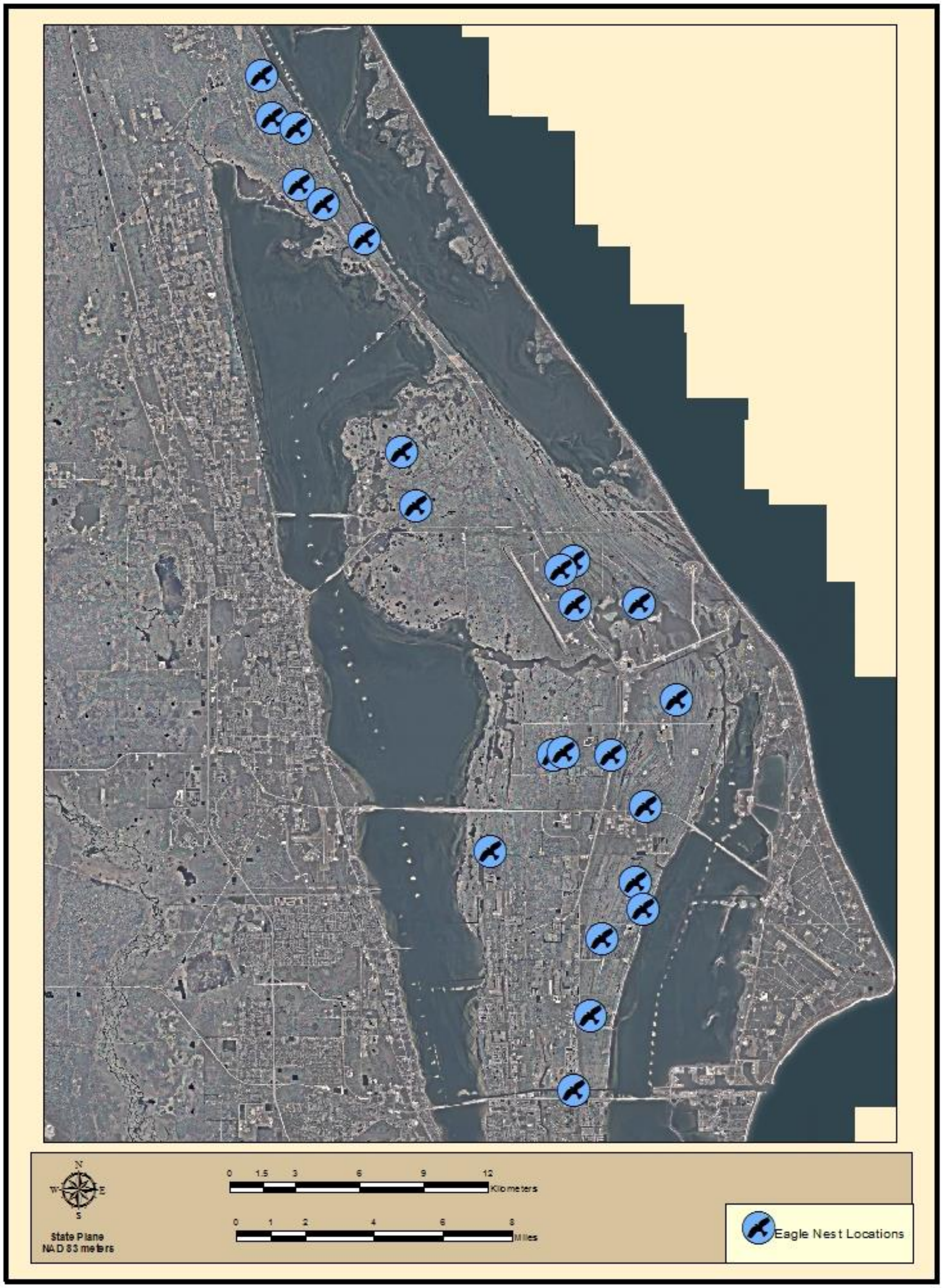


Figure 3-10. Bald eagle nest locations on KSC during the 2011/2012 nesting season.

Florida Scrub-jay

The threatened Florida scrub-jay is found in Florida and nowhere else in the world. They live year-round in fairly stable territories, mate for life, and the young stay in their natal territory with the family for several years before establishing territories of their own (Woolfenden and Fitzpatrick 1984). Habitats occupied by Florida scrub-jays are typically oak scrub, oak/palmetto scrub, and coastal scrub, as well as ruderal and disturbed areas in coastal regions. In order for scrub-jays to persist and flourish, the characteristics of the habitat (e.g., vegetation height, thickness of ground cover) must fall within a narrow range that is, ideally, maintained by fire. State-wide, many populations of the Florida scrub-jay continue to decline in spite of legal protection, because of habitat loss and degradation caused by the lack of sufficient management.

Although KSC likely has the capacity to support at least 450 scrub-jay family groups, current estimates of population size are much lower (250-350 families) (Breininger unpublished data). Scrub-jay habitat is intensively managed on KSC by the USFWS, primarily by controlled burning and mechanical treatment. Mitigation measures and compensation rates for scrub habitat that are used for development are determined in conjunction with the USFWS Endangered Species Office on a case-by-case basis.

Wood Stork

Wood storks were listed as an endangered species in 1984, primarily due to the loss and degradation of suitable wetlands habitat in south Florida (USFWS 2010). Since being protected, some of the threats to wood stork populations have been reduced, and, in addition, wood storks have substantially expanded their breeding range northward into Georgia and South Carolina (USFWS 2012a). Based on surveys conducted between 1984 and 2006, the number of nesting pairs has almost doubled, indicating a stable or increasing population (USFWS 2007). In south Florida, wood storks have increased from 175 pairs in the mid-1980s to 1,868 pairs in 2002. Breeding populations in north and central Florida have remained constant at approximately 3,100 pairs. In 2010, the USFWS released in a 90-day finding that reclassifying the wood stork from endangered to threatened may be warranted (USFWS 2010), but that action has not yet been taken.

Wood stork nesting has not been documented on KSC since 1991. Aerial wading bird surveys in feeding habitats have been done between five and twelve times per year since 1987; the average number of wood storks seen using the survey route impoundments and estuaries is six or seven birds per survey (E. Stolen unpub. data, pers. comm.). It appears that more wood storks feed in the freshwater roadside ditches than in the estuarine environments, particularly in winter when there is an influx of non-resident birds (B. Bolt, E. Stolen pers. obs.).

Southeastern Beach Mouse

The range of the threatened southeastern beach mouse once extended from Ponce Inlet to Miami Beach. Now the mouse can only be found on the contiguous stretch of habitat on CNS, KSC, and CCAFS, with isolated small populations at Archie Carr National Wildlife Refuge and

Sebastian Inlet State Park (USFWS 2012b). Southeastern beach mice inhabit the coastal dune and adjoining scrub. Extensive coastal development in unprotected areas has resulted in the loss and fragmentation of those habitats, causing population extirpation from privately owned and most small publically owned lands.

Studies and surveys have been done on the southeastern beach mouse population on KSC since the 1970s. Populations appear to have remained stable over the years, likely due to the continuity of the habitat (CNS/KSC/CCAFS) that allows recolonization when subpopulations are extirpated by natural events such as hurricanes and other storms. In a study conducted on KSC between 2003 and 2005, capture rates of beach mice were good, but less than those experienced further south on CCAFS where the expanse of suitable habitat is much wider (Provancha et al. 2005). Age classes captured included mostly adults, but also sub-adults and juveniles; many of the adults from each trapping event were in reproductive condition. Subsequent studies using tracking tubes that record footprints of mice indicated that southeastern beach mice are distributed along the entire CNS/KSC/CCAFS coastline (Figure 3-11; E. Stolen pers. comm.).

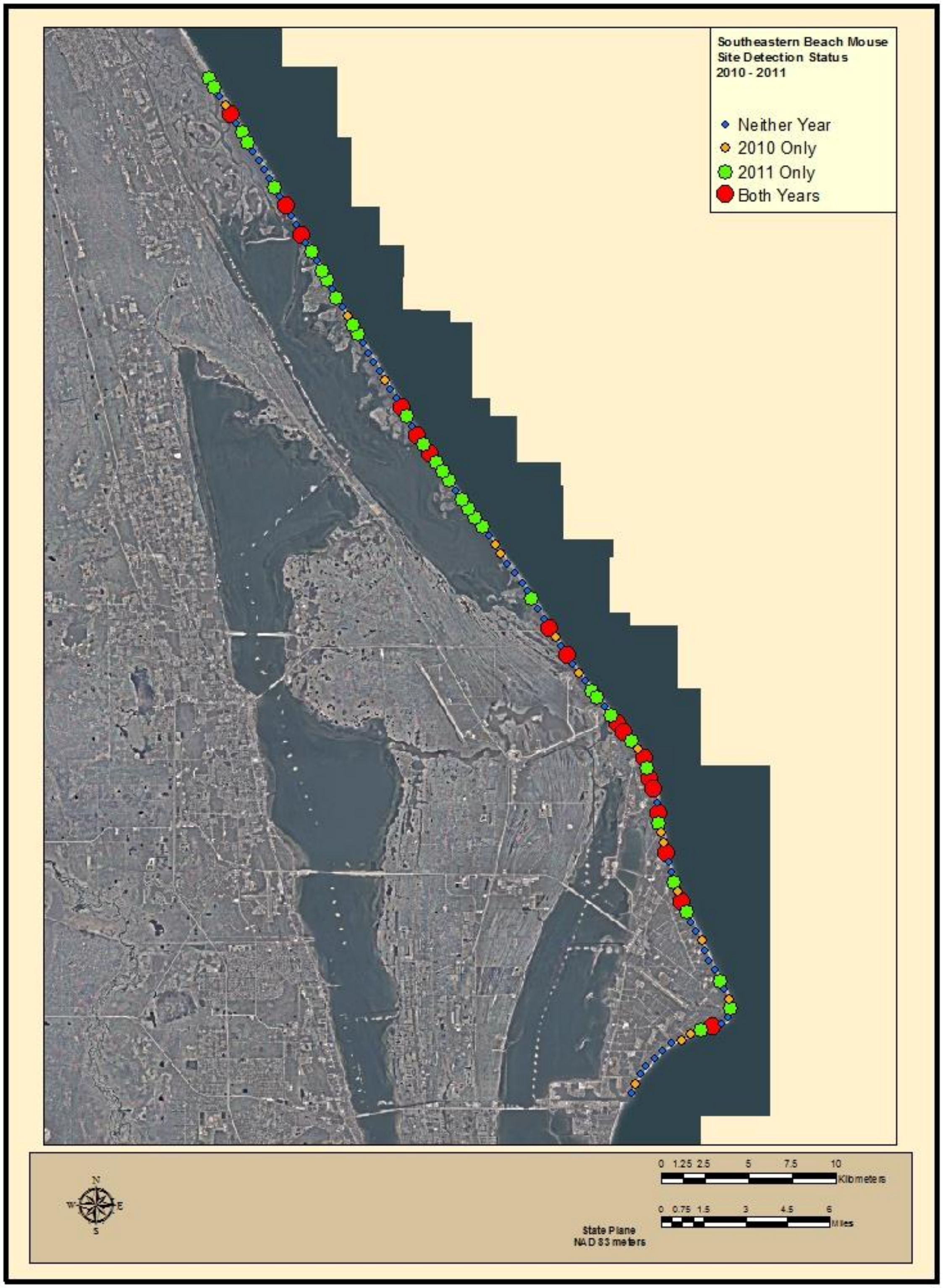


Figure 3-11. Detections via tracking tubes of southeastern beach mice on CNS, KSC, and CCAFS in 2010 and 2011.

Northern Right Whale

The northern right whale occupies waters off Boston and Canada for feeding during the summer and migrates south during the winter months (Wynne 1999). Females and calves can be found very close to Georgia and Florida shores, the only known right whale calving grounds, between December and March when pregnant females give birth to their young (NOAA 2012). In 1994, NMFS designated the coastal waters of Georgia and Florida as right whale critical habitat (Federal Register 1994; Fig. 3-12). Right whales are observed regularly off the Brevard County coast; the Cape Canaveral region is generally considered to be their southern limit, although there are occasional sightings further south (NOAA 2012).

North Atlantic right whales are critically endangered with an estimated population size of 300 - 400 individuals, but recent analysis of sighting data suggests a slight growth in population size (NOAA 2012). Mortality from boat strikes and fishing gear entanglement are the two major threats to this species, but habitat degradation, contaminants, climate change, and noise are also concerns.

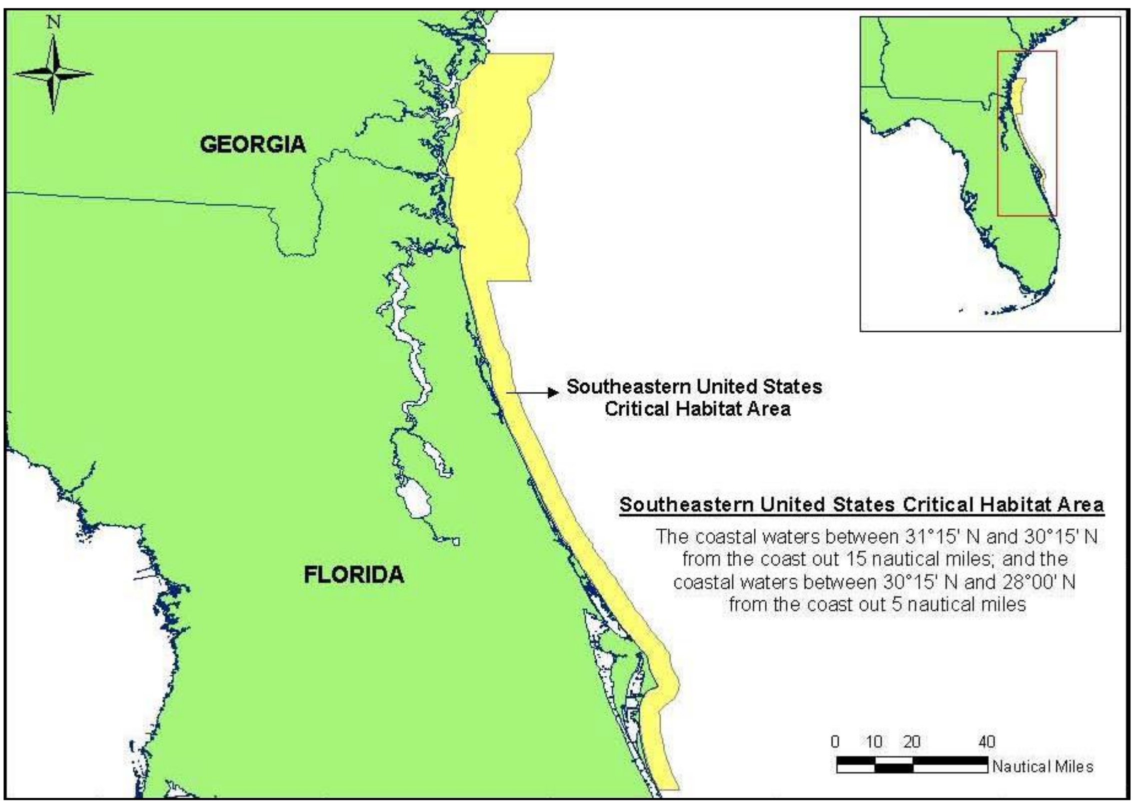


Figure 3-12. Location of designated critical habitat for the northern right whale in the southern part of the range.

West Indian Manatee

The estuarine waters surrounding KSC serve to provide year-round safe harbor and foraging areas for West Indian manatees. Monthly aerial surveys of manatees have been conducted over the KSC portion of the Banana River since 1977. Manatees can be found at KSC during all months of the year, except when winter cold fronts drop water temperatures below 19°C (66°F). KSC generally experiences a spring peak in manatee numbers followed by a fairly consistent number of animals in summer, another increase each fall, and then a drop each winter. The north end of the Banana River, south to near KARS Park I, is protected from entry of motorized watercraft, either by KSC security restrictions or as a designated manatee sanctuary. Over the last three decades, spring numbers within the KSC survey area have increased nearly tenfold; in 2012 over 1000 individuals were observed on one survey. This represents approximately 20 to 25% of the total Florida population. Average counts per survey for summers 1990-2010 are shown in Figure 3-13.

It has been assumed that the quiet KSC waters (within the sanctuary) combined with extensive seagrass beds, primarily shoalgrass (*Halodule wrightii*) and manatee grass (*Syringodium filiforme*), provide good habitat that manatees continue to use and teach their offspring to locate (Provancha and Hall 1991). However, recent episodic algal blooms in this region resulted in an approximate 90% reduction in seagrass in 2011 and 2012 (J. Provancha pers. obs.). The impacts on manatees and other seagrass dependent species remain to be seen. Seagrass mapping in collaboration with the SJRWMD and the U.S. Geological Survey is underway, and monitoring of manatee distribution continues (J. Provancha pers. comm.).

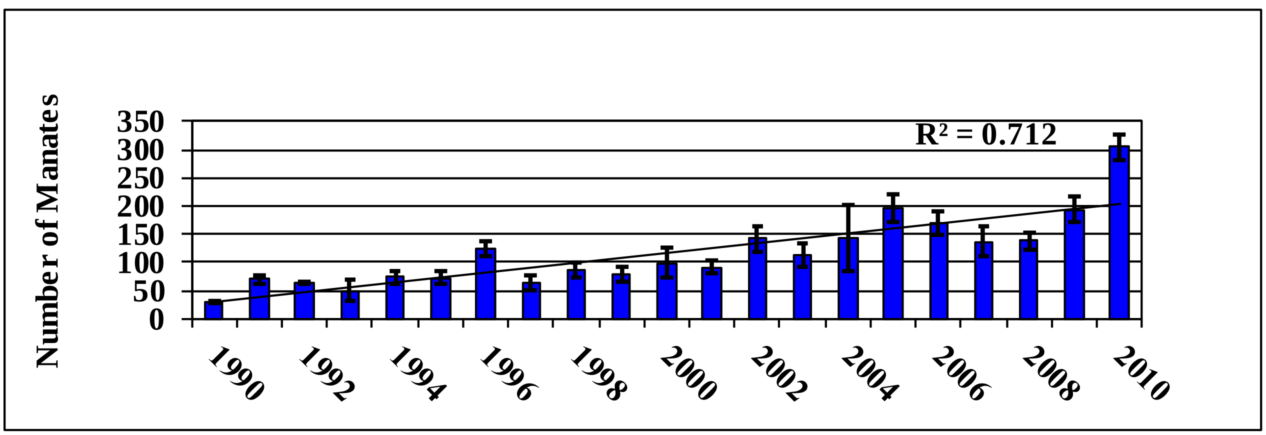


Figure 3-13. Mean number of manatees per aerial survey in the KSC Banana River survey route during summers 1990-2010.

3.4.6 Geology and Soils

Data regarding the geology and soils of KSC were well described in "Geology, Geohydrology and Soils of Kennedy Space Center: A Review" (Schmalzer and Hinkle 1990). Descriptions of these resources are found in the KSC Environmental Resources Document (NASA 2010) as well.

3.4.6.1 Geology

Sediments underlying KSC have accumulated in alternating periods of deposition and erosion since the Eocene. Surface sediments are of Pleistocene and Recent ages. Fluctuating sea levels with the alternating glacial interglacial cycles have shaped the formation of the barrier islands. The formation of Merritt Island may have begun as much as 240,000 years ago, but most of the surface sediments are not that old. Cape Canaveral was probably formed less than 7,000 years ago, as was the barrier strip separating Mosquito Lagoon from the Atlantic Ocean. Deep aquifers beneath KSC are recharged inland, but are highly mineralized in the coastal region and interact little with surface vegetation. The Surficial Aquifer is recharged by local rainfall and sand ridges in the center of Merritt Island. Discharge is from evapotranspiration and seepage to canals, ditches, interior wetland swales, impoundments, lagoons, and the ocean. This aquifer exists in dynamic equilibrium with rainfall and with the freshwater/saline water interface. Freshwater wetlands depend on the integrity of this aquifer and it provides freshwater discharge to the lagoons and impoundments.

3.4.6.2 Soils

The soils of KSC are mapped in the soil surveys for Brevard County (Huckle et al. 1974) and Volusia County (Baldwin et al. 1980). Fifty-eight soil series and land types are represented, even though Merritt Island is a relatively young landscape formed from coastal plain deposits. The primary source of parent material for KSC soils is sands of mixed terrestrial and biogenic origin. Soils on the barrier island section east of Banana River and Mosquito Lagoon are younger than those of Merritt Island and, therefore, have had less time to weather. Well-drained soil series (e.g., Palm Beach and Cape Canaveral) in these areas still retain shell fragments in the upper layers, while those inland on Merritt Island (e.g., Paola and Pomello) do not. The presence of shell fragments influences soil nutrient levels, particularly calcium and magnesium, and pH. The eastern and western sections of Merritt Island differ in age. The eastern section of Merritt Island, inland to near SR 3, has ridge/swale topography, presumably retained from its formation as a barrier island. West of SR 3, the island is flatter, without obvious ridges and swales, probably due to its greater age. Differences in age and parent material account for some soil variations, but on landscapes of Merritt Island with similar age, topography has a dramatic effect on soil formation. Relatively small elevation changes cause dramatic differences in the position of the water table that, in turn, affect leaching, accumulation of organic matter, and formation of soil horizons. In addition, proximity to the lagoon systems influences soil salinity (NASA 2010).

Soils at LC 39A and LC 39B are highly disturbed since the sites have been used as an industrial facility launching rockets over the last 50 years. The soils map indicates the entire area within the perimeter of both launch complexes and the Crawlerway is classified as urban land (Figure 3-14). The sites have received many cubic feet of fill and concrete and have been disturbed by launch operations and maintenance. Surface soils within the LC 39A fence were sampled by

Schmalzer et al. in 1993 as part of the long-term monitoring for the Space Shuttle Program. The pH in the soil is highly buffered and remains alkaline even after 10 years of processing Space Shuttle launches and the associated hydrogen chloride (HCl) deposition that occurred with each launch.

The five HIF location options vary in soil composition. Figure 3-15 shows drainage characteristics of soils in the Proposed Action area. The majority of HIF Option 1 is considered existing urban land with areas of poorly to moderately drained soils. It contains Felda and Winder ponded soils, which are usually found inside dikes built for mosquito control and accumulate water during rainy periods. Immokalee sand found in the southeastern portion of the site is a poorly drained sandy soil. HIF Options 2, 3, and 4 all have moderately drained, poorly drained (Immokalee) to very poorly drained soils, and also include areas of submerged soils classified as tidal marsh and open lagoon. Option 3 also contains a large parcel of Canaveral sand, which is a moderately well drained sandy soil mixed with shell fragments. HIF Option 5 is located in an area classified as urban land with small pockets of moderately well drained (Canaveral), and very poorly drained soils.

The RP-1 option locations include existing roadways that are considered disturbed. The Common RP-1 Storage option has small areas of submerged soils along the unnamed road that connects Titusville Beach Road to the Crawlerway at LC 39B. These road areas also contain Myakka and Immokalee sand. The Myakka series consists of poorly drained sandy soils usually found in broad areas of flatwoods, and in areas between sand ridges and swales. There are very poorly drained soils, classified as submerged marsh along Titusville Beach Road and Pad A Emergency Road. The proposed Common RP-1 site is classified as urban land with a small area of submerged marsh. The areas within the Individual RP-1 Storage option are poorly drained and are classified as tidal marsh and submerged marsh. Small pockets of excessively drained soils (Palm Beach sand) are present along Phillips Parkway and LC 39A By-Pass Road. RP-1 Individual storage areas located at LC 39A and LC 39B are considered urban land, which are disturbed due to past launch operations and maintenance.

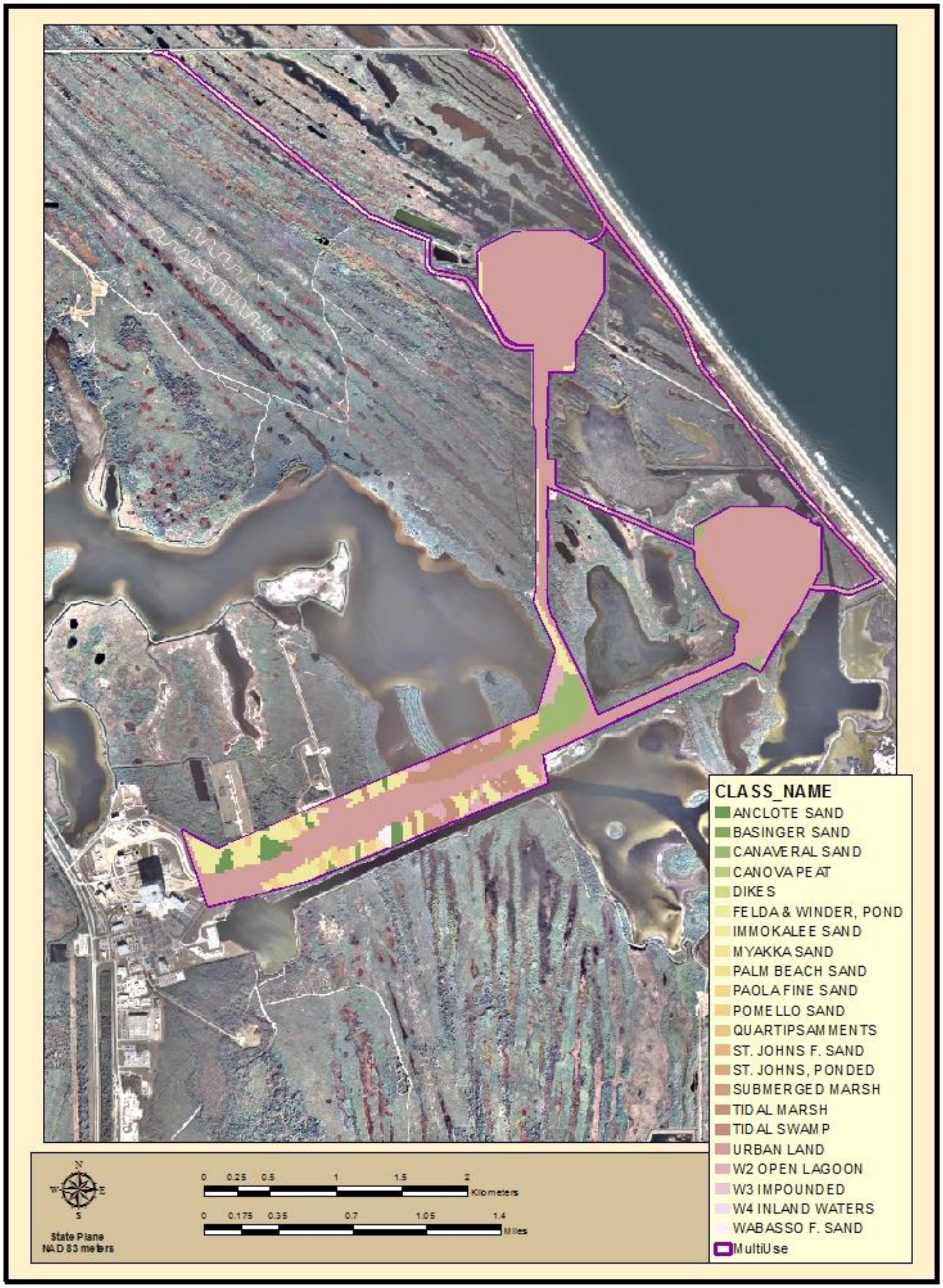


Figure 3-14. Soils classifications within the Proposed Action area.

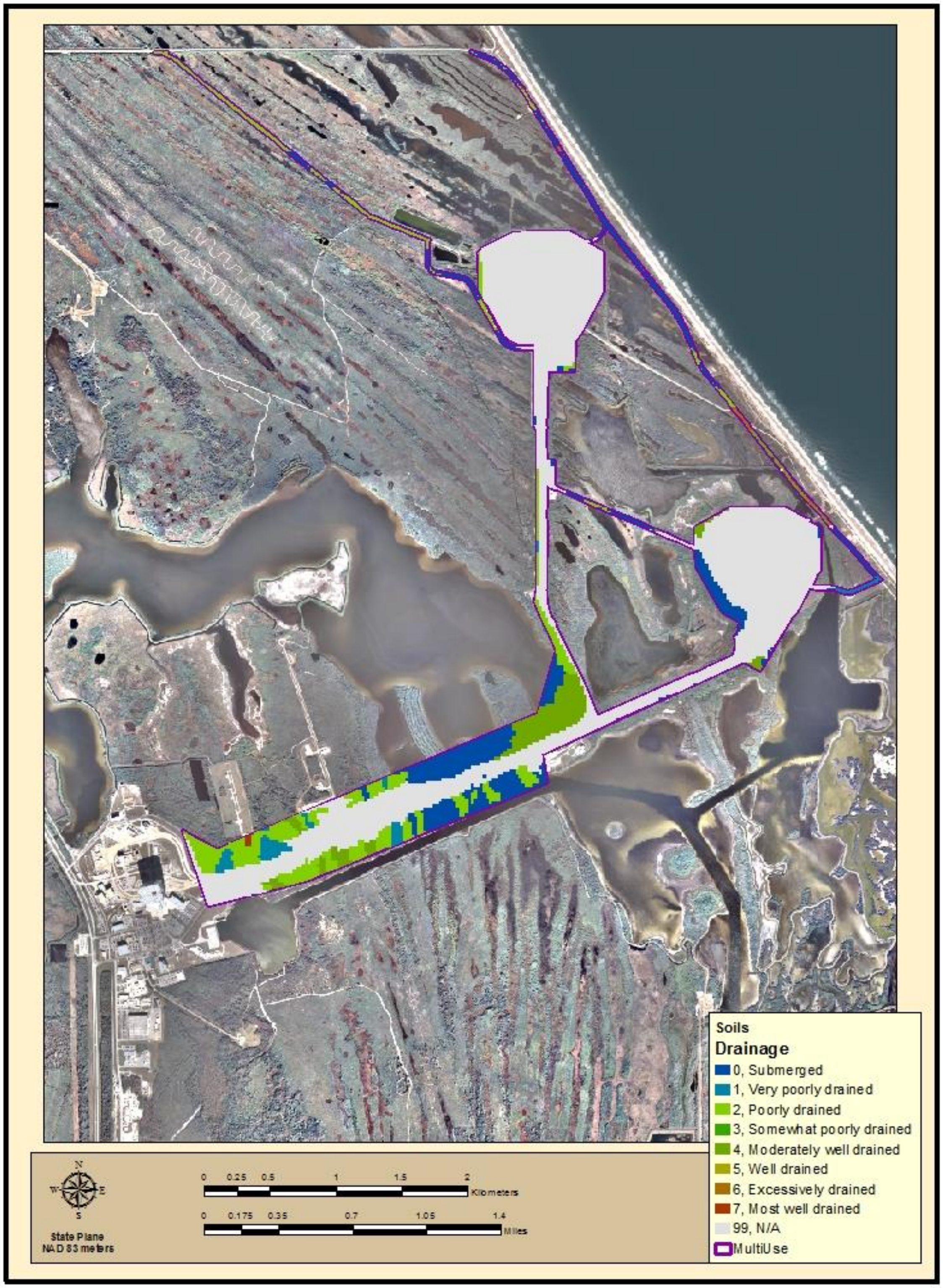


Figure 3-15. Soil drainage characteristics in the Proposed Action area.

3.4.7 Historic and Cultural Resources

In January 2000, LC 39A (constructed in 1965) and LC 39B (constructed in 1968) became the first KSC sites to be listed in the National Register of Historic Places (NRHP) (State Identification Number 8BR2686 and 8BR2010, respectively). There are approximately 24 contributing resources (e.g., camera pads, LOX/LH2 facility, support buildings, etc.) at each complex. The boundary of the historic site designation extends approximately 9 m (100 ft) outward and parallel to the perimeter service road of each complex.

The launch pads underwent major modifications from 1976 to 1985 to accommodate the Space Shuttle vehicle. The main elements of the rebuilt pads were the hardstand, the flame trench and deflector system, the fixed service structure (formerly part of the Apollo-era launch umbilical tower), and the rotating service structure, which included the payload changeout room. Other modifications were new weather protection structures and a fully computer-automated payload ground handling mechanism.

LC 39A was the site of the first Saturn V launch in 1967, the Apollo 4 mission, and the Apollo 11 mission in 1969 which took astronauts Armstrong, Aldrin, and Collins to the moon. In total, 11 Apollo missions and one Skylab mission, all using the Saturn V rocket, were launched at LC 39A. On April 14, 1981, the first Space Shuttle was launched from LC 39A, followed by an additional 80 launches.

LC 39B was the launch pad for one mission for the Apollo Program, Apollo 10 (May 18, 1969) and three Skylab Program missions on May 25, July 28, and November 16, 1973. The Apollo-Soyuz Test Project mission in 1975 was the last flight of the Apollo Program. On January 28, 1986, Challenger was the first Space Shuttle to lift off from LC 39B. This mission ended when Challenger exploded approximately one minute after launch, taking the lives of all the astronauts. This launch facility was also the site of two “Return-to-Flight” missions, one after Challenger (STS-26 on September 29, 1988) and the other after the Columbia accident (STS-114 on July 26, 2005). Fifty-four Shuttle launches occurred at LC 39B. In 2008, a new Lightning Protection System (LPS) was constructed in support of the Constellation Program. The LPS consists of three free-standing towers approximately 161 m (528 ft) tall with a network of grounding cables extending between the towers. Prior to the completion of the Space Shuttle Program, the Florida State Historic Preservation Officer (FL SHPO) concurred in 2009 on the modifications of certain historic assets at LC 39B (FDOS 2009) so that NASA KSC could transform the complex to support the next space exploration program, Constellation. This agreement was reached because KSC has another existing launch complex (LC 39A) for which NASA completed mitigation of early historic recordation in August 2010 (ACI 2010a). On October 28, 2009, Ares I-X was launched from LC 39B as the first stage prototype and design concept demonstrator in the Ares I Program, a launch system for human spaceflight developed by the U.S. Space Agency, as part of the Constellation Program. The Constellation Program was subsequently cancelled.

The Crawlerway (State Identification Number 8BR1689) was completed in 1965 and listed in the NRHP in January 2000. Originally nominated because of its importance to the Apollo Program, the Crawlerway has since gained significance in the context of the Space Shuttle Program. The Crawlerway was originally designed and built during the Apollo era as the roadway for the transportation of the combined Mobile Service Structure, launch umbilical tower/launch vehicle, and Crawler Transporter(s), between the VAB and launch pads. It performed the same function in the transportation of the Space Shuttle vehicle atop the Mobile Launcher Platforms (MLPs) and Crawler Transporters. The Crawlerway is a unique dual-lane surface engineered to withstand the pressure from the massive weight of the combined launch vehicle, its support structure, and the Crawler Transporters. The portion of the Crawlerway located west of the VAB was altered ca. 1985 with the addition of modular office buildings, trailers, and a parking lot. The boundary of the historic property includes the length and width of the existing Crawlerway, roughly defined by an approximate 3 m (10 ft) buffer zone along the outer extent of the surface aggregate, and expands to include the facility support pedestals at each MLP Refurbishment Area. This includes the facility and all necessary components historically required for its functions.

The KSC railroad track was surveyed in January 2012 (ACI 2012) and NASA KSC determined that 30.6 km (19 mi) of the railroad track (Figure 3-16) was eligible for listing in the NRHP. The FL SHPO concurred with this determination in January 2013 (FDOS 2013). The railroad system was used throughout the Space Shuttle Program to carry Solid Rocket Booster components between the Jay Jay Yard and the various facilities within KSC.

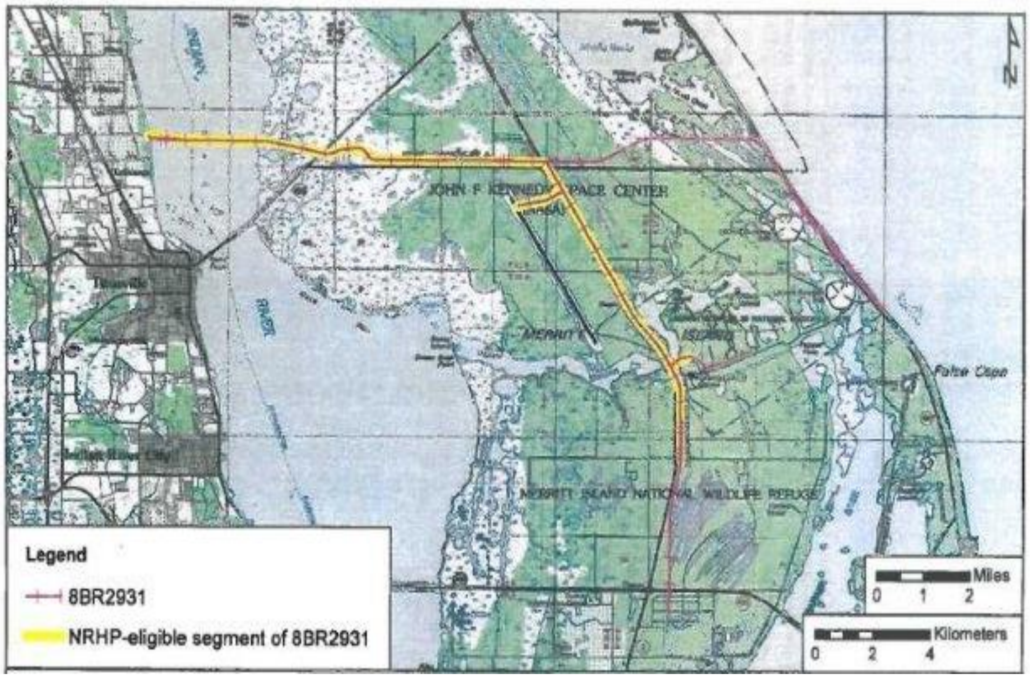


Figure 3-16. Segment of KSC railroad track recently determined eligible for the NRHP (ACI 2012).

In addition to historic facilities, there are archaeological and historic areas of significance on KSC within or near the project boundary. Between 1990 and 1996, Archaeological Consultants, Inc., established differential zones of archaeological potential (ZAPs) within all areas of KSC. The ZAPs were defined as low, moderate, and high probability based on background research and archaeological field surveys. In 2008-2009, NASA initiated a study of the last 200 years of KSC history, including the development of a historic context and expansion of the predictive model to include historic period archaeological sites, ca. 1700 to 1958. A total of 122 ZAPs were identified within KSC and approved by the FL SHPO in February 2010. Predictive modeling has been used as an effective tool for KSC during the early planning stages of an undertaking, for targeting field surveys, and for other management purposes. As funds become available or projects arise, areas will be groundtruthed and known archaeological sites requiring additional surveys will be reevaluated for NRHP eligibility.

For the Individual RP-1 Storage areas, there are two known archaeological sites (8BR84/No Name and 8BR79/Titusville Beach) and two historic areas (#118 and #119) along Phillips Parkway (ACI 2009). The 8BR84 site is believed to contain historic refuse; however, it could not be found during the 1991 survey. The precise location and nature of the site is uncertain. It is believed that 8BR84 is associated with the Ribault shipwreck. The 8BR79 site is within a moderate ZAP area, shown in Figure 3-17, and contains shell middens and historic refuse.

8BR79 was largely destroyed in the mid-1960s during construction of the railroad and Coast Guard Station, as well as the subsequent demolition of the Coast Guard Station and land clearing activities. Further, midden material for 8BR79 may have been used as fill at LC 39A. The site has undergone additional changes since the 1960s due to extensive land leveling. The FL SHPO concurred with the findings and site management recommendations report in 1991 (FDOS 1991). Further field work would be required for 8BR84 if the location of the site can be found. Land alterations in the area of 8BR79 can proceed without further archaeological consideration.

Historic Area #118 consists of seven structures shown on a 1934 Intracoastal Waterway map; four structures and the label for the Canaveral Club are found on the 1949 quad map. The Canaveral Club was a hunting and fishing club composed entirely of members of the Harvard University class of 1890. The 22 room clubhouse had a concrete swimming pool, golf course, and stables. The clubhouse was destroyed by fire and the site was demolished by the construction of the launch pads. Historic Area #119 was the location of the Chester Shoals House of Refuge/Coast Guard Station; 8BR79 is also located in this area. An 1882 Act of Congress authorized construction of the House of Refuge and it was used as a Coast Guard and training station until World War II. Historic areas #118 and #119 are recommended for future archaeological testing (ACI 2009).

An archaeological site (8BR2364/Bottle Dump Site) is located within Historic Area #118. During a routine post-launch ecological survey, a KSC employee observed 20 to 30 bottles along the lagoon shoreline (ACI 2009b). In November 2009, KSC conducted an archaeological survey and evaluation of the area to determine if this site was eligible for listing in the NRHP and/or connected to the Canaveral Club. Results of the survey show the site is composed of fill materials. The artifacts found at the site consisted of ceramics, glass, white ware, and bottles, etc. It is still uncertain whether the bottles found were re-deposited or were an actual intact feature (ACI 2009b). The FL SHPO concurred that the site is considered ineligible for listing in the NRHP and further testing at 8BR2364 is not warranted (FDOS 2010).

Historic Area #54 is noted in the ACI report (2009a) and consists of a series of roads found on a 1934 Intracoastal Waterway map and a 1949 quad map. Local lore says they were built by Max Hoeck in order for him to traverse the property. One of the roads was incorporated into the road leading to LC 39B.

Figure 3-17. Historical and cultural properties in the vicinity of the Proposed Action. Note: 8BR and Historic Area numbers are not noted on the map to protect these sites.

3.4.8 Hazardous Materials and Waste Management

3.4.8.1 Hazardous Materials Management

A hazardous material is defined in the Hazardous Materials Transportation Act (HMTA) as a substance or material in a quantity and form that may pose an unreasonable risk to health and safety or property when transported in commerce. Hazardous materials are identified and regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), OSHA, the Toxic Substance Control Act (TSCA), and the Emergency Planning and Community Right-to-Know Act (EPCRA). Numerous types of hazardous materials are used to support the various missions and general maintenance operations at KSC. These materials range from common building paints to industrial solvents and hazardous fuels. Categories of hazardous materials used in support of past Space Shuttle activities include petroleum products, oils, lubricants, volatile organic compounds (VOC), corrosives, refrigerants, adhesives, sealants, epoxies, and propellants. Management of hazardous materials, excluding hazardous fuels, is the responsibility of each organization.

The KSC Spill Prevention, Control, and Countermeasures (SPCC) Plan (NASA 2012d) outlines the criteria established by KSC to prevent, respond to, control, and report spills of oil. Various types and quantities of oil are stored, transported, and handled to support the operations of KSC. The KSC SPCC Plan describes both the facility-wide and site-specific (KSC-PLN-1920) approaches for preventing and addressing spills.

3.4.8.2 Hazardous Waste Management

Hazardous waste is defined in the Resource Conservation and Recovery Act (RCRA) as any solid, liquid, contained gaseous, or semi-solid waste, or any combination of wastes that could or do pose a substantial hazard to human health or the environment. Waste may be classified as hazardous because of its toxicity, reactivity, ignitability, or corrosivity. All hazardous wastes generated on KSC must be managed, controlled, stored, and disposed of according to regulations found in 40 CFR Parts 260 through 282 and FAC Chapter 62-730.

In this section, the presence of known or suspected contaminants on or near the action alternative sites is discussed. NASA KSC has a program to evaluate sites where contamination is present under RCRA and its Hazardous and Solid Waste Amendments. KSC's Remediation Program was initiated in response to an agreement with FDEP in the late 1980s regarding KSC's oldest contamination remediation sites or Solid Waste Management Units (SWMU), Wilson Corners and Ransom Road Landfill. Since then, KSC has been working with the EPA and FDEP to identify potential release sites and implement corrective action at those sites as warranted. EPA's SWMU Assessment (SA) initially identified 16 sites for investigation under the corrective action program. More sites were also identified by KSC as the program was implemented. In addition to corrective action sites, the NASA Remediation Group also manages petroleum contamination sites. To date, KSC has identified and investigated approximately 200 sites.

SWMUs and Potential Release Locations (PRLs) are generally concentrated in operational areas such as the VAB, LC 39, Industrial Area, and facilities on CCAFS currently or formerly operated by NASA. The most prevalent soil contaminants are petroleum hydrocarbons, RCRA metals, and polychlorinated biphenyls (PCB); and the most prevalent groundwater contaminants are chlorinated solvents and associated degradation products. Locations of the surrounding SWMU and PRL sites are depicted in Figures 3-18 and 3-19.

SWMU 8 LC 39A

LC 39A has been designated as SWMU 8. There are nine operational support areas that may have impacted environmental media at LC 39A. These areas are the Compressed Air Building (J8-1659), Environmental Control System (J8-1768), Heating, Ventilation, and Air Conditioning Building (J8-1707), Hypergol Fuel Facility (J8-1906), Hypergol Oxidizer Facility (HOF, J8-1862), Deluge Basin Area (DBA, two holding tanks), Sewage Treatment Facility (STP #5), Domestic Treatment Plant (DTP) #1 associated with LOX Operation Support Building A-1 (J8-1503), and DTP #2 associated with LH2 Operation Support Building A-2 (J8-1614).

RCRA Facility Investigation (RFI) activities were performed at LC 39A from early 1998 through mid-2000. In the DBA portion of the site, groundwater impacts due to VOCs were observed. In the HOF area, PAHs, pentachlorophenol, and 2, 4, and 6-trichlorophenol were detected above maximum contaminant levels and groundwater cleanup target levels (MCLs/GCTLs) in two monitoring wells. Surface water inside and outside of the perimeter fence contained PAHs and metals above Surface Water Cleanup Target Levels (SWCTLs) and some pesticides were also detected outside the fence line. An interim measure (IM) was conducted in 2000, which removed soils contaminated with PCBs and PAHs (Geosyntec 2002).

Supplemental RFI activities were performed from mid-2000 through early 2003 to further evaluate extent of contamination and potential ecological risks to the environment. These investigations focused on the LOX area, the DBA, the HOF area and the surface water and sediment outside of the perimeter fence. Groundwater at LC 39A is classified as GIII (for remediation purposes) and will not be used as a future source of drinking water. Groundwater from the pad area discharges to surrounding surface waters, which are classified as OFW and therefore, must not receive discharges of contaminants above background levels. A Corrective Measures Study (CMS) Work Plan has been developed to address groundwater contamination at LC 39A. Metals are present in the swale sediments and a CMS was recommended to evaluate means for controlling potential off-site migration of these contaminants. There are several contaminants in site soils that pose an unacceptable risk to future potential residents. Restrictions are in place for any site work to prevent soils from leaving the area from which they were excavated. An interim measure was completed in 2009 for trichloroethylene (TCE) contaminated soils in the area west of the LOX tank. This activity included excavation and disposal of 382 m^3 (500 cubic yards [cy]) of contaminated soil. A groundwater plume has been identified in the northwest portion of the pad and is under investigation (Geosyntec 2003).

Sitewide soil and groundwater sampling at various intervals was conducted between December 2011 and October 2012 to determine current baseline conditions and further evaluate contamination resulting from former launch activities. The investigation confirmed the presence of VOCs in groundwater at concentrations greater than FDEP GCTLs. Soils were found to exceed the Industrial Soil Cleanup Target Levels (SCTLs) for PAHs and PCBs. Additional soil areas have one or more Chemicals of Concern (COCs) in exceedance of residential SCTLs. These contaminants include arsenic (As), barium (Ba), copper (Cu), nickel (Ni), thallium (Tl), PAHs, and PCBs (NASA 2012e).

SWMU 9 LC 39B

An RFI was conducted at LC 39B in 1998. Results indicated metals, PCBs, and PAHs were present in soils; and chlorinated volatile organic compounds (CVOCs), pentachlorophenol, and metals were present in groundwater.

Additional RFI activities from 2000 to 2003 indicated the extent of inorganic constituents exceeding screening criteria outside the pad fence is limited. TCE and inorganic constituents were found to exceed the SWCTLs. An interim measure was conducted in 2003 and 2004 to remove soil impacted with PCBs.

Groundwater at LC 39B contains VOCs and metals above the FDEP groundwater cleanup target level values. Soil remaining on site contains benzo(a)pyrene (B(a)P) and As in the Heating, Ventilation, and Air Conditioning area, PCBs in the Deluge Basin Area, and Ni in the Compressed Air Building Area. Swale soil contains Zn at concentrations above Residential Soil Cleanup Target Level (R-SCTL) values.

Corrective measures for groundwater were implemented from December 2005 to September 2007 and involved an enhanced bioremediation approach, which relied on the injection of sodium bicarbonate, potassium lactate, and a microbial culture into a network of injection wells. Approximately 52% total CVOC removal resulted from this activity (NASA 2012f).

A Land Use Control Implementation Plan (LUCIP) was prepared to inform workers at LC 39B of institutional controls implemented at the site. These land use controls are necessary to prohibit the use of groundwater from the site and prohibit residential exposure to soil and swale soils.

A comprehensive sampling effort was conducted in 2011/2012 to evaluate current environmental conditions. Goals included identifying the absence or presence of impacts to groundwater, surface water, soil, and sediment. Soils at current and former transformer locations were analyzed for PCBs and total recoverable petroleum hydrocarbons (TRPH), and were below R-SCTL for all but one former transformer location. Soils throughout LC 39B were analyzed for 8 RCRA metals, Zn, Al, PAHs, and PCBs. There were exceedances of As, Ba, Cr, B(a)P toxic equivalents, and PCBs. Analysis of surface water samples detected arsenic, chromium, copper, and zinc above screening criteria. Semi-volatile organic compounds (SVOCs), PAHs, and metals (Cu, lead [Pb], mercury [Hg], and Zn) were detected in sediments. An interim measure is planned for soil.

SWMU 5 Flight Crew Rescue Training Area

The Flight Crew Rescue Training Area is located between the Barge Turning Basin and Saturn Causeway. This area encompasses 4 ha (10 ac) and included a rescue trailer, an administration trailer, and a replica of the forward compartment of the Space Shuttle for training purposes. This area was previously used as a staging area for construction materials unloaded from barges, and as a parking area for heavy equipment during construction of the VAB. A Health and Environmental Risk Assessment (HEA) was performed and identified no Chemicals of Potential Concern (CPOCs) in the soil. VOCs were the only analytes consistently detected in groundwater at the site. Monitoring of VOCs was recommended in the RFI and decreases in concentrations of VOCs led to the assumption that these CPOCs would naturally attenuate. Sampling events in January and April 1998 detected no vinyl chloride, the only chemical previously detected above Florida MCLs. A No Further Action (NFA) was recommended since it was determined that human health and ecological risks associated with the site did not warrant corrective measures or further monitoring (NASA 2000).

SWMU 56 Mobile Launcher Platform (MLP) Park Sites/VAB Area

The MLP Park Sites/VAB Area (SWMU 56) includes the three MLP Rehabilitation Sites and the VAB. A LUCIP has been prepared for the MLP/VAB Area to prohibit the use of groundwater from the site and residential exposure to surface soil northwest of the VAB. The RFI identified VOCs and ammonia in groundwater, and B(a)P and PCBs in surface soil that exceeded FDEP and EPA cleanup target levels. SWMU 56 also includes VOCs and ammonia present in the groundwater at the KSC Press Site, the former Saturn V Rocket Display Area, and Orbiter Processing Facility 3. Enhanced bioremediation was implemented in the TCE source area from August 2006 until March 2009. The area is currently being monitored and the biosparge system is still operational. An IM is being implemented and involves using a network of air sparge wells to treat a zone defined by the area with high TCE and cis-dichloroethene concentrations, which encompasses approximately 0.4 ha (1 ac) with a vertical treatment interval from 9 to 15 m (30 to 50 ft) below land surface (BLS). These IM activities will be performed over the period of one to two years and may be continued as appropriate to treat COCs and groundwater impacts until concentrations reach FDEP GCTLs.

SWMU 106 Fire Station #6

The Fire Station #6 Area has been designated SWMU 161 under KSC's RCRA Program. IM activities were conducted to remediate soil affected by COCs above FDEP Residential SCTLs. Contaminants included As, Ba, Cr, Cu, Pb, Hg, carcinogenic PAHs, B(a)P equivalents, and

PCBs. Approximately 79.8 m^3 (104.4 cy) of soil was excavated from the site at drainage outfalls, groundwater storage tanks, and a former aboveground storage tank location.

PRL 167 Launch Control Center (LCC) Area

The LCC area encompasses 8.9 ha (22 ac) approximately 107 m (350 ft) east of the VAB and within the security controlled VAB fenced area. An SA of this site, designated PRL 167, identified five Locations of Concern (LOCs) including transformers, hazardous waste staging buildings, and the High Pressure Gas Storage Area (NASA 2007b). Soil in the LCC area was impacted with PCBs and Cu at concentrations exceeding the FDEP R-SCTL values (NASA 2008a). An IM was performed to mitigate human health risks associated with PCBs and Cu present in the soil. Areas included in the IM were five transformers northeast of the LCC, High Pressure Gas Storage Area (K7-0853), and Hazardous Waste Staging Building (K6-0998). An NFA designation has been approved by FDEP for this PRL. However, the LCC is within SWMU 56, which has land use control requirements for groundwater.

PRL 174 Area 2 Repeater Buildings

PRL 174 consists of five distinct areas, four of which are within the Proposed Action boundary. These facilities are Repeater 1 (K7-0709), Repeater 2 (K7-0422), Repeater 3 (K7-0089), and Cable Terminal Building (J8-1567). No LOCs were identified at K7-0709 or J8-1567. Transformer site LOCs were identified at K7-0422 and K7-0089. No exceedance was found at Repeater 3 during confirmation sampling. An IM was performed at Repeater 2 to mitigate human health risks associated with Cu and B(a)P equivalents.

PRL 175 LC39A Operations Support Building Area

The LC 39A OSB Area includes the Pad A OSB, Operations Building No. 1, Sewage Treatment Plant No. 8, Pad A Gate House, Repeater Building No. 4, Rechlorination Building, a survey tower, and guard house. This site was designated PRL 175. Nine LOCs were identified throughout the area including drainage outfalls, survey tower, service area, former drainfield, former crawler parking and laydown area, tank storage area, and transformer areas (NASA 2009b). A Confirmation Sampling Work Plan was developed to provide procedures and strategies to be implemented during field sampling to confirm presence or absence of chemicals of potential concern.

PRL 176 Barge Terminal Facility Area

The Barge Terminal Facility Area (PRL 176) is comprised of the Turning Basin, Helipad area, and former temporary building TRM-001. Current activities at the site include unloading equipment from barges, barge and boat docking, barge repair, and helicopter take-off and landing. Treated wooden camels, a transformer pad, and an unpaved strip of land adjacent to a parking and storage lot were all identified as LOCs during the SA (NASA 2009a). Suspected contaminants of concern are metals, PCBs, PAHs, TRPHs, and SVOCs. Confirmatory sampling activities proposed to evaluate soil, sediment, and groundwater quality have been put on hold.

PRL 196 Area 2 Universal Camera Pads

Universal Camera Pad #7 is one of three camera pads and other structures and sites included in the Area 2 Universal Camera Pads PRL. Camera Pad #7 is located midway between LC 39A and LC 39B on the east side of Phillips Parkway. It is used for remotely operated high speed film and video operations and is also a stop on the KSC Bus Tour. LOCs include an electrical equipment area, a ruderal habitat area by the railroad, and site groundwater. Confirmatory sampling was recommended to determine presence or absence of contaminants including metals, PCBs, hydrocarbons and solvents (NASA 2011c).

PRL 208 Area 3 Camera Pads

Universal Camera Pad #4 is one of the four camera pads included in Area 3 Camera Pads (PRL 208). It is located on the west side of Phillips Parkway, 0.4 km (0.25 mi) south of the intersection of Phillips Parkway with Patrol and Playalinda Roads. This site contains a former residence, electrical equipment, Camera Pad #4 (H7-1986), and Field Mill Site #8 (H7-1965). The SA identified four LOCs including active and former electrical equipment, and the former residence. Confirmatory sampling of soil and groundwater is recommended to determine presence or absence of PCBs, TPH, PAHs, and VOCs.

The following remediation sites are adjacent to the Proposed Action area.

SWMU 30 Component Cleaning Facility (CCF)

The CCF (SWMU 30) is located adjacent to and north of the Crawlerway between the VAB and LC 39A and LC 39B. The area adjacent to the CCF was historically used for converting liquid nitrogen to nitrogen gas, which was then piped to the launch pads. A components cleaning facility and analytical chemical laboratory were established at the CCF but have since been demolished. A RCRA Facility Investigation conducted between 1992 and 1999 identified chemicals of concern including VOCs and SVOCs in groundwater. Institutional land use controls are in place to prohibit groundwater use. Treatment to remove groundwater and surface water contamination consists of an air sparge/soil vapor extraction system and a groundwater pump and treat system.

SWMU 43 East Crawler Park Site

The East Crawler Park Site (SWMU 43) was used as a parking area for the crawlers that transported Space Shuttles from the VAB to the launch pads. Formerly the site was used for parking the Mobile Service Structure (MSS) used during the Apollo Program. Suspected contaminants include lubricating grease and oil, and solvent used during operation and maintenance of the crawlers and former MSS (NASA 2002a). Land use controls are in place to prohibit residential use of the site due to PCBs in surficial soils that exceeded FDEP and EPA cleanup target levels. Soils with PCBs at concentrations over industrial site cleanup target levels were removed.

SWMU 89 Converter/Compressor Building (CCB)

An interim LUCIP has been prepared to inform users of the CCB of controls implemented to prohibit use of groundwater at the site. During an SA, four LOCs were identified and soil, groundwater, and surface water samples were collected in 2004 and 2005. Chemicals of potential concern were present in all media sampled. No further evaluation of surface water was conducted since it is only present during periods of high rainfall and is limited in extent. Further investigation of soils resulted in a designation of NFA for all but one location. An interim measure was conducted to remove soil contaminated with PAHs and PCBs at that location, and an NFA was later approved by FDEP (NASA 2012g). Groundwater containing VOCs greater than FDEP Groundwater Cleanup Target Levels is the only remaining media of concern at the CCB.

SWMU 100 Area South of K7-0516

The Area South of K7-0516 (SWMU 100) includes parking and grassy and forested areas on the southern side of the former Component Cleaning Facility (CCF) and west of the Non-Destructive Evaluation Laboratory (NDEL) PRL. Wastewater from operations at CCF and K7-0516 was discharged to area drainage ditches. The site has been used for miscellaneous storage including storage of compressed gas tankers and demineralized water tankers. The Propellants North breathing air transfer system was located in the parking area during 2002 and 2003. Confirmatory sampling of soils and shallow groundwater resulted in levels less than regulatory criteria; NFA was approved in 2004. However, investigations in the vicinity of the CCF groundwater treatment system showed TCE concentrations moving in the direction of the area south of K7-0516. Recent investigations show the contaminated groundwater plume has extended to the Barge Canal. Groundwater at this site contains VOCs at concentrations greater than FDEP GCTLs. An Interim LUCIP was approved by FDEP in January 2012 to prohibit the use of groundwater at the site and to prevent potential discharge of contaminated groundwater to adjacent surface water bodies designated as OFW.

SWMU 102 Propellants Support Building Area (PSBA)

SWMU 102 is located along Fluid Servicing Road north of the Components Cleaning Facility and the Converter Compressor Building, and contains the Liquid Nitrogen Storage Area (K7-0314). This site consists of paved areas and undeveloped portions classified as brushland and shrub. K7-0314 was at one time used for storage of drums that may have contained TCE and Freon. In 1996, it was outfitted for storage and transfer of Halon and Freon R-21. K7-0314 is currently used for the storage and transfer of Halon, Freon R-21, liquid nitrogen, argon, ammonia, and ethylene glycol. The primary contaminants are TCE and degradation products (NASA 2012h).

The SA for PSBA identified seven LOCs including areas of known drum storage and potential equipment cleaning operations. Soil and groundwater samples were collected as part of Confirmatory Sampling (CS) activities conducted from October 2007 to April 2008 and all soil results were less than regulatory criteria. The CS Report (CSR) recommended NFA for all

LOCs, except LOC 2, due to the presence of VOCs in groundwater. LUCs are necessary to prohibit future use of groundwater in this area. Groundwater at the site contains VOCs at concentrations greater than FDEP GCTLs. The past, current, and projected future land use of PSBA is industrial in nature. LUCs are required to prohibit the use of groundwater at the site until cleanup levels are achieved.

PRL 043 LC39B Transformer Pad Spill

This site was established at the LC 39B Pump Station (J7-1388) after a transformer spill occurred. The area was designated PRL 43, placed under the petroleum program, and was later declared NFA.

PRL 074 Non-Destruct Evaluation Laboratory

The Non-Destruct Evaluation Laboratory was originally constructed in 1984 as a security building and was converted in 1990 for functions including administration, x-ray processes, painting and electrical operations, and storage of various equipment and wastes. Identified LOCs included areas of hazardous and non-hazardous substance use and associated waste storage areas, electrical and painting operations and waste storage, x-ray development and waste discharges, former sewage treatment plant and effluent disposal pond, a previously investigated soil exceedance, and electrical transformers. Soil exceedance of metals and other Residential Human Health and Leachability Criteria were within the range of background values or less than R-SCTLs. Groundwater VOC and hydrocarbon contaminant levels were below GCTLs. An NFA was recommended after it was determined that operations at the NDEL have not resulted in contaminant concentrations in site media above acceptable levels. FDEP concurred with NFA status in August 2004.

PRL 87A Sewage Treatment Plant (STP) 9

An SA of soil and groundwater quality was conducted at STP-9 to determine presence or absence of contaminants. Parameters above screening criteria were detected in area media including the metals aluminum, arsenic, iron, and manganese in surface water and soil, but the values were not indicative of release to the environment. The results were well within the range of values found at other locations across KSC that have no history of discharges to groundwater. VOCs, 1,4-dichlorobenzene and chlorobenzene, were found in groundwater slightly above screening criteria. Sampling results identified low level VOCs in one shallow well north of the former treatment pond. The pond area appears free of suspect contaminants. Since the former treatment pond doesn’t serve as the source of contamination, an NFA was proposed for the site (NASA 1998).

PRL 172 LC 39 Observation Gantry Area

The LC 39 Observation Gantry Area (PRL 172) is located along Saturn Causeway, northeast of the VAB Area. There are four facilities associated with the KSC Visitor Complex tour stop including the LC 39 Observation Gantry Exhibit Building (K7-0140), Guard House (K7-0140A), LC 39 Observation Tower (K7-0141), and LC 39 Tour Stop Concession Building (K7-0142).

This PRL also includes the Security Boathouse (K7-0287), fuel aboveground storage tank (AST) (K7-0287A), and Marine Storage Building (K7-0288). The five LOCs identified during the SA were the AST, Paint, Oil, and Lubricant (POL) Locker, Former/Current Vehicle Storage Area, Retention Basin, and Storage Shed/POL Locker. Groundwater from the AST area contained no contaminants above GCTLs. Soil samples collected at the AST indicated TRPH and lead were below SCTLs and PAHs were above SCTLs but below reference values. NFA was recommended for the AST location. NFA was also recommended for the POL Locker after analysis of groundwater samples came back below GCTLs and soil sample constituents were below SCTLs. Soil samples at the Retention Basin analyzed for TRPH, PCBs, SVOCs, and inorganics were also below SCTLs, and therefore NFA was recommended. NFA was recommended for groundwater after samples from the Storage Shed/POL Locker analyzed for VOCs, PAHs, and TRPH came back below GCTL, and ammonia was found below background levels. Soil samples at the Vehicle Staging Area were found to contain PCBs above R-SCTLs. An Interim Measure Work Plan will be prepared. Groundwater samples at this site were above GCTLs for VOCs. A Step 1 Engineering Evaluation (EE) is being prepared for groundwater.

PRL 193 Tracking Stations

The Tracking Stations area located along the coastline is comprised of the Beach Tracking Sites North and South and the Sea Surveillance Radar Tower. These sites are used for remotely operated film and video of launches and for radar operations. The Beach Tracking Site North (J8-1821) is adjacent to the Proposed Action alternative site boundary. Potential contaminants include hydrocarbons, solvent, and PCBs. Confirmatory sampling has been recommended.

PRL 212 National Park Service (NPS) Lifeguard Station

The NPS Lifeguard Station has been designated PRL 212. This site includes previously identified PRL 81, known as Lloyd's Place. NFA status was given for the Lloyd's Place site by FDEP in February 2005. PRL 212 is located where Phillips Parkway meets Patrol Road and intersects Playalinda Road. The NPS Lifeguard Station boundary extends on both sides of Playalinda Road and includes Eagle 4 Observation Tower (H7-1684), Lifeguard Building (H7-1681), Beach Maintenance Garage (H7-1682), and Chemical Storage Shed (H7-1681A). A SWMU Assessment Report (SAR) has not yet been developed for this PRL.

PRL 221 Beach Warehouse (BEWH)

Adjacent to PRL 174 is the Beach Warehouse (PRL 221). This site was used as a storage and staging area for construction activities at LC 39A. The metal structure was located there from 1965 until 1969 when it was moved to Contractors Road on KSC (D. Sciarini pers. comm. July 2013). This site is currently under investigation by NASA to determine if any past operations are of contamination concern.

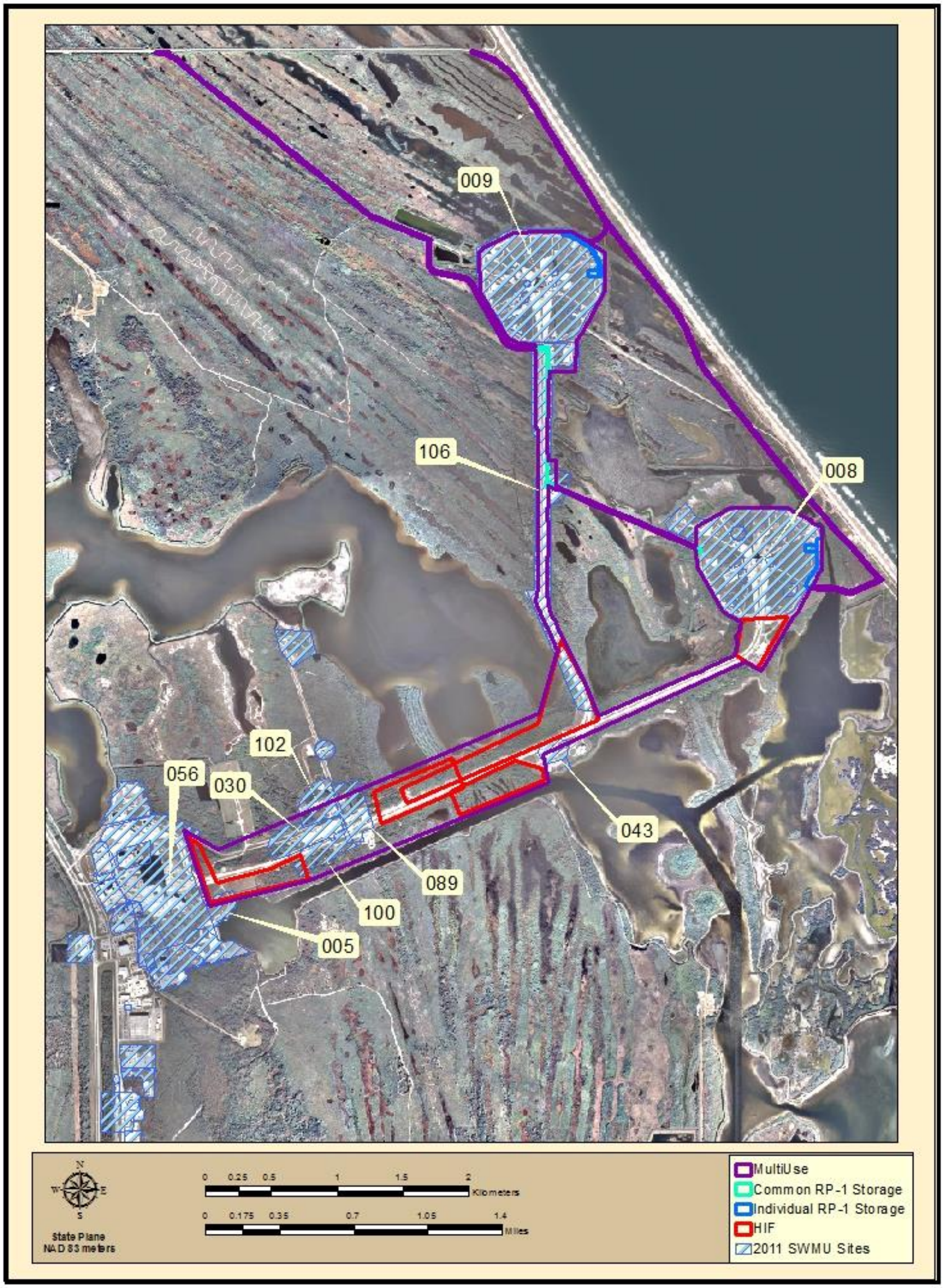


Figure 3-18. Solid Waste Management Unit (SWMU) sites within the Proposed Action area.

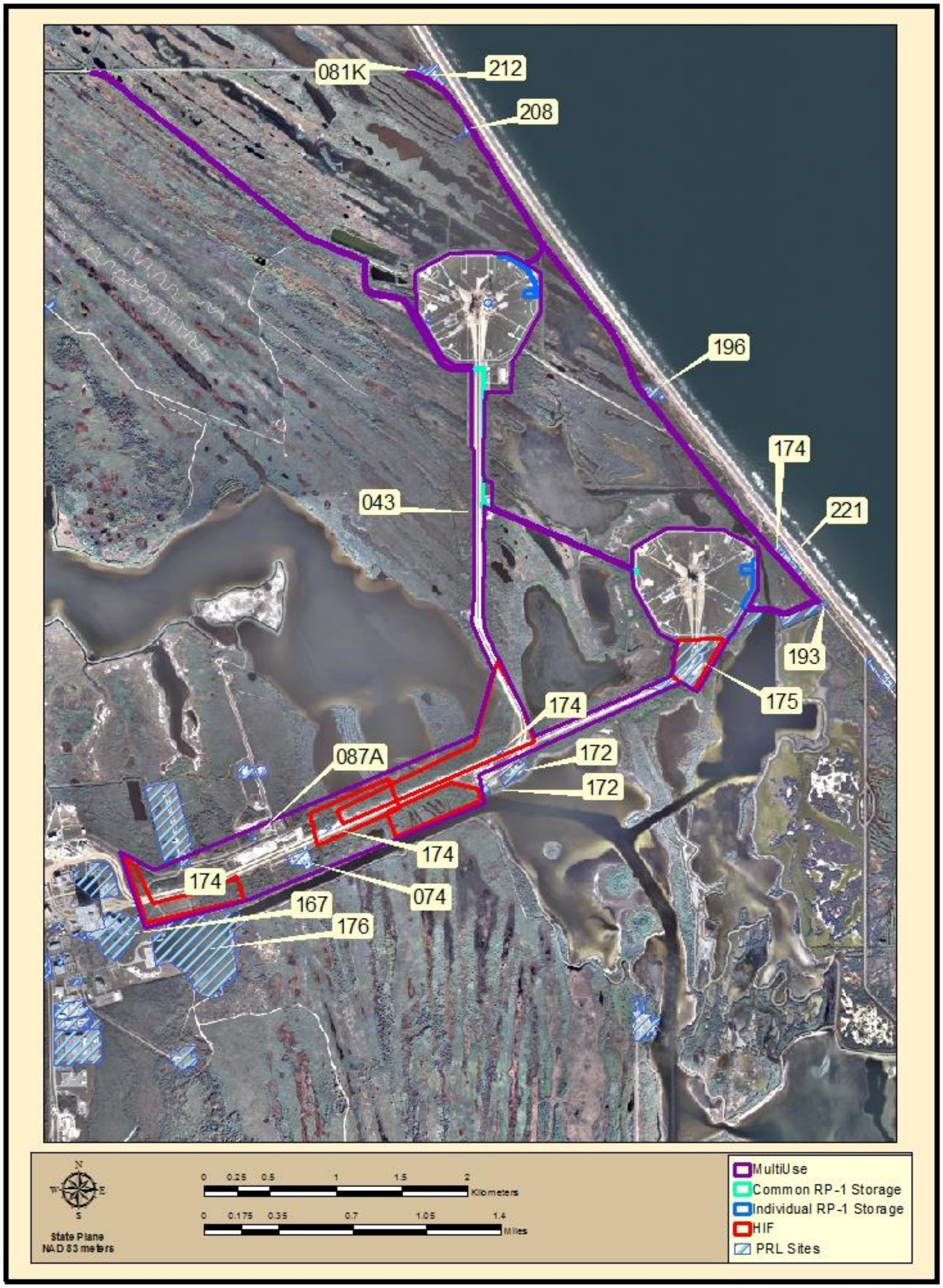


Figure 3-19. Potential Release Location (PRL) sites within the Proposed Action area.

3.4.9 Global Environment

The troposphere is the lowest region of the atmosphere, extending from the Earth's surface to a height of 6 to 10 km (19,700 to 32,800 ft), which is the lower boundary of the stratosphere. The atmosphere above 914 m (3,000 ft) includes the free troposphere ranging from 914 m (3,000 ft) to between 2 and 10 km (6,600 to 32,800 ft) in altitude and the stratosphere extending from 10 km (32,800 ft) to 50 km (164,000 ft). These boundaries should be taken as approximate annual mean values as the actual level of the boundary between the troposphere and stratosphere (tropopause) is variable on a seasonal and day-to-day basis.

3.4.9.1 Troposphere

The upper (free) troposphere ranges from 2 km (6,600 ft) to 10 km (32,800 ft) and is generally referred to as the free troposphere. This layer is characterized by vigorous mixing, which is driven by convective upwelling, horizontal and vertical winds, as well as transport and washout of gases that have been introduced into this region by industrial sources. This layer does not contain any uniquely important atmospheric constituents and it does not generally influence air quality in the lower troposphere (i.e., atmospheric boundary layer [ABL], which extends from Earth's surface to about 3 km [6,600 ft]). The air temperature of the ABL decreases with increasing altitude until it reaches the inversion layer where the temperature increases with increasing altitude. The ABL is considered the most important boundary layer with respect to the emission, transport, and dispersion of airborne pollutants. The portion of the ABL between Earth's surface and the bottom of the inversion layer is known as the mixing layer. Almost all of the airborne pollutants emitted into the ambient atmosphere are transported and dispersed within the mixing layer. Some of the emissions penetrate the inversion layer and enter the free troposphere above the ABL.

The concentrations of gases and particles emitted into the free troposphere by transient sources, such as launch vehicles are quickly diluted to very low levels before they can be deposited onto or transported near the ground by precipitation or strong down-welling events (NASA 2011a).

3.4.9.2 Stratosphere

The stratosphere extends from 10 km (32,800 ft) to 50 km (164,000 ft) and is important because of ozone formed within the stratosphere. The stratospheric ozone layer mainly lies between 16 km (52,100 ft) and 26 km (84,700 ft) altitude, but varies seasonally and geographically. The stratospheric ozone absorbs most of the most harmful ultraviolet (UV-B) radiation from the sun. Depletion of ozone following the introduction of man-made materials can result in an increase in solar UV on the ground, which can pose serious ecological and health hazards. The importance and global nature of the ozone layer requires careful consideration of all sources of disturbance.

The concentration and distribution of stratospheric ozone is controlled by various chemical reactions, the most important of which are the catalytic reactions involving nitrogen, chlorine, bromine, and hydrogen compounds known as radicals. The importance of these radicals lies in the fact that they destroy ozone molecules without being destroyed themselves. Small (less than a millionth of a meter) aerosol particles in the stratosphere (mainly sulfate) also play a role in stratospheric chemistry by providing a surface on which chemical reactions can proceed. Thus, even though radicals and particles are present in the unperturbed stratosphere in relatively small amounts (hundreds to thousands of times less than ozone), they exert a controlling influence on ozone concentrations. Ultimately, relatively small amounts of radicals and particles can sufficiently perturb the stratosphere to cause substantial ozone loss.

In 1980, ozone was not significantly depleted by the chlorine and bromine then present in the stratosphere. Now, the ozone layer is characterized by a substantial disturbance caused by the introduction of chlorine and bromine (halocarbon) radicals from the photochemical breakdown of man-made halocarbons after they have mixed into the stratosphere. Global ozone loss from halocarbons is thought to be about 4 percent (WMO 2006). Most halocarbon production and use has been banned by international agreement and so the expectation is that the ozone layer will return to 1980 levels by the mid-21st century as the previously released halocarbons are expected to be consumed by sunlight and natural processes, which will slowly remove the liberated chlorine and bromine (WMO 2006).

3.4.9.3 Climate Change

Greenhouse gases, thermal emissions, and solar irradiance are the key factors interacting to maintain temperatures on Earth within the tolerance limits for life to exist. Changes in greenhouse gas concentrations in the atmosphere have been identified as the primary drivers of past climate change on Earth (EPA 2009a). Human land use changes, burning of fossil fuels for energy, and other activities are contributing to increases in greenhouse gases in the atmosphere. The potential impacts of increasing concentrations of atmospheric CO_2 and other climate altering materials such as methane, aerosols, and black carbon particulates, on the Earth's climate have been well documented by the International Panel on Climate Change, and are the dominant reason for societal interest in the carbon cycle (IPCC 2007). They include warmer temperatures, rising sea levels, changes in rainfall patterns, and a host of other associated and often interrelated effects. However, the consequences of the buildup of CO_2 in the atmosphere extend beyond climate change alone. "CO_2 fertilization" of plants and ocean acidification are foremost among these direct, non-climatic effects (Caspersen et al. 2000, Schimel et al. 2000, Houghton 2002). The uptake of CO_2 by the world's oceans as a result of human activity over the last century has made them more acidic (Orr et al. 2005). This acidification will compromise the growth and survival of corals, plankton, and other marine organisms that build their skeletons and shells from calcium carbonate, and could dramatically alter the composition of ocean ecosystems, possibly eliminating coral reefs by 2100 (Orr et al. 2005).

Emissions of CO_2 at KSC are primarily associated with commuting vehicle traffic, ground support operations, and launch events; however, a comprehensive carbon budget for each activity is not available. A baseline annual estimate for the last 30 years of the Space Shuttle Program was calculated with the following assumptions:

- An average workforce of 15,000 employees with 13,000 vehicles (NASA 2010), averaging 20 miles per gallon, driving an average of 60 miles a day, 240 days a year
- Center power consumption of 1,400,000 million British thermal units (MMBtu) from a combination of electrical purchases, natural gas, fuel oil, diesel, and gasoline
- Four (4) Space Shuttle launches per year utilizing two (2) four segment SRBs per launch.

Commuting contributes approximately 83,200 metric tons (mt) of CO_2; Center energy use contributes 60,600 mt, and the four Shuttle launches contribute 156 mt for an estimate of 144,000 mt of CO_2 per year for each year of the 30 year Space Shuttle Program (Dreschel and Hall 1990). With retirement of the Space Shuttle and the reduction in the work force and ground support operations, annual CO_2 emissions are currently estimated at approximately 99,000 mt. This assumes a reduction to 7,000 vehicles, Center energy use of 1,200,000 MMBtu, and no Space Shuttle launches (NASA 2013a).

In 2010, the NASA Headquarters Office of Strategic Infrastructure and the NASA Earth Sciences Office established the Climate Science Adaptation Investigator (CASI) team to develop climate change forecasts for the different NASA centers to address potential impacts and adaptation strategies to ensure sustainability of valuable NASA infrastructure. Members of the CASI team have developed regional and local climate projections for KSC using 16 different global climate models (GCMs) and statistical methods to link the model values to empirical long-term data from the City of Titusville covering the period between 1900 and 2010. The Titusville data for rainfall and temperature are presented in Figures 3-20 and 3-21, respectively. Rainfall has displayed no trend in intensity or volume while temperature has been trending upward for the period of record.

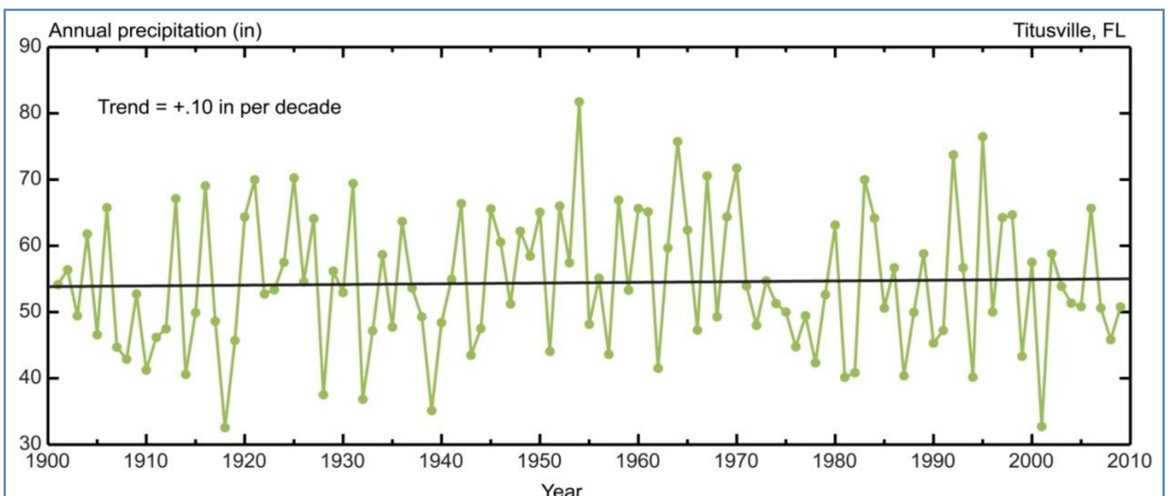


Figure 3-20. Long-term rainfall data for Titusville, Florida, showing no trend.

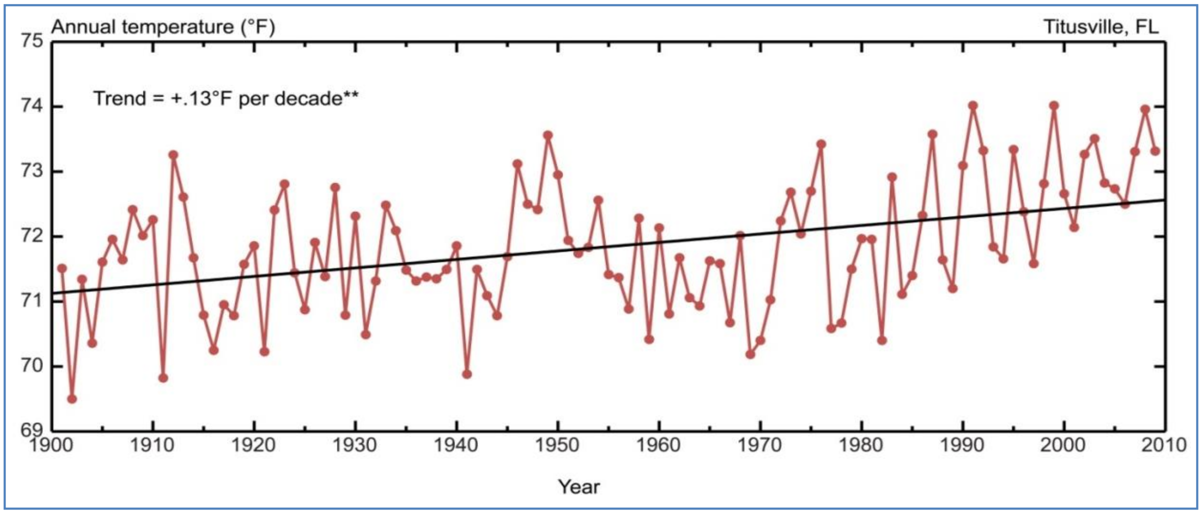


Figure 3-21. Long-term temperature data from Titusville, Florida, showing an increasing trend.

Results of the regional CASI GCM based forecast for future climate conditions in the project area are summarized in Tables 3-9 to 3-11. Average air temperature for the 30-year climate baseline period is 22°C (72°F). Climate forecasts for the region suggest average temperatures will increase by as much as 6 degrees during the latter part of the century. Rainfall projections indicate little change in the total annual amount of 135 cm (53 in). Projections for the occurrence of days above and below temperatures that impact the outdoor workforce are shown in Table 3-10. Current estimates suggest there will be a dramatic increase in the numbers of days above 32°C (90°F) when compared to the annual baseline average. This will greatly influence the potential for heat stress and will require additional management action. The number of cold days is expected to decrease slightly. Projections of the occurrence of extreme events are summarized in Table 3-11. As the amount of energy in the atmosphere increases, the probability of extreme events like downpours and extreme winds increases. The intensity of rainfall events will likely increase and the possibility of extreme winds (hurricanes) is more likely to trend upward.

Table 3-9. Estimated climate conditions for air temperature and rainfall for KSC[1].

	Baseline 1971-2000	2020s	2050s	2080s
Air Temperature Central range[2]	22°C (72 °F)	-17 °C (to +1 to 2 °F)	-16 °C (+2.5 to 3.5 °F)	-16 to -14 °C (+3 to 6 °F)
Precipitation Central range	135 cm (53 in)	-5 to +5 %	-5 to +5 %	-5 to +5 %

[1] Based on 16 GCMs and 3 emissions scenarios the baseline for temperature and precipitation in a 30-year period 1968 and 2007, with the best available observed daily weather data in Titusville. Data from National Climatic Data Center (NCDC) temperature data and precipitation data are from Titusville. [2] Central range equal middle 67% of values from model-based probabilities; temperature ranges are rounded to the nearest half-degree, and precipitation to the nearest 5%.

Table 3-10. Estimated changes in the numbers of days of extreme hot or cold temperatures for KSC (Adapting Now to a Changing Climate, NP-2010-11-687-HQ, NASA).

Daily Temperature	Baseline	2020s	2050s	2080s
Days at or above 35 °C (95 °F)	12	21 to 28	31 to 57	42 to 101
Days at or above 32 °C (90 °F)	82	99 to 114	118 to 142	125 to 173
Days at or below 4.4 °C (40 °F)	20	13 to 15	10 to 14	7 to 11
Days at or below 0 °C (32 °F)	4	2 to 3	2	1 to 2

Table 3-11. Projected likelihood of extreme events through the later part of the 21st Century, based on global climate simulations, published literature, and expert judgment (Adapting Now to a Changing Climate, NP-2010-11-687-HQ, NASA).

Event	Trend	Likelihood
Heat Stress	up	Very Likely (>90%)
Downpours	up	Likely (>66%)
Intense Storms	up	More likely than not (>50%)
Extreme Winds	up	More likely than not (>50%)

3.4.10 Socioeconomics and Children's Environmental Health and Safety

KSC was established as a launch operations center in 1962 and grew to become the Nation's premier spaceport. In similar fashion, KSC can attract the private sector, initially through launch missions and in time, engage its full scope of business. KSC's capability to attract, enter, and leverage the commercial market is critical to its sustainability, and essential for regional economic recovery and long-term growth. KSC bears a proud legacy in space exploration and technological advancement in an ecologically sensitive wildlife sanctuary.

KSC is Brevard County's largest revenue source and among its biggest employers. In fiscal year 2010, KSC and other NASA centers spent $1.8 billion in wages and purchases within Florida. Its monetary injection is found to have a total state-wide impact of $4.1 billion in total output (NASA 2010b).

In 2009, commercial space transportation and enabled industries generated $208.3 billion in economic activity, and launch vehicle manufacturing and its services industry generated $828 million. The industry created $76 billion in induced economic activity in the form of housing, consumption, and other purchases.

Commercial presence at KSC introduces opportunities for tourism and community outreach in addition to the economic activity directly resulting from flight operations. Furthermore, commercial use of KSC creates opportunities for the private industry to experience KSC's vast resources, efficiency, and workforce qualifications.

In January 2011, the workforce was downsized and future reductions are anticipated. In significant contrast, the commercial space and launch manufacturing industry employed over one million employees in 2009 (FAA 2009). Despite the current U.S. financial crisis and increased unemployment, KSC is uniquely positioned to participate in private ventures.

In early 2010, KSC's workforce population was 15,248, of which 14% were civil servants. Each space-related job was found to create an additional 1.26 jobs within Florida's labor market. KSC's 2010 presence was directly and indirectly responsible for nearly 33,000 jobs state-wide (NASA 2010b). The highest employment levels at KSC were recorded during the Apollo Program. In 1968, KSC recorded a peak population of 25,895. Employment dropped to a historic low of 8,441 upon Apollo's mission fulfillment in 1976. The Space Shuttle Program injected a sharp rise in employment in 1979 and by the year 2005, approximately 14,595 personnel were employed at KSC, of which civil service employees accounted for 12% of the workforce. In September 2010, KSC workforce population was 13,631, and downsized to 9,011 personnel in 2011, with civil service employees representing approximately 25% of the workforce.

Children's Environmental Health and Safety

Under EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, dated April 21, 1997, federal agencies are encouraged to consider potential impacts of proposed actions on the safety or environmental health of children. The nearest location containing a moderate concentration of children is the KSC Child Development Center located approximately 6.4 to 12.8 km (4 to 8 miles) away from the Proposed Action locations. This is a child care center and pre-school service available for children ages six weeks to five years old. There are no other schools, daycare facilities, playgrounds, or other places where children are concentrated within KSC.

Estimations show that a launch event comparable to that of an Ares I or Ares V launch could result in the rise of daycare center exterior sound levels to 80 or 90 dBA. The interior sound levels at this time may differ from 10 to 15 dBA less than the exterior. The duration of these increased sound levels, both interior and exterior, would be less than 30 seconds (NASA 2007c). These sound levels would be shorter in duration and lower in frequency than experienced during the use of gas powered mowers maintaining the grounds at the Child Development Center (Table 3-3).

3.4.11 Orbital and Reentry Debris

Orbital debris is a potential collision hazard to spacecraft and vehicles in space, and large pieces of debris can potentially reenter Earth's atmosphere and crash. Orbital debris is classified as either natural or man-made objects. The measured amount of man-made debris equals or exceeds that of natural meteoroids at most low-Earth orbit (LEO) altitudes. Man-made debris consists of material left in Earth's orbit from the launch, deployment, and deactivation of spacecraft. Orbital debris moves in many different orbits and directions, at velocities ranging from 3 to over 75 km/s (1.9 to over 47 mi/s) relative to Earth (USAF 2001; USAF 2007). Re-entry debris would include non-recoverable items from launch activities such as jettisoned vehicle stages, as well as recoverable items like solid rocket boosters and manned spacecraft. Impacts from recoverable and non-recoverable components from launch activities are planned to occur in broad ocean areas cleared of shipping or air traffic.

An Executive Branch policy directive, National Space Policy (1996), identifies the following guidance to support major U.S. space policy objectives: "The United States will seek to minimize the creation of space debris. NASA, the Intelligence Community, and the DoD, in cooperation with the private sector, will develop design guidelines for future government procurements of spacecraft, launch vehicles, and services. The design and operation of space tests, experiments and systems will minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness."

There are two issues of note in evaluating orbital and reentry debris. The first is the physical reentry of foreign objects and the resulting noise, contact force, and settling of the debris. The second is the potential for hazardous materials that may be contained in or on the debris.

The anticipated reentry trajectory has not yet been established for the rockets evaluated in this EA; however, the reentry objects could include, but are not limited to, expendable boosters, engine cores, or stages. The expendable boosters are estimated to impact the water at Mach 0.5 (384 mph). NASA and other launch organizations would ensure that "Notices to Mariners" and "Notices to Airmen" (NOTAM) would be provided prior to any launch to reduce the risk to aircraft and surface vessels. Reentry is controlled by Range Safety and efforts would be coordinated to reduce the risk to shipping lanes and ensure vessel activity would be outside the launch and reentry zone.

There are four laws relating to marine debris: 1) the Marine Plastic Pollution Research and Control Act; 2) the Marine Debris Research, Prevention, and Reduction Act (MDRPRA); 3) the Shore Protection Act; and 4) the Marine Protection, Research, and Sanctuaries Act (MPRSA) which regulates the ocean disposal of hazardous waste. The most applicable law to reentry boosters is the MDRPRA. This Act tasks NOAA and the USCG to assess, reduce, and prevent marine debris and its adverse impacts on the marine environment and navigation safety.

3.4.12 Aesthetics

NASA considers the extent to which any lighting or other visual impacts associated with an action would create an annoyance among people in the vicinity or interfere with their normal activities. Visual and aesthetic resources refer to natural or developed landscapes that provide information for an individual to develop their perceptions of the area. Areas such as coastlines, national parks, and recreation or wilderness areas are usually considered to have high visual sensitivity. Heavily industrialized urban areas tend to be the areas of the lowest visual sensitivity. The existing conditions at KSC are characterized as having low visual sensitivity, because the site is currently an industrialized area that supports rocket launches. Notable visual structures include the lightning protection towers at LC 39B. Due to the flat topography and the height of the lightning towers (approximately 161 m [528 ft]), the lightning protection towers can be seen several miles away. Existing light sources at KSC include nighttime security lighting at the launch complexes and buildings. NASA has guidelines to address the light impacts to wildlife species under the KSC Light Management Plan (NASA 2002).

4.0 ENVIRONMENTAL CONSEQUENCES

This section evaluates the potential impacts to KSC resources from the Proposed Action based on the best information available. It also addresses cumulative impacts on KSC and the nearby communities for the next 20 years.

Tables 4-1, 4-2, and 4-3 are Resource/Issue matrices that define the potential impact to each resource category for the Proposed Action and the No Action alternatives. Table 4-1 discusses potential impacts that could occur within the entire Proposed Action project area and Tables 4-2 and 4-3 are specific to the potential impacts from the two RP-1 option locations and the five HIF option locations. Impact classifications are defined as follows:

- None – no impacts expected

- Minimal – impacts are not expected to be measurable, or are too small to cause any discernable degradation to the environment
- Moderate – impacts would be measureable, but not substantial, because the impacted system is capable of absorbing the change, or the impacts could be managed through conservation measures and/or mitigation
- Major – impacts could individually or cumulatively be substantial
- Beneficial – impacts are positive in nature

Table 4-1. Resource/Issue matrix for the Proposed Action and No Action are categorized separately for construction, designated as "C", and operations, designated as "O", except in circumstances when the construction and operations impacts are expected to be the same. Launch specific impacts, designated as "L", are also included.

Resource/Issue	Proposed Action		No Action
Land Use			
Surrounding Land Use		Moderate	None
Coastal Zone Management		None	None
Facilities and Infrastructure			
Water Supply and Treatment	C	Minimal	None
	O	L Moderate	None
Stormwater Collection	C	Moderate	None
	O	Minimal	None
Electricity and Natural Gas	C	Minimal	None
	O	Minimal	None
Communications	C	Minimal	None
	O	None	None
Solid Waste	C	Minimal	None
	O	Minimal	None
Transportation	C	Moderate	None
	O	L Moderate	None
Environmental Resources			
Health and Safety		Moderate	None
Surface Water	C	Moderate	None
	O	L Moderate	None
Groundwater	C	Minimal	None
	O	Minimal	None
Atmospheric Environment			
Climate	C	None	None
	O	None	None
Air Quality	C	Minimal	None
	O	Moderate	None

Noise and Vibration			
	C	Moderate	None
	O	Moderate	None
Biological Resources			
Habitats and Vegetation	C	Moderate	None
	O	L Moderate	None
Wildlife	C	Minimal	None
	O	L Minimal	None
Threatened and Endangered Species	C	Moderate	None
	O	L Moderate	None
Geology and Soils			
	C	Moderate	None
	O	Moderate	None
Historic and Cultural Resources			
	C	Moderate	None
	O	Moderate	None
Hazardous Material and Waste Management			
	C	Minimal	None
	O	L Moderate	None
Orbital and Reentry Debris			
	C	None	None
	O	L Minimal	None
Global Environment			
Climate Change	C	Minimal	None
	O	Moderate	None
Socioeconomics			
	C	Beneficial	Moderate
	O	Beneficial	Moderate

Table 4-2. The Resource/Issue matrix for the RP-1 location options. Option 1 has storage and transfer facilities located at each of the launch complexes. Option 2 has a combined storage and transfer facility in a central location. C=construction impacts; O=operational impacts

Resource/Issue	Option 1 (individual)		Option 2 (combined)	No Action
Land Use				
Surrounding Land Use		None	Moderate	None
Coastal Zone Management		None	None	None
Facilities and Infrastructure				
Water Supply and Treatment	C	Minimal	Minimal	None
	O	Minimal	Minimal	None
Stormwater Collection	C	Moderate	Moderate	None
	O	Minimal	Minimal	None
Electricity and Natural Gas	C	Minimal	Minimal	None
	O	Minimal	Minimal	None
Communications	C	Minimal	Minimal	None
	O	None	None	None
Solid Waste	C	Minimal	Minimal	None
	O	Minimal	Minimal	None
Transportation	C	Moderate	Moderate	None
	O	Minimal	Minimal	None
Environmental Resources				
Health and Safety		Moderate	Moderate	None
Surface Water	C	Minimal	Minimal	None
	O	None	None	None
Groundwater	C	Minimal	Minimal	None
	O	None	None	None
Atmospheric Environment				
Climate	C	None	None	None
	O	None	None	None
Air Quality	C	Minimal	Minimal	None
	O	Minimal	Minimal	None
Noise and Vibration				
	C	Moderate	Moderate	None
	O	None	None	None
Biological Resources				
Habitats and Vegetation	C	None	Minimal	None
	O	None	None	None
Wildlife	C	None	Minimal	None
	O	None	None	None
Threatened and Endangered Species	C	None	Minimal	None
	O	None	None	None

Geology and Soils				
	C	Minimal	Moderate	None
	O	None	None	None
Historic and Cultural Resources				
	C	Moderate	Moderate	None
	O	None	None	None
Hazardous Material and Waste Management				
	C	Minimal	Minimal	None
	O	Minimal	Minimal	None
Global Environment				
Climate Change	C	Minimal	Minimal	None
	O	Minimal	Minimal	None
Socioeconomics				
	C	Beneficial	Beneficial	Moderate
	O	Beneficial	Beneficial	Moderate

Table 4-3. The Resource/Issue matrix for the HIF location options. Locations are shown in Figure 2-8. C=construction impacts; O=operational impacts

Resource /Issue		Option 1	Option 2	Option 3	Option 4	Option 5	No Action
Land Use							
Surrounding Land Use		None	Moderate	Moderate	Moderate	None	None
Coastal Zone Management		None	None	None	None	None	None
Facilities and Infrastructure							
Water Supply and Treatment		Minimal	Minimal	Minimal	Minimal	Minimal	None
Stormwater Collection	C	Moderate	Moderate	Moderate	Moderate	Moderate	None
	O	Minimal	Minimal	Minimal	Minimal	Minimal	None
Electricity and Natural Gas	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	Minimal	Minimal	Minimal	Minimal	Minimal	None
Communica-tions	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	None	None	None	None	None	None
Solid Waste	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	Minimal	Minimal	Minimal	Minimal	Minimal	None
Transporta-tion	C	Moderate	Moderate	Moderate	Moderate	Moderate	None
	O	Minimal	Minimal	Minimal	Minimal	Minimal	None

Environmental Resources							
Health and Safety		Moderate	Moderate	Moderate	Moderate	Moderate	None
Surface Water	C	Minimal	Moderate	Moderate	Moderate	Minimal	None
	O	Minimal	Minimal	Minimal	Minimal	Minimal	None
Ground water	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	None	None	None	None	None	None
Atmospheric Environment							
Climate	C	None	None	None	None	None	None
	O	None	None	None	None	None	None
Air Quality	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	Moderate	Moderate	Moderate	Moderate	Moderate	None
Noise and Vibration							
	C	Moderate	Moderate	Moderate	Moderate	Moderate	None
	O	Moderate	Moderate	Moderate	Moderate	Moderate	None
Biological Resources							
Habitats and Vegetation	C	Moderate	Moderate	Moderate	Moderate	Moderate	None
	O	None	None	None	None	None	None
Wildlife	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	None	None	None	None	None	None
Threatened and Endangered Species	C	Moderate	Moderate	Moderate	Moderate	Moderate	None
	O	None	None	None	None	None	None
Geology and Soils							
	C	Minimal	Moderate	Moderate	Moderate	Minimal	None
	O	None	None	None	None	None	None
Historic and Cultural Resources							
	C	None	None	None	None	None	None
	O	None	None	None	None	None	None
Hazardous Material and Waste Management							
	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	Moderate	Moderate	Moderate	Moderate	Moderate	None
Global Environment							
Climate Change	C	Minimal	Minimal	Minimal	Minimal	Minimal	None
	O	Minimal	Minimal	Minimal	Minimal	Minimal	None
Socioeconomics							
	C	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial	Moderate
	O	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial	Moderate

4.1 Land Use

LC 39A and LC 39B are currently designated as NASA operational areas with the land use category of Launch (LA). Allowing multiple users access to the launch complexes would not cause a change in land use categorization. RP-1 Option 1 (individual storage facilities within the launch pad perimeters) and HIF Options 1 and 5 also would not involve a change in land use category.

Impacts to land use from construction and operation of RP-1 Option 2 and HIF Options 2, 3, and 4 would be moderate due to changes in land use classification needed for establishment of zones to protect personnel and facilities from hazards. Quantity Distance (QD) arcs, transitional surfaces, and other safety setbacks and exposure limits are restrictions on the use of land adjacent to facilities. In addition, RP-1 Option 2 and HIF Options 2, 3, and 4 are proposed for sites currently in areas managed by MINWR. Development of any of these sites would require that land management responsibilities be transferred back to NASA. Once removed from MINWR oversight, these lands would no longer be available for controlled burning operations or impoundment management. MINWR would also have to consider site activities in their management planning and coordination in adjacent lands to ensure that operations at these facilities would not be negatively impacted.

LC 39A, LC 39B, and the Crawlerway are 4(f) properties that would be impacted by the Proposed Action construction activity. Although the Proposed Action would constitute a physical use of these Section 4(f) properties via permanent use of land, it would not adversely affect the activities, features, or attributes of the properties, as the NASA land use designation for LC 39A and LC 39B is Launch (LA) and the designation for the Crawlerway is Launch Support (LS). Further, there is no feasible and prudent alternative that meets the purpose and need of the Proposed Action. Based on past and current use of the properties, the FAA determined that the physical use would be considered *de minimis* under Section 4(f). NASA agrees with the FAA's *de minimis* determination for LC 39A, LC 39B, and the Crawlerway.

In addition to assessing the potential for physical use, the FAA must consider the potential for constructive use of 4(f) properties that would not be temporarily or permanently taken. If there is the potential for constructive use, the FAA must determine if the impacts would substantially impair[1] the 4(f) property. Section 3.2 identifies 4(f) properties located at or near KSC. Due to their proximity to the launch complexes, many of these properties would experience noise from proposed Falcon 9 v1.1 launches. Noise levels at these 4(f) properties would increase temporarily during launches. The increased noise level would only last a few minutes and would occur at most twice a month at each launch complex under the Proposed Action. For decades, these 4(f) properties have been experiencing increased noise levels during launches taking place at KSC and adjacent CCAFS. Some of the launch vehicles (e.g., Space Shuttle and Titan IV) that have launched from CCAFS and KSC produced more thrust and louder noise than would occur under the Proposed Action. Due to the long history of these 4(f) properties experiencing noise from launches at CCAFS and KSC, and because there would only be a maximum of two launches per month at each launch complex, the FAA has determined the Proposed Action would not substantially diminish the protected activities, features, or attributes of any of the 4(f) properties identified, and thus would not result in substantial impairment of the properties.

[1] Substantial impairment occurs when the protected activities, features, or attributes of the Section 4(f) property are substantially diminished.

Therefore, the Proposed Action would not be considered a constructive use of these Section 4(f) properties and would not invoke Section 4(f) of the DOT Act.

Coastal Zone Management

Florida's coastal zone includes the entire state and its territorial seas. KSC is explicitly excluded from the FCMP, but still voluntarily complies with it. NASA has determined that the Proposed Action to allow multiple entities to utilize LC 39A and LC 39B for launch purposes is consistent with the FCMP. As part of the CZMA determination process, this EA will be sent to the FDEP and the Florida State Clearing House during the public review period.

4.2 Facilities and Infrastructure

Current facilities and structures at LC 39A and LC 39B would need to be modified to support multiple users. Employees supporting launch activities would use existing office space. All five HIF options and the two RP-1 options would require new facilities and connection to existing utilities. New ground operations facilities, launch structures, parking lots, roads, and other supporting infrastructure would need to be built.

Construction and ground support activities of the Proposed Action at any of the alternative sites are anticipated to have minimal impacts on the current wastewater treatment (domestic and industrial), potable water resources, electricity and natural gas, communications, and solid waste resources on KSC. All of these utilities are currently available in the general vicinity of each of the sites, and tie-ins could be established without significantly affecting the local areas. In some cases, utilities ducts would need to be laid, but these would be routed along roadways and other easements, areas that are already maintained for those purposes. All of the utilities and services at each of the proposed site options are expected to be able to absorb the additional demands. Existing substations and wastewater treatment plants would have sufficient capacities for anticipated needs.

Construction of all RP-1 and HIF sites would require stormwater management systems and permits and would, therefore, result in moderate impacts. A stormwater treatment system would be built on site for RP-1 Option 2 and all of the HIF options. RP-1 Option 1 and any modifications within launch pad perimeters might require compensatory stormwater treatment elsewhere.

Launch activities at LC 39A and LC 39B would require industrial wastewater permits for launch deluge water. A study was initiated in August 2012 to evaluate whether it would be more beneficial to connect the individual launch pads' deluge water systems to the sanitary sewer system, or to maintain the existing operational concept. Another option being considered is the treatment, storage, and reuse of launch deluge water similar to the process utilized at Space Launch Complex 2 on Vandenberg Air Force Base. Data from these investigations are not yet available; however, treatment and management of industrial wastewater from launch operations will likely have a moderate impact.

Construction activities associated with the Proposed Action might include the addition of a railroad to accommodate distribution of RP-1 fuel and provide transportation of launch vehicle components to the HIF for pre-launch processing. Construction of the railroad and associated modification to roadways would result in moderate impacts to transportation. Increases to traffic during daily operations related to multiple user launch activities would be minimal and should not exceed existing capacity of KSC roads. Public viewing is often encouraged and, if allowed during launch events, the increased volume of traffic from spectators would be mitigated via use of large buses for transportation to viewing areas. Road closures and speed limit modifications would also be expected on launch days. Operational impacts to transportation would be considered moderate when taking launch events into account.

Sea level rise is anticipated to increase the vulnerability of the KSC coast due to erosion. An eroded beach no longer functions as protection of inland areas from storm waves and flooding. Critical launch infrastructure assets are in danger of being compromised or destroyed as a result of shoreline erosion and sea level rise. There have been significant hurricane and non-hurricane storm events over the last 10 to 15 years which resulted in overwash and severe erosion of the dunes and beach. KSC infrastructure continues to be at high risk for storm damage from future dune breach and overwash events. The section of railroad that runs along the coast has already been compromised by previous storms. Most recently, Hurricane Sandy in October 2012 impacted approximately 3 km (1.9 mi) of beach, resulting in considerable scarping, landward retreat of the dune, and loss of elevation. Breach of the primary dune, particularly between LC 39A and LC 39B, could result in large-scale inundation, along with loss of critical launch assets.

4.3 Environmental Resources

4.3.1 Health and Safety

Potential adverse effects to human health and safety could occur during modifications to LC 39A and LC 39B, and during construction of the proposed RP-1 and HIF sites. These potential effects, as well as those from operations conducted under the launch vehicle programs, are discussed below.

Compliance with OSHA regulations and other recognized standards would be implemented during both the construction/modification and operational phases of the Proposed Action. A Health and Safety Plan would be developed and a formally trained individual would be appointed to act as Safety Officer. The appointed individual would be the point of contact on all aspects involving job site safety. During construction, contractors would comply with OSHA regulations, other recognized standards, and applicable NASA regulations or instructions prescribed for the control and safety of personnel and visitors to the job site. Therefore, human health and safety would not be adversely impacted by general construction-related hazards. With the implementation of safety and health plans, and environmental protection measures, potential health risks to project personnel and the public from construction would be minimal.

Physical hazards typical for outdoor environments are present in the proposed project area and have the potential to adversely impact the health and safety of personnel during construction. To provide for the health and safety of workers and visitors who may be exposed to hazards during construction, federal OSHA regulations would be implemented, and health and safety plans would be developed and implemented. To minimize the potential adverse impacts from hazards during construction, awareness training would be incorporated into the worker health and safety protocol.

Documentation required from commercial launch providers would contain the technical, safety, and crew health and medical requirements that are mandatory to obtain a Crew Transportation System Certification to transport NASA crew and limited cargo to and from the ISS. The NASA Range Flight Safety Program (NPR 8715.5 Rev A) requirements are currently listed as part of this certification. If commercial crew missions are licensed by the FAA, then FAA safety regulations would apply rather than NPR 8715.5. NASA Range Safety would remain engaged as needed to support the Commercial Crew Program Office and coordinate with safety authorities regarding any FAA licensed activities (NASA Range Safety Reports 2011 and 2012i).

Commercial entities that use KSC would be required to comply with all applicable safety regulations for storage, use, and transfer of toxic and hazardous materials associated with their projects. Impacts related to hazardous and toxic propellants, radiation, payload transport accidents, and launch vehicle impacts are discussed in detail in the NASA Routine Payload EA (NASA 2011a). If reasonable and prudent measures are taken, operations associated with the Proposed Action would result in moderate impacts to health and safety.

4.3.2 Water Quality

Many construction activities can significantly impact surface water quality by increasing run-off from vegetation clearing, soil disturbance, and grading. Exposed soils are more easily transported and can increase turbidity and nutrient loads of surface waters or wetland systems. Compacted soils are less permeable and can increase runoff. These impacts could potentially be significant, but would be lessened to moderate through the use of Best Management Practices (BMPs).

Infrastructure such as facilities, paved areas, and landscaped areas would alter, to some degree, the hydrological cycle and surface/groundwater quality. Specific site plans for proposed HIF and RP-1 sites have not yet been developed, so the amounts of impervious vs. pervious surfaces cannot be determined. However, impervious surfaces, such as launch support structures, roads, sidewalks, parking lots, and buildings reduce the area available for rainwater to percolate into the soil. This has two direct consequences: there is less water available for recharging the local surficial aquifer, while at the same time, the amount of runoff that flows into low-lying areas increases. Stormwater management systems would help mitigate many of the impacts associated with impervious surfaces. However, extreme rainfall events associated with tropical systems would likely exceed the capacity of most stormwater systems, and some runoff could be transported off-site.

Surface Water

Construction – Modifications to existing structures at LC 39A and LC 39B would not impact the existing swales within the pad perimeter, and any additional management of runoff required would be accomplished by compensatory treatment outside the launch complex perimeter. There are no existing surface waters or wetlands on the proposed sites for either RP-1 option. The majority of the land proposed for the HIF sites has been previously developed. However, there would be direct moderate impacts to surface water at HIF options 2, 3, 4, and 5. HIF Site 2 extends into Banana Creek, which is part of the IRL systems and is designated OFW. The use of BMPs would reduce impacts to this surface water. A significant portion of HIF Site 3 could potentially impact Banana Creek. HIF Site 4 involves filling in surface waters directly connected to the Barge Canal and also encroaches upon wetlands, including mangroves. There are drainage ditches, as well as some wetlands at Site 5, which would require filling and would involve permitting through the SJRWMD and USACE. All of the dredging and filling activities associated with construction on these sites would require permitting and mitigation for wetland impacts, and would constitute a moderate impact. Siting constraints including hazard arcs, launch vehicle transportation requirements, and impacts to other resources may result in no practicable alternative to the selection of a HIF site within an existing wetland area. Measures would be taken to minimize harm to wetlands including best management practices and adherence to permit conditions.

The eastern edge of LC 39B is within floodplain zone X500 which represents areas between the limits of the 100-year and 500-year flood. Proposed HIF and common RP-1 storage sites include flood zones AE, X500, and AO. Because the HIF and RP-1 sites must be located near the launch complexes and Crawlerway, no practicable alternatives to development in the flooplain exist. NASA would ensure that its actions comply with EO 11988, Floodplain Management, to the maximum extent possible. Since the Proposed Action would involve federally funded construction in the floodplain, this EA serves as NASA's means for facilitating public review as required by EO 11990 and EO 11988.

Operation **–** Non-launch-related activities from the Proposed Action would have minimal impacts on surface water quality. Surface waters at the launch complexes would drain to existing swales within the pad perimeters. Stormwater management systems would be built at new facilities for RP-1 and HIF operations. An Environmental Resource Permit (ERP) would be obtained from the SJRWMD.

The launching of vehicles using solid rocket propellant (Table 2-1) would result in the emission of HCl and aluminum oxide particulates. This could cause short-term acidification of surface water from contact with the exhaust cloud or through HCl fallout. Surface and groundwater in the vicinity of the launch pads area are highly buffered as a result of local soils and geological conditions. Following Shuttle launches, this aquatic buffering system reacted with the HCl exhaust to produce $CaCl_2$, CO_2, and H_2O (Dreschel and Hinkle 1983). Advective and diffusive mixing during the 48 to 72 hours after Shuttle launches returned pH and alkalinity measurements in the lagoon to pre-launch levels (Schmalzer 1993). It is expected that the rockets included in this EA would produce the same effects and that the natural system would react in the same manner. This would be considered a moderate impact.

Groundwater

Construction - The groundwater quality at all proposed sites is affected by runoff that percolates into the surficial aquifer from roadways and/or existing facilities. Construction for the Proposed Action could temporarily increase the amount of sedimentation and, therefore, pollutants that could migrate into the groundwater system. However, employing BMPs and constructing stormwater management systems would reduce groundwater quality impacts to a minimal amount.

Operation –The Proposed Action would have minimal impact to the groundwater quality. Impacts from surface water degradation would be absorbed by the surface water management system that would be constructed, preventing transfer of pollutants into the groundwater. Groundwater studies at LC 39A and LC 39B showed no clear evidence of metals accumulation in the Surficial Aquifer, nor did they show a cause and effect relationship between Shuttle launches and detectable concentrations of metals in the groundwater (Clark 1986).

For RP-1 and HIF site development, a National Pollutant Discharge Elimination System (NPDES) Stormwater Construction Permit would be required by FDEP, and a Stormwater Pollution Prevention Plan (SWPPP) would have to be implemented. A stormwater management system would need to be designed and an ERP obtained from SJRWMD for any activity that meets the requirements listed in Rule 40C, F.A.C. Impacts to groundwater would be minimal to none with required treatment of runoff by a permitted stormwater management system prior to percolation into the ground. The potential local impacts to hydrology and water quality from the construction and operation of launch, vehicle processing, and fuel storage sites are summarized in Table 4-4.

Table 4-4. General site-specific impacts to hydrology and water quality associated with construction and operations of roads and facilities.

Activity	Impact
Vegetation Clearing	Alters local evapotranspiration processes, exposes soil to wind and rain erosion (turbidity), reduces storage, increases runoff potential, alters surficial aquifer recharge rates.
Soil Disturbance	Alters runoff, storage, and infiltration rates. Increases turbidity potential.
Grading	Alters runoff, storage, and infiltration rates. Increases turbidity potential.
Impervious Surfaces	Alters runoff, storage, and infiltration rates. Alters local evapotranspiration processes. Reduces local surficial aquifer recharge.
Landscaping	Alters local evapotranspiration processes, runoff, storage, and infiltration rates. Use of fertilizers and pesticides. Mowing and other maintainance often required.
Irrigation	Alters local evapotranspiration processes, runoff, storage, and infiltration rates. Impacts to surficial aquifer.
Stormwater Conveyance	Alters local evapotranspiration processes, runoff, storage, and infiltration rates. Impacts to surficial aquifer.
Retention Ponds	Alters local evapotranspiration processes runoff, storage, and infiltration rates. Impacts to surficial aquifer.
Vehicle Use	Increased loading of pollutants associated with parking lots, roads, tires, fossil fuel combustion (NO_2, CO, CO_2, grease and oil, polycyclic hydrocarbons, metals).
Ground Processing	Accidental releases of a variety of chemicals could occur during the operational phase of the Proposed Action and potentially affect surface and groundwater quality. Some of the chemicals likely used at the Proposed Action sites are listed in Table 4-8.

4.3.3 Atmospheric Environment

No impacts to climate are expected from construction or operations from the Proposed Action at LC 39 or any of the site location options. The remainder of this section describes the environmental consequences of the Proposed Action and each of its option locations on air quality within KSC and the nearby surrounding area. Impacts to air quality would be due to activities associated with ground and launch procedures, including spaceflight hardware processing, construction activities, the occasional operation of generators, and ground vehicle emissions. These effects on air quality on a local and regional scale are expected to be minimal to moderate in extent. However, commercial tenants would apply for their own Title V Operating Permit if they anticipated having any significant emission sources, operations, or processes from operations not funded by NASA. Tenants under NASA contracts or directly supporting NASA missions would be included in the KSC Title V Operating Permit.

LC 39 Area

The Proposed Action vehicles for launch at KSC would use LOX, LH_2, RP-1, and solid fuels as propellants (Table 2-1). The primary air emission products released during liftoff and flight are carbon dioxide (CO_2), carbon monoxide (CO), water vapor (H_2O), small amounts of nitrogen oxides (NO_x), HCL, and particulate matter (PM).

The largest vehicle proposed in this EA, the SLS Block 2 configuration, will use five liquid-fueled main engines in addition to two Advanced Boosters at launch; thus, the SLS would produce more heat in the exhaust than the Shuttle main engines. Two five-segment solid rocket boosters, derived from the Space Shuttle boosters, would be used for the first two, 70 metric ton flights of the Block 1 SLS. This configuration is similar to the Ares V and uses approximately 25% more solid propellant in each SRB than the Space Shuttle, therefore releasing more emissions overall (NASA 1978).

Table 4-5 lists the quantity of criteria pollutants including NOx, CO, SO_2, HCl, and PM less than 10 microns in diameter (PM10) that would be emitted into the lowest 915 m (3,000 ft) of atmosphere during each launch of four of the vehicles in the Proposed Action. The worst case for each pollutant individually was calculated by multiplying the largest value by 24 launches per year, a scenario with virtually no chance of occurring. These data bound the absolute upper case for each pollutant for all the launch vehicles that would be launched from both launch pads. Emission of aluminum oxide from the strap-on solid rocket motors (SSRMs) is included in the PM10 column. These four vehicles represent the largest emission sources from various combinations of liquid engines and SSRMs on the vehicles evaluated in this EA. Specifically, they represent: 1) LH_2/LOx engines (Delta IV-H), 2) RP-1/LOx engines (Atlas V-Heavy, Falcon 9), 3) LH_2/LOx engines with SSRMs (SLS), and 4) RP-1/LOx engines with SSRMs (Atlas V-551/552). The emissions from other candidate vehicles would be within the emission envelope of these four scenarios.

Table 4-5. Air emissions of criteria pollutants and HCl per launch of candidate vehicles into lowest 916 m (3,000 ft) of atmosphere.

Vehicle	Pollutants in metric tons				
	NO_X	CO	SO_2	PM10	HCl
Atlas V 551/552	1.1	0.01	0	15	7.8
Delta IV-H	1.6	0	0	0	0
Falcon 9	0	781.3	0	0	0
SLS*	0.38	2.75	0	138**	74.7
24 launch worst case	38.4	18751	0	3312	1792.8

Key: CO=carbon monoxide; SO_2=sulfur dioxide; HCl=hydrogen chloride; NOx=nitrogen oxide; PM=particulate matter; *emissions into stratosphere; **aluminum oxide. (Source: NASA 1978, NASA 2011a)

Based on these estimates and a review of additional EAs and reports for activities involving rockets using similar propellants, the total potential emissions of any criteria pollutants under the Proposed Action would not be expected to cause exceedances of the NAAQS or the FAAQS (FAA 2006b, FAA 2007, FAA 2010). Emissions below 915 m would be of short duration (a matter of seconds) as the vehicle rises above the launch pad and accelerates. The high temperatures of the exhaust products cause them to rise rapidly and disperse with prevailing winds. Therefore, impacts to air quality from launch activities are expected to be moderate. In cases where a sound suppression system is utilized, exhaust gases and particulates may be partially scrubbed as they mix with the water vapor and droplets that form as the cloud rises and cools. These compounds rain out of the cloud, further reducing airborne concentrations.

HIF Option Locations

Impacts to air quality from construction of a HIF at any of the Proposed Action options would be minimal and of short duration. At each site and in the immediate vicinity, dust from the removal of vegetation and exposure of topsoil and exhaust from heavy machinery would temporarily decrease the local air quality. Air pollutants generated could include PM10, sulfur and nitrogen oxides, and others. These materials would quickly dissipate and the air quality would return to the average ambient levels found at each location. Possible burning of cleared vegetation could occur at each of the option locations. The use of controlled burns to dispose of ground cover from land clearing activities is a common practice in Florida. Burning debris emits smoke and ash into the air, reducing air quality. Open burning is a regulated activity and requires authorization from the Florida Division of Forestry and a burn permit from the KSC Duty Office. Burning vegetative debris on KSC requires strict adherence to specific procedures, restrictions, and criteria to be followed during the burning activities. Construction of railway extensions are also expected with the Proposed Action HIF options. This construction would provide rail access to one of the HIF option locations. On a regional scale, construction-related air quality impacts are expected to be negligible for all Proposed Action option activities.

Impacts to air quality from operations conducted at any of the HIF options is also expected to be minimal and of short duration. Typical activities at the HIF could include cleaning, vehicle preparation, testing, and loading. Various cleaning solvents, including isopropyl alcohol (IPA) would be used before and after vehicle preparation. IPA is not a listed or regulated hazardous air pollutant (HAP) due to its low toxicity and flammability characteristics. The KSC Title V Air Operation Permit identifies general chemical and solvent use as an insignificant emission source. Individual fuel loading operations are typically independent, sequential, and conducted in a closed-loop system (Aerostar Env Services 2007). During fueling operations, all propellant liquid and vapors would be contained. If small leaks occurred during propellant loading, immediate steps would be taken to stop loading, correct the leakage, and clean up leaked propellant with approved methods before continuing.

RP-1 Option Locations

Impacts to air quality due to construction activities for either RP-1 option would be considered minimal and of short duration. This construction would include connecting new railways and transportation lines for vehicle segments and fuels, to provide access to both LC 39A and LC 39B and to existing railways and roadways, and construct new RP-1 storage facilities including associated transfer lines.

Potential Additional Impacts

Because the exact types and quantities of exhaust-generating devices for the Proposed Action are not known, this paragraph addresses reasonably foreseeable air quality impacts from boilers, hot water generators, and backup electric generators, and non-toxic substances often associated with ground processing activities. The capacities for typical operations of the size proposed at the LC 39 Area, HIF, and RP-1 storage option site locations are estimated to be small, have low fuel usage, and are not expected to produce emissions above potential to emit (PTE) threshold levels established as major sources of pollution(listed in Chapter 62-213.430 F.A.C. For that reason, the emissions are estimated to have minimal air quality impacts. Tenants of the Proposed Action facilities would be required to meet all federal, state, and local air quality requirements, and tenants would apply for their own Title V operating permits if they expected to have any regulated air pollution sources, operations, or processes for operations not funded by NASA.

The increase of emissions related to traffic associated with LC 39 Area, HIF, and RP-1 storage area operations would be negligible. The addition of workforce that would be expected for the Proposed Action could increase traffic emissions. However, this increase would not exceed emissions that were associated with traffic volume prior to the end of the Space Shuttle Program.

4.3.4 Noise and Vibration

Noise-related impacts from the Proposed Action would be considered significant if a noise sensitive area experienced an increase in noise of day/night average sound level (DNL) of 1.5 dBA or more at or above the DNL 65 dBA exposure level when compared to existing conditions

(FAA Order 1050.1E, Chg 1). Estimations of sound levels experienced during a launch event would result in the rise of exterior sound levels to above the threshold limits. The interior sound levels at this time may differ from 10 to 15 dBA less than the exterior. The duration of these increased sound levels, both interior and exterior, would be less than 30 seconds (NASA 2007c).

HIF and RP-1 Storage Location Options

Moderate impacts due to noise could be expected at any of the HIF and RP-1 options due to construction and increased operations, but would be localized around the facilities. These operations would be consistent with ongoing and historic processes at KSC. The workforce would be protected from undue noise impacts by the OSHA safety practices in place at KSC.

While estimates of sound levels experienced during a launch event would result in the rise of exterior sound levels above the DNL threshold limits, the duration of these would be less than 30 seconds (NASA 2007c), resulting in moderate impact.

LC 39 Area

Of the vehicles being evaluated in this EA (Table 2-1), the expected noise levels of the SLS vehicle would be the greatest, in the range of 130 dBA at the launch site, diminishing to 99-102 dBA at a distance 4.8 km (3 mi) (e.g., at the VAB). This is based on the assumption that noise levels from launch of the SLS are comparable to those projected for the Ares V due to similar booster configurations. Noise levels would continue to diminish to 78-82 dBA (e.g., City of Titusville) at a vehicle height of 91 m (300 ft) and the noise would be of short duration (20-30 seconds) (NASA 2008). The noise levels resulting from the launch of the remaining vehicles listed in Table 2-1 would be less than those produced by the SLS.

Overall Sound-Pressure Levels (OSPL) in excess of 110 dB, which could cause structural damage claims at a rate of 1 per 1,000 households, would be limited to a 4.5 km (2.8 mi) radius from the launch site. A safe distance around LC 39 would be cleared of people before launches, and there are no residential communities within KSC or CCAFS (USAF 1998).

Sonic booms generated from ascending launch vehicles and jettisoned launch vehicle components would reach Earth's surface at a distance downrange of KSC over the Atlantic Ocean and not affect coastal land areas. Sonic boom measurements were recorded at various points in Florida along the descent and landing trajectory of multiple Space Shuttle flights (Stansbery and Stanley, 1984a, 1984b, 1984c). A maximum measured overpressure of 2.2 psf (15.2 kPa) was recorded in Titusville during the landing of the STS-51D flight. All sonic boom measurements recorded in Florida during orbiter landings have been accurately predicted by computer model analyses. Estimated noise levels over the open ocean under vehicle flight path ranged from 2 to 4 psf for reentry of Space Shuttle SRB casings and the external tank. Atmospheric entry sonic boom or overpressures from the Space Shuttle Orbiter were estimated at 2.1 psf. The launch vehicles evaluated for the Proposed Action would produce sonic booms lesser in magnitude than those of the Space Shuttle. These sound overpressures occur over the Atlantic Ocean, are directed in from of the vehicle, and do not impact land areas. No serious impacts were observed during the Shuttle Program (NASA 2008).

The Constellation Programmatic EIS indicated the magnitude and location of Constellation (Ares I and V) sonic booms would be similar to those experienced with the Space Shuttle. SLS sonic booms are expected to be similar to those estimated for the Ares I or V vehicles. The exact location of the sonic boom footprint would be mission specific and would occur over the open ocean (NASA 2011).

Sonic booms would also be generated over the Pacific Ocean during reentry of the Orion crew module. Sonic booms are dependent on atmospheric entry trajectory, size, and velocity of the returning object. The magnitude of sonic booms from Orion or any of the reusable spacecraft, including Dream Chaser and other horizontal and vertical takeoff and landing launch vehicles, would be expected to remain below that of the sonic booms from Space Shuttle atmospheric entries since they are smaller and lighter weight vehicles.

Noise Impacts to Wildlife

Noise generated during construction activities of the Proposed Action at any of the option locations would potentially have discernable, but temporary effects on wildlife occurring nearby. A degree of buffering of noise is afforded to wildlife by vegetation; attenuation rates of up to 10 dBA per 100 m (328 ft) have been demonstrated in vegetated areas (Price et al. 1988). Given that rate, noise would be expected to carry 300-400 m (984-1,312 ft) away from the construction sites. Beyond this distance, noise levels would be lower than what has been experimentally shown to have deleterious effects on animals (Brown 2001). Most wildlife occurring closer to noise sources would be free to move away or find shelter (e.g., burrows); therefore, the impacts would be expected to be minimal.

Noise from launches and sonic booms was identified as a potential concern for wildlife during the NEPA documentation process for the Space Shuttle Program, however, no impacts were observed (NASA, 1979). Even the maximum number of launches anticipated in the Proposed Action (24 per year from both pads) would result in only interrupting normal behavior twice per month. Some of the proposed launch vehicles would generate sonic booms, and it is possible that the sonic booms would reach the ocean surface and possibly 8underwater depths. These types of booms represent a potential threat of physical and physiological impairment to marine animals in the vicinity of the water surface. However, at this depth they would be well attenuated and would not be expected to negatively impact any marine species because of their low frequency, the low density of marine species in the ocean's surface water, and the distance of the sonic boom footprint from KSC.

4.3.5 Biological Resources

4.3.5.1 Habitat and Vegetation

For the purposes of the EA, it is assumed that each site will be entirely altered by construction. Each will experience a combination of vegetation clearing, filling of any low-lying areas (including wetlands and surface waters), construction of ditches and stormwater retention ponds, and the addition of various impervious surfaces. Surface water impacts are discussed in Section 4.3.2.

Areal coverage of habitats found within the Proposed Action project footprint are displayed in Table 3.5. Construction would impact ruderal herbaceous and ruderal woody cover types the most. This vegetation is found on heavily modified or disturbed land and is generally low quality habitat. Herbaceous ruderal vegetation covers 160 ha (394 ac), representing approximately 10.8% of the KSC total for this cover type. At least a portion of the herbaceous ruderal vegetation would eventually be replaced as mowed grass areas around facilities and along roadsides. Woody ruderal vegetation covers 37 ha (90 ac), comprising approximately 6.2% of the KSC total for this cover type. Removal of invasive exotic vegetation often found in this habitat type, such as Brazilian pepper (*Schinus terebinthifolius*), would be beneficial, eliminating seed sources that could impact natural areas.

Upland habitats impacted by construction would include hardwood hammock, mixed upland forest, and scrub. Scrub is potential habitat for the Florida scrub-jay, and impacts would be mitigated via restoration and management on KSC in accordance with guidance from the USFWS. Mitigation for wetland losses would consist of enhancing, restoring, or creating wetlands of like function on KSC. Restoration ratios would be determined through agreements with the USACE and/or the SJRWMD. Overall impacts would be moderate.

HIF Option Locations

HIF Option impacts are displayed for comparison in Table 4-6. HIF Options 1, 2, 3 and 4 would all require wetlands mitigation in accordance to requirements from the appropriate regulatory agencies. Both scrub and wetlands impacts would occur from development at the HIF 3 site and would be mitigated in concurrence with the appropriated regulatory agencies' requirements.

Table 4-6. Habitats and acreages potentially impacted within the five HIF options. "%" represents the percent of the total of that habitat type present on KSC.

Habitat Types Impacted	**HIF 1**	**HIF 2**	**HIF 3**	**HIF 4**	**HIF 5**
	ha (ac) **%**	**ha (ac)** **%**	**ha (ac)** **%**	**ha (ac)** **%**	**ha (ac)** **%**
Ruderal-herbaceous	6 (14.9) 10.8	4 (10) <1	5.7 (14.1) 10	1.3 (3.2) <1	5 (12.2) <1
Ruderal-woody	1.1 (2.6) <1	7 (17.4) 1.4	10.2 (25.3) 2	2.5 (6.2) <1	-
Hardwood - hammock	0.1 (0.2) <1	-	-	1.7 (4.3) <1	-
Ditch	0.3 (0.8) < 1	*	<1 (<1) <1	-	0.1 (0.2) <1
Wetland scrub-shrub freshwater	4.2 (10.5) <1	0.4 (1) < 1	-	-	-
Estuary	-	0.7 (1.7) <0.1	3.6 (8.8) <0.1	2.3 (5.8) <1	-
Wetland scrub-shrub saltwater	-	0.4 (1) <1	3.7 (9.1) <1	2.3 (5.8) <1	0.3 (0.7) <1
Mangrove	-	1.3 (3.1) <1	1.8 (4.5) <1	-	-
Oak scrub	-	-	3.9 (9.7) <0.1	-	-

Habitat Types Impacted	HIF 1 ha (ac) %	HIF 2 ha (ac) %	HIF 3 ha (ac) %	HIF 4 ha (ac) %	HIF 5 ha (ac) %
Upland mixed forest	-	-	0.5 (1.2) <0.1	-	-
Palmetto scrub	-	-	-	-	0.2 (0.5) <0.1
Cabbage palm	-	-	-	-	0.1 (0.2) <0.1

The RP-1 storage locations, for both Option 1 and Option 2 (common storage site), would cause some impacts to wetlands and would require like-kind mitigation elsewhere on KSC. Table 4-7a shows the areal coverage of vegetation impacts for each option by vegetation type. Mitigation would also be required for impacts to oak scrub and coastal strand habitats.

Table 4- 7a. Habitats and acreages potentially impacted within the two RP-1 storage options. "%" represents the percent of the total of that habitat type present on KSC.

Habitat Types Impacted	RP-1 Individual (Option 1) ha (ac) %	RP-1 Common (Option 2) ha (ac) %
Ruderal-herbaceous	8.9 (21.9) <1	6.3 (15.6) <1
Interior freshwater	-	0.2 (0.4) <1
Freshwater marsh	-	0.1 (0.2) <1
Ditch	0.2 (0.4) <1	0.4 (1.0) <1

Habitat Types Impacted	RP-1 Individual (Option 1) ha (ac) %	RP-1 Common (Option 2) ha (ac) %
Estuary	0.5 (1.2) <1	-
Mangrove	0.2 (0.4) <1	< 1 (<1) <0.5
Oak scrub	< 1 (<1) <0.2	1.2 (3.1) <0.1
Coastal strand	0.5 (1.2) <0.2	-
Upland mixed forest	-	0.2 (0.5) 0.1
Wetland scrub-shrub saltwater	0.4 (0.9) <1	0.8 (1.9) <0.5
Salt marsh	0.1 (0.3) <1	0.2 (0.5) <0.5
Interior saltwater	<1 (<1) <1	<1 (<1) <1

The common storage option for the RP-1 storage facility would impact 6.3 ha (15.6 ac) of ruderal herbaceous vegetation. This accounts for less than 1% of the total for KSC. This option impacts 1.2 ha (3.1 ac) of oak scrub, less than 0.1% of the total for KSC, and 0.2 ha (0.5 ac) each of upland mixed and hardwood forest, constituting approximately 0.1 % of the total.

The common storage site impacts less than 1 ha of interior saltwater, 0.2 ha (0.5 ac) of salt marsh, less than 1 ha of mangrove, and 0.8 ha (1.9 ac) of wetland scrub-shrub saltwater. This totals less than 0.5% of the total for KSC. Impacts to freshwater systems include 0.4 ha (1.0 ac) of ditches, 0.1 ha (0.2 ac) of freshwater marsh, and 0.2 ha (0.4 ac) interior freshwater. These impacts total to less than 1% of the total for KSC. All impacts to wetlands would require like-kind mitigation elsewhere on KSC.

Operational impacts to habitats in the vicinity of launch pads on KSC and CCAFS have been well documented. These impacts include outright destruction of plants in the path of exhaust plumes followed by regrowth during the same growing season, and damage to leaves from wet deposition of HCl. Deposition spotting tends to persist for long periods of time, but mortality of plants or changes in community composition have not been documented. Occasionally, brush fires occur immediately after a launch, but these are quickly contained and confined to ruderal vegetation that recovers rapidly. The area impacted from Shuttle launches was dependent on environmental conditions such as wind speed and direction, and was contained to approximately 20 ha (50 ac) north of the launch pad flame trenches (Dreschel and Hall 1990). Other rockets (e.g., Atlas, Titan, and Delta) have similar impacts, but over a much smaller habitat area than Shuttle (Schmalzer et al. 1998).

4.3.5.2 Wildlife

Construction – Loss of habitat is the primary impact to wildlife (excluding marine animals) from construction for the Proposed Action. Most of the species that might be directly affected by the development are common on KSC and not legally protected (Breininger et al. 1994). The loss of a maximum of 362.4 ha (895.5 ac) as described in the Proposed Action is a fraction (0.7%) of the KSC habitat not used for space operations on KSC. Additionally, these impact areas are adjacent to areas that are already developed, so fragmentation of undeveloped habitat would be negligible. The impact of construction to the overall wildlife population and biodiversity on KSC from the Proposed Action is expected to be minimal.

Operations – Expected operational impacts on wildlife would result from noise and vibration (addressed in Section 4.3.4). Additionally, impacts to marine wildlife or habitat could result from potential orbital and reentry debris (addressed in Section 4.3.11).

4.3.5.3 Threatened and Endangered Species

Construction **-** Loss of habitat is the primary impact expected to federally protected wildlife (excluding marine animals) from construction of the Proposed Action. Table 4.7b shows the potentially affected habitats and the corresponding listed species. Each of these species is discussed in the following paragraphs.

American Alligator

Of the 19 habitats (Table 4-7b), the alligator could occur in nine of them, four freshwater and five brackish. If the entire footprint of the Proposed Action was developed, the loss of alligator habitat would be 55.2 ha (136.4 ac). All of the habitats are used for feeding, and the freshwater marsh totaling (0.1 ha [0.3 ac]) provides nesting areas. Loss of a relatively small amount of habitat, compared to what is available, is expected to have a minimal impact on the population.

Marine Turtles

Construction is expected to take place during daylight hours and would not occur on the beach or primary dunes. Therefore, the three species of marine turtles that commonly nest on KSC beaches and the two species common in the open water lagoon are not expected to be impacted by construction of the Proposed Action.

Gopher Tortoise

Four of the potentially impacted habitats are suitable for gopher tortoises: coastal strand, oak scrub, palmetto scrub, and ruderal herbaceous. Only 9.4 ha (23.2 ac) of the coastal strand, oak scrub, and palmetto scrub combined would be developed in a 100% build out scenario. However, ruderal herbaceous has the largest amount of acreage, 159.5 ha (394.1 ac), that would be impacted by the Proposed Action. Tortoises use ruderal herbaceous habitats for feeding because the vegetation, primarily grass, is naturally low-growing or is maintained by mowing. Tortoises often dig burrows in this habitat. Loss of the ruderal herbaceous habitat would constitute a moderate impact that could be lessened by relocation of tortoises from the impact area and replacement of ruderal vegetation after the construction is complete.

Eastern Indigo Snake

The Eastern Indigo Snake is the least habitat-specific of all of the protected animals listed in Table 4-7b. They may be found in any of the Proposed Action habitats except for open water borrow pits and retention ponds (water-interior-fresh habitat type). If the entire area was developed for the project, 362 ha (894 ac) of potential indigo habitat would be lost. Based on indigo snake radiotracking data in Brevard County, including KSC, this represents enough habitat to support three male indigos with average size territories and /or nine females with average size territories (Breininger et al. 2011). This could be a major impact, but replacement of ruderal herbaceous habitat and mitigation for loss of scrub and wetlands habitats would lessen the impacts to moderate.

Wood Stork

Wood storks use the wetland habitat types present within the project area for feeding; nesting has not occurred on KSC since 1991 after freezing temperatures in the late 1980s decimated many mangroves. If the entire wetlands acreage was developed (ditch, estuary, mangrove, freshwater and saltwater marshes, fresh and salt interior waters, and fresh and salt scrub-shrub), there would be a loss of 55.2 ha (136.4 ac). This is approximately 0.4% of the total wetlands habitat (14,642 ha (36,179 ac) available on KSC (NASA 2010). Monthly aerial wading bird surveys show that there is an average of 250 wood storks present on KSC throughout the year, but the numbers are lower in summer as there is an influx of non-resident birds during the winter. These winter visitors commonly feed in the roadside ditches rather than in the other wetland types. Development in wetlands would require mitigation and any ditches that were filled would have to be replaced for stormwater purposes. Impacts to the wood stork population would be expected to be moderate.

Bald Eagle
Eagles use two of the project habitats, the estuary for feeding, and pine trees in the upland mixed forest for nesting. Loss of 14.6 ha (36.0 ac) of estuarine waters would not be expected to seriously impact the availability of food for eagles on KSC, and this wetlands habitat loss would legally require mitigation. Based on yearly surveys conducted for eagles' nests, the closest nest to any of the Proposed Action project development is more than 2.6 km (1.6 mi) away (B. Bolt, unpub. data). Impacts to bald eagles from construction are expected to be minimal.

Florida Scrub-jay
There are 9.4 ha (23.2 ac) of potential scrub-jay habitat within the project footprint. The suitability of jay habitat is constantly changing due to natural processes and/or active management. Compensation for loss or alteration would be determined by the USFWS Endangered Species Office on a real-time basis shortly before impacts would occur. Mitigation would take place elsewhere on KSC in potential scrub-jay habitat that is degraded and in need of restoration. Impacts to Florida scrub-jays from construction are anticipated to be moderate.

Southeastern Beach Mouse
There are 0.5 ha (1.2 ac) of coastal strand habitat that could potentially be occupied by beach mice within the project area. If this habitat was developed for the project, consultation with the USFWS Endangered Species Office would be required and appropriate mitigation determined. A few southeastern beach mice have been documented from inland oak scrub habitat on KSC. There are 8.5 ha (21.1 ac) of scrub that could be lost or altered by construction; consultation with the USFWS and mitigation for scrub habitat impacts would coincidentally be required because of Florida scrub-jays. Potential impacts to southeastern beach mice are being classified as moderate.

Northern Right Whale
There would be no impacts to northern right whales from construction of the Proposed Action.

West Indian Manatee
Development of 14.6 ha (36.0 ac) of estuary could occur during construction for the Multi-use Project. The areas that would be developed have been mapped as having unvegetated bottom (i.e., no seagrass food resources; R. Cancro, unpub. data), so impacts from construction are expected to be minimal for manatees. BMPs would include observers for watercraft operations that might accommodate construction.

Operations – Most operational impacts are anticipated to be from noise and vibration (addressed in Section 4.3.4) and the very low potential to sea turtles and marine mammals from potential orbital and reentry debris (addressed in Section 4.3.11). Operations of facilities would not have impacts, but the potential consequences from orbital and reentry debris after launch are discussed in Section 4.3.11. It is highly unlikely that a right whale would be directly hit by debris. There could be degradation to the marine environment from rocket parts such as fuel tanks that would break apart after hitting the water, sinking quickly, but dispersing contents and substances from their surfaces. Some elements would sink to the bottom intact and degrade over time. These impacts would be classified as moderate for right whales because the corrosion rates would be very slow and the volume of water available to dilute toxins would keep them below dangerous levels (NASA 2008; Letter from NMFS 2013, Appendix A).

There is potential for disorientation impacts to nesting and hatching marine turtles from facility lighting or launches at night. All facilities will have to comply with the KSC Light Management Plan (NASA 2002). The update of this plan is currently in progress with the estimated publication date in September 2013). The KSC nesting beach is monitored during the nesting season and mitigation for launch-induced disorientation events would be determined by the USFWS Endangered Species Office.

NASA will initiate consultation with NMFS and USFWS during the public review period of this draft EA.

Table 4-7b. Habitat types within the LC 39 Multi-user Project area and associated federally protected wildlife species that are reasonably expected to occur.

Habitat	American Alligator	Marine Turtles	Gopher Tortoise	Eastern Indigo Snake	Wood Stork	Bald Eagle	Florida Scrub-jay	Southeastern Beach Mouse	Northern Right Whale	West Indian Manatee
Ocean									X	
Cabbage palm				X						
Coastal strand		X	X	X			X	X		
Ditch	X			X	X					
Estuary	X	X		X	X	X				X
Hardwood hammock				X						
Mangrove	X			X	X					
Marsh freshwater	X			X	X					
Marsh saltwater	X			X	X					
Oak scrub			X	X			X	X		
Palmetto scrub			X	X			X			
Ruderal herbaceous			X	X						
Ruderal woody				X						
Upland mixed forest				X		X				
Upland hardwood forest				X						

Habitat	American Alligator	Marine Turtles	Gopher Tortoise	Eastern Indigo Snake	Wood Stork	Bald Eagle	Florida Scrub-jay	Southeastern Beach Mouse	Northern Right Whale	West Indian Manatee
Water interior fresh	X				X					
Water interior salt	X			X	X					
Wetland scrub-shrub freshwater	X			X	X					
Wetland scrub-shrub saltwater	X			X	X					

4.3.6 Geology and Soil

LC 39 Area

The majority of the LC39 area, including the launch pads, is considered disturbed and any construction activities associated with the Proposed Action and its options would have minimal to moderate impacts to the geologic characteristics of the area. Launch operations associated with the six proposed vehicles from LC 39A or LC 39B would have minimal impacts to soils. Deposition of materials from launch occurs through two processes if large amounts of deluge water are used for sound suppression. One mechanism is the direct deposition of the deluge water mixed with exhaust products and blown from the pad by rocket motor ignition. The second source of deposition is rainout that occurs as the exhaust cloud, composed of water and exhaust products, rises, cools, and drifts from the pad with prevailing winds. Water and exhaust products that run off of the pad surface are captured and contained within the deluge ponds for processing and disposal.

Through the 30 year flight history of the Shuttle Program there were 135 launches, 82 from LC 39A and 53 from LC 39B. In the non-saline soils, there were increases in conductivity, Ca, K, Na, and zinc (Zn), and decreases in phosphorus (P), nitrate nitrogen (NO_3-N), and ammonium as N (NH_4-N). In the saline soils, there were increases in Ca, K, Na, Zn, and P but not conductivity, and decreases in NH_4-N, but not NO_3-N. These changes may be attributed in part to the neutralization reaction produced by addition of HCl (Schmalzer 1993). It is expected that continued deposition of HCl from the SLS would result in similar reaction processes. Areas of high repeated deposition may eventually lose their buffering potential, leading to soil acidification. This could be mitigated by periodic addition of buffering compounds such as $CaCO_3$.

In addition, aluminum oxide would not affect soils because it would be deposited as a stable compound (Schmalzer 1993). Therefore, no measureable direct or indirect, short or long-term effects on soil chemistry would be expected as a result of launch activities.

HIF Option Locations

Construction of the HIF at Options 1 and 5 would have minimal impacts to geology and soils due to the previously disturbed aspects of the locations. Land clearing activities associated with construction of the HIF at Options 2, 3 or 4 would cause moderate disturbance in the upper soil layers of these relatively undisturbed sites, and might result in changes in the subsurface flow of water from rainfall events. Stormwater runoff is discussed further in Section 4.3.2. Erosion and sediment control BMPs would be implemented during all construction activities. Much of the existing land at Options 2, 3, and 4 is classified as submerged or poorly drained. It would be necessary to truck in large amounts of fill material for development of these sites.

The operations of the HIF at any of the Proposed Action locations would require all safety procedures for storage, fueling operations, testing, and cleaning be followed. Therefore, no impacts to geology and soils are expected from operations.

RP-1 Options Locations

The proposed railways associated with both RP-1options would be constructed along the center of existing roadways, which would have minimal to no impacts to geology and soils.

The operation of the RP-1 Individual Storage (Option 1) would have no impacts to geology and soils as these RP-1 storage areas would be constructed within the perimeters of LC 39A and LC 39B, which are previously disturbed areas. Proper safety procedures to prevent spills during fuel transfer, piping, and loading would be required.

The RP-1 Common Storage (Option 2) would require land clearing and site preparation in an undisturbed area that is adjacent to an existing facility. Moderate impacts to soils in this area would occur during construction activities. Operations at the common storage option would have no impacts to geology and soils, but would require proper safety procedures to prevent spills during fuel transfer, piping, and loading.

4.3.7 Historic and Cultural Resources

The impacts for the Proposed Action on the historic facilities at LC 39A and the Crawlerway are unknown at this time because future modification or demolition activities have not been addressed. Any proposed modification or demolition activities to NRHP-listed facilities would require consultation with the FL SHPO in accordance with the current Programmatic Agreement for Management of Historic Properties at KSC, dated May 2009 (NASA 2009c, KCA-4185). The FL SHPO has 30 days to comment per Stipulation III.C. There are minimal to no impacts to the archaeological sites and historic areas.

LC 39 Area

Construction – In order to support the use of LC 39A and LC 39B by the proposed six launch vehicles, modifications and/or demolition activities will be necessary. If any proposed launch activities require modification or demolition, a moderate impact to the NRHP-listed individual launch pads and historic districts would be expected. Under the Programmatic Agreement (PA), NASA KSC must consult with the FL SHPO (pursuant to Stipulation III) when an "adverse effect" to the historic property has been determined by an undertaking. The launch complexes have undergone major modifications between the Apollo, Space Shuttle, and Constellation programs to support the Agency's missions. Historic American Engineering Record (HAER FL-8-11-F), at a Level II, for the complexes was completed in 2010. The recordation package contains a written history of the complexes, process descriptions of activities that occurred at the site, interviews with program experts, as built drawings, and archival and current photos (ACI 2010). The HAER was performed to mitigate for "adverse effects" to the complexes that might occur with post Shuttle Program redevelopment. There are no known archaeological resources impacted within the launch complexes.

Construction of the RP-1 storage and transfer area at each launch complex would not have an impact to the historic district. In Section 2.2, it is noted that the proposed location of a new RP-1 storage and transfer area at each of the complexes is the former RP-1 facility.

Operations – Making the launch complexes available to commercial entities would not have an impact to the historic district. Within NASA's agreement documents are environmental clauses and stipulations that protect KSC's historic properties. Prior to any modifications, an Environmental Checklist is prepared and a Record of Environmental Consideration is completed to evaluate the impacts to the historic properties and to determine if consultation with the FL SHPO is required.

HIF Option Locations

Construction/Operations – The proposed locations for the five HIF options would have minimal impact to the historic Crawlerway. There are no known archaeological sites within this "low" ZAP area. Modifications to the railroad track would not impact the newly eligible track, but could have minimal impact to the Crawlerway.

RP-1 Common Storage Area

Construction/Operations – Clearing approximately 0.61 ha (1.5 ac) of undisturbed land would be required to construct an RP-1 common storage area located at the northeast corner of intersection Pad B Road and Pad A Emergency Road. Installation of underground piping would follow the existing roadway in previously disturbed areas. There are no known archaeological sites within this low ZAP area. Historic Area #54, discussed in Section 3.4.7, would not be impacted by construction or operation of the RP-1 common storage area and was not recommended for additional testing.

RP-1 Individual Storage Areas

Construction/Operations – There are two archaeological sites (8BR79 and 8BR84) and two Historic Areas (#118 and 119) found within this area, noted in Section 3.4.7. 8BR79/Titusville Beach was destroyed by the construction of the railroad and Coast Guard Station, as well as by land clearing operations. It is within Historic Area #119 and a "moderate" ZAP area. The FL SHPO concurred that ground disturbing activities may proceed within 8BR79. The precise location and nature of the archaeological site 8BR84/No Name is unknown and is recommended for further archaeological testing. Historic Area #118 was known as the Bottle Dump Site, an ineligible archaeological site (concurred by the FL SHPO) which does not require further archaeological testing. Historic Area #119 was the old Canaveral Club which was destroyed by fire and is recommended for further archaeological testing. Installation of underground piping for the individual storage areas would follow the existing disturbed roadways and would have minimal to no impact on archaeological sites and historic areas.

4.3.8 Hazardous Materials and Waste Management

Hazardous materials and solid and hazardous wastes are managed and controlled in accordance with federal and state regulations. KSC has established plans and procedures to implement these regulations. The use, management, and disposal of hazardous materials for both the construction and operations phases are described in KNPR 8500.1, KSC Environmental Requirements. An active pollution prevention program is in place to reduce the use of hazardous materials and generation of hazardous waste.

All wastes generated by commercial entities must be properly containerized, stored, labeled, manifested, shipped, and disposed of in full regulatory compliance. Hazardous wastes generated by commercial entities and their contractors must be manifested, shipped, and disposed of under the company's EPA identification number. Commercial entities are required to maintain copies of waste management records and manifests onsite and have them available for review by NASA upon request.

Construction

The construction activities would use small quantities of hazardous materials, which would result in generation of small volumes of hazardous wastes. Hazardous materials that are expected to be used are common to construction activities and include diesel fuel and gasoline to power the construction equipment, hydraulic fluids, oils and lubricants, welding gases, paints, solvents, adhesives, and batteries. Appropriate hazardous material management techniques would be followed to minimize their use and waste disposal. The construction contractors would make all reasonable and safe efforts to contain and control any spills or releases that may occur. All hazardous material releases to air, water, soil, and pavement at KSC must be reported per the requirements in KDP-KSC-P-3008, Hazardous Materials Emergency Response. With the proper procedures and safeguards in place, it is not expected that soil or groundwater contamination would be caused by development of RP-1 or HIF sites.

Nonhazardous and hazardous waste generated during modification of the launch sites and construction of new facilities would include construction debris, empty containers, spent solvents, waste oil, spill cleanup materials, and lead-acid batteries from construction equipment. Construction contractors would be responsible for safely removing these wastes from the site for recycling or disposal in accordance with applicable requirements. Vegetation and construction debris resulting from site preparation would be taken to the KSC landfill or burned onsite. Combustible vegetative materials may be burned within the confines of KSC after obtaining a burn permit issued by KSC. Burning may be limited or prohibited during periods of dry weather, or when sensitive flight hardware is housed in the vicinity of the burn site. Burn permits must be scheduled a minimum of 48 hours in advance and may be requested through the Duty Officer. The Florida Division of Forestry must also be notified when burning land clearing debris, and authorization must be obtained the same day the burn is to take place or after 4:00 p.m. the previous day. Compliance with hazardous material and waste management regulations and adherence to guidelines established by NASA as outlined in KNPR 8500.1 should result in only minimal impacts from construction activities related to the Proposed Action.

Operation

Hazardous materials and hazardous and solid wastes are controlled in accordance with federal and state regulations. KSC has established procedures to implement these regulations and those management procedures are documented in KNPR 8500.1. All wastes generated by commercial entities must be properly containerized, stored, labeled, manifested, shipped, and disposed of in full regulatory compliance under the company’s EPA identification number.

The approximate quantities of materials that would be used during processing of spacecraft are listed in Table 4–8. Any materials remaining after completion of processing would be properly stored for future use or disposal in accordance with all applicable regulations.

Table 4-8. Payload Processing Materials of a Routine Payload Spacecraft

Material	Quantity	Purpose
Isopropyl Alcohol	22.7 liter (5 gal)	Wash
Denatured Alcohol	22.7 liter (5 gal)	Wash
Ink, White	0.5 liter (1 pt)	Marking
Ink, Black	0.5 liter (1 pt)	Marking
Epoxy adhesive	4.5 liter (1 gal)	Part bonding
Epoxy, Resin	4.5 liter (1 gal)	Repairs
Acetone	4.5 liter (1 gal)	Epoxy cleanup
Paint, Enamel	4.5 liter (1 gal)	Repair & marking
Paint, Lacquer	4.5 liter (1 gal)	Repair & marking
Mineral Spirits	4.5 liter (1 gal)	Enamel thinner
Lacquer Thinner	4.5 liter (1 gal)	Thinning lacquer
Lubricant, Synthetic	0.5 liter (1 pt)	Mechanism lube
Flux, Solder, MA	0.5 liter (1 pt)	Electronics
Flux, Solder, RA	0.5 liter (1 pt)	Electronics
Chromate conversion coating	0.5 liter (1 pt)	Metal Passivation

Source: NASA, 1998

During the operation of any of the alternative sites, hazardous and solid waste would be handled and disposed of in a manner consistent with the guidelines established by NASA as outlined in KNPR 8500.1. There would also be contingency plans for responding to and minimizing the effects of spills. All hazardous material releases to air, water, soil, and pavement at KSC must be reported per the requirements in KDP-KSC-P-3008. With the proper procedures and safeguards in place, it is not expected that soil or groundwater contamination would be caused by operational activities at the Proposed Action sites.

The processing of launch vehicles at the launch site requires the use of hazardous materials and results in the production of hazardous wastes. Impacts due to use of large quantities of hazardous materials and creation of large quantities of hazardous waste would be measureable but would be reduced through appropriate management and conservation measures. These impacts from launch and launch vehicle processing are therefore considered moderate. Table 4-9 lists estimated amounts of hazardous materials used per launch for the Titan series or Atlas vehicle with SRMs. The Titan IV is used as an example of hazardous materials usage and hazardous waste generation by a launch vehicle system since it is a large vehicle with SRMs and is much larger than the Falcon 9. The NASA Routine Payloads Environmental Assessment can be referenced for further details that pertain to hazardous materials and waste management in relation to vehicle processing and launch impacts.

Table 4-9. Hazardous Materials Used per Titan IV and Atlas V Launches

Material	Quantity	Purpose
Petroleum, oil, lubricants	2177 kg (4790 lb)	Booster Processing
VOC-based primers, topcoats, coatings	145 kg (320 lb)	External maintenance
Non VOC-based primers, topcoats, coatings	86 kg (190 lb)	External maintenance
VOC-based solvents, cleaners	627 kg (1380 lb)	Surface cleaning
Non VOC-based solvents, cleaners	432 kg (950 lb)	Surface cleaning
Corrosives	2500 kg (5500 lb)	Surface preparation
Adhesives, sealants	1036 kg (2280 lb)	Structural, electronic
Other	291 kg (640 lb)	Booster processing
Electron QED cleaner	5.7 liter (5 qt)	SRM cleaning
MIL-P-23377 primer	2.8 liter (5 pt)	SRM exterior
Silicone RTV-88	45 liter (10 gal)	SRM sealant
Electric insulating enamel	0.1 kg (5 oz)	SRM touchup
Acrylic primer	22 liter (5 gal)	SRM touchup
Conductive paint	45 liter (10 gal)	SRM antistatic coating
Chemical conversion coating	0.3 kg (10 oz)	SRM surface preparation
Cork-filled potting compound	5.7 liter (5 qt)	SRM thermal protection
Epoxy adhesive	5.7 liter (5 qt)	SRM modification

Derived from USAF, 2000a to illustrate quantities associated with Atlas V 500 and Titan IV SRMs.

Remediation Program

The Proposed Action, including construction and operation, should not have a significant impact on the NASA KSC Remediation Program's plans for managing SWMU and PRL sites or interfere with ongoing investigations at these sites. The remediation areas within or adjacent to the Proposed Action are described in Section 3.4.8.2. Confirmation sampling work plans have been or will be developed for some of these PRL sites. These sampling efforts could occur along with launch, HIF, and RP-1 operations without interference. Activities at LC 39A, LC 39B, or within any active SWMU and PRL site would be reviewed for contamination related issues and requirements. Care must be taken to prevent damage to any of the monitoring wells located at the launch complexes and other remediation sites throughout the Proposed Action project area.

4.3.9 Global Environment

Rocket engine combustion emissions are not regulated and are not subject to limitations on production or use. However, launching rockets could potentially impact the global environment. Table 4-10 presents the emissions from propulsion systems used on the launch vehicles being evaluated in this EA. Rocket engine combustion is known to produce gases and particles that reduce stratospheric ozone concentrations locally and globally (WMO 2006). Table 4–10 does not account for all emissions, only those most relevant to ozone chemistry. For example, all of the systems emit CO_2, but CO_2 does not play a direct role in ozone chemistry in the stratosphere (NASA 2008).

Table 4-10. Launch vehicle emissions from rockets being evaluated for the Proposed Action. Al2O3, soot, and sulfate particles are less than 5 microns. Parentheses denote compounds that have not yet been measured but are expected to be present.

Propellant	Launch Vehicles	Emissions
LOX/LH_2	SLS, Liberty, Delta IV Heavy, Antares	H_2O, (NO_X, HO_X)
LOX/RP-1	Falcon 9, Falcon Heavy, Atlas V	H_2O, (NO_X, HO_X), soot (carbon), H_2SO_4
Solid	SLS, Liberty, Atlas V,	H_2O, HCl, Cl_X, NO_X, (HO_X), Al_2O_3
LO2/IPA	Xaero	H_2O, CO_2, soot (carbon)
LO2/LCH4	RSLV-S	H_2O, CO_2, CO
HTPB (solid)	Athena IIc	NO_x, CO_2, HNO_3, soot (carbon)

Key: Al_2O_3=Alumina; Cl_X=Chlorines; H_2O=Water; HCl=hydrogen chloride; HO_X=hydrogen oxides; H_2SO_4=hydrogen sulfate; LOX=liquid oxygen; LH_2-liquid hydrogen; NO_X=nitrogen oxides; RP-1=rocket propellant

The impact of rocket emissions is separated into an immediate local response following each launch, and a long-term global response that reflects the steady, cumulative influence of all launches. Fast chemical reactions between reactive plume gases, particles, and the surrounding air cause the local response and can result in 100% ozone loss within the plume (Ross 2000). This phase lasts for several days until the reactive exhaust gases have been largely deactivated and the plume has substantially dispersed. The ozone loss in this phase, while dramatic, does not likely contribute significantly to the global impact (Danilin 2001).

The global response is driven by the accumulation of all gas and particulate emissions over a long period of time after the exhaust has been mixed throughout the stratosphere. An approximate steady state is achieved as exhaust from newer launches replaces the exhaust from older launches, which is removed from the stratosphere by the global atmospheric circulation, a process that takes about three years. The emitted compounds add to the natural reservoirs of reactive gases and particle populations that control ozone amounts.

Of the propellant combinations that would be utilized by the proposed launch vehicles and listed in Table 4-10, only SSRM emissions have been studied in depth. The local and global impact of chlorine emitted by SSRMs has been extensively measured and modeled and is relatively well understood (WMO 1991, 2006). The Shuttle solid booster and other SSRMs release reactive chlorine gases directly in the stratosphere; the quantities are small in comparison with other tropospheric sources. Additional modeling and observation results have concluded that stratospheric accumulation of chlorine and alumina exhaust from launch activities lead to small (< 0.1%) global column ozone decreases (WMO 2006).

The impact of alumina, soot particulate, NOx, and HOx emissions are less well understood than chlorine emissions. Laboratory and plume data suggest that the impact of alumina particulate is not substantial, although some uncertainty remains. For some plausible model assumptions, the global impact of alumina particulate is comparable to the chlorine impact (Jackman 1998). NOx and HOx emissions are small and their impacts are likely not significant compared to chlorine and alumina.

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In contrast to SSRMs, the impacts of liquid propellant rocket engine emissions have not been extensively studied. The few findings that have been published highlight the reactive gas and soot emissions of kerosene-fueled engines and associated potential for ozone impacts (Newman 2001; Ross 2000). Because of the scant data and lack of modeling tools, it is not possible to estimate the impact of liquid propellant systems with the same degree of confidence as has been done for solid propellant systems. Further research is required before the stratospheric impacts of LOX/LH_2, LOX/RP-1 emissions can be quantified.

Among the proposed launch vehicles, the SLS would most likely emit the greatest amount of exhaust into the stratosphere. The SLS vehicle was designed to use 125% more solid propellant than the Shuttle. It is estimated to release 90 mt (99 tons) of chlorine and 127 mt (140 tons) of particulate matter to the stratosphere in a single launch (NASA 2008). The remaining vehicles in Table 4-10 are expected to have less impact than the SLS on a per launch basis.

The construction and operation of the RP-1 Storage at any of the two option locations and the five HIF option locations would have minimal impacts to the global environment. Any effects would be due primarily to machine and vehicle usage.

4.3.9.1 Climate Change

During the construction phase of the Proposed Action, greenhouse gas emissions such as CO_2 would be released by fossil fuel powered machinery and vehicles. These emissions would be considered minimal and unavoidable, and in many cases, represent only a shift in location of machinery and vehicle use and not an addition to total regional emissions rates.

Another activity affecting the local carbon budget would be loss of vegetation from construction of the HIF Option 2, 3 or 4 locations and from construction of the RP-1 Common storage area (Option 2). Vegetation, alive or dead, is an important carbon stock, and ecosystems in the U.S.

contain approximately 60,418 million metric tons (mil mt) (66,600 mil tons) of carbon (Heath and Smith 2004). According to the U.S. Climate Change Science Program (CCSP), the size of the carbon sink in U.S. forests appears to be declining, based on inventory data from 1952 to 2007 (Birdsey et al. 2007). The carbon density (the amount of carbon stored per unit of land area) is highly variable, as it is directly correlated to the amount of biomass (including the organic component of soil) in an ecosystem or plant community. When land is cleared, carbon dioxide is released into the atmosphere through such processes as decomposition and burning. The dominant vegetative habitats within the Proposed Action project footprint are ruderal herbaceous (44.0%) and ruderal woody (10.1%) vegetation.

Many ecosystems often function as carbon sinks, and in addition to the carbon stored in live vegetation, plant communities can contribute carbon to the soil. Consequently, each parcel of land that is cleared of vegetation results in the loss of a potential carbon sink. The loss of vegetative communities within HIF Option 2, 3, and 4 locations, as well as the RP-1 Common Storage (Option 1) would result in less land available for carbon sequestration.

Therefore, the clearing of land for the Proposed Action would have two impacts as it relates to climate change: carbon would be released by the removal and disposal of vegetation, and a carbon storage area would be lost. However, it is likely that these consequences could be minimized and offset by long-term reductions in fossil fuel use and other mitigation strategies related to regional land management scenarios.

Operational phase impacts include the release of greenhouse gases from energy use in support of ground operations and flight operations. Emissions associated with ground operations include employee vehicle emissions, emissions from heavy machinery, emissions from electric power generation, and intentional and unintentional venting or discharges of volatile components of aircraft and rocket fuels. Proposed increases in aircraft flight operations would also contribute to local emissions of greenhouse gases and moderate impacts to climate change may be expected.

Of growing concern is the potential climate change impact of the emerging commercial space industry that the Proposed Action supports (Ross et.al. 2010). The six launch vehicles evaluated in this EA are a source of black carbon "soot" emitted directly in the stratosphere above 20 km (12 mi). These black carbon or soot particles can have a greater impact on climate change than rocket emissions of CO_2. Black carbon is known to be the second most important compound driving climate change (Bond, et al, 2013). In modeling studies, utilizing the Whole Atmosphere Community Climate Model, researchers have shown these soot particles may accumulate into a thin cloud at an altitude of about 40 km (24 mi), which remains relatively localized in latitude and altitude (Ross et.al 2010). The model suggests that if this layer reached high enough concentrations, the Earth's surface and atmospheric temperatures could be altered. The globally integrated effect of these changes is, as for carbon dioxide, to increase the amount of solar energy absorbed by the Earth's atmosphere. Research on the potential climate change impacts of black carbon from rockets is in a very early stage and projections of impacts are being refined.

Mitigation and/or minimization of this potential impact are being addressed in the aerospace industry by advancing propulsion system designs and innovative fuel mixtures that burn more cleanly and reduce soot formation. Impacts are considered minor.

The amount of CO_2 that would potentially be released by the Proposed Action as a result of associated energy is estimated to be less than 6,000 mt (66.2 mil tons) annually. With continued implementation of energy conservation programs at KSC and other measures that minimize the use of fossil fuels, it is expected that emissions from the additional workforce and increased flight activities would not make a substantial contribution to greenhouse gas (GHG) emissions or climate change.

NASA has developed a "Guidance On Climate Change and GHG Emissions" document that will assist in determining the extent of potential impacts due to these emissions. In addition to the document, NASA Headquarters has provided the *NASA Template Statement for NEPA Actions Influencing GHG Emissions and Climate Change* and the Microsoft Excel based *NASA's NEPA Emission Estimation Tool* (N2E2), for NASA centers to accomplish these assessments. This N2E2 tool will aid in better quantifying potential climate change impacts due to the Proposed Action. Each governmental and non-governmental entity would utilize this tool to assist in quantifying GHG emissions pertaining to their actions.

4.3.10 Socioeconomics and Children's Environmental Health and Safety

This section identifies potential impacts on the population, housing, social conditions, employment, and regional economy that might result from the Proposed Action. The construction of the HIF and the RP-1 storage facility would draw from the local workforce for construction efforts, having a beneficial impact on the local economy. In addition, the operations associated with the Proposed Action, primarily the planned two launches per month from LC 39A and LC 39B, would have a beneficial impact to the local economy with the addition of full-time employees. For example, there are 50 full-time SpaceX employees and contractors on-site for Falcon vehicle activities at Launch Complex 40. During the launch preparation and launch timeframe an additional 50 local or transient workers would be employed at the launch complex or launch control center area (NASA 2013b).

Impact to Children's Environmental Health and Safety

Impacts to children's environmental health and safety were evaluated in terms of the potential for high and adverse environmental consequences resulting from the project to disproportionately affect children. The only location where children are concentrated in the vicinity of the project area is at the KSC Child Development Center, which is approximately 6.4 to 12.9 km (4 to 8 mi) from the proposed site locations. Children at the Center may be exposed to increased noise levels during launches. However, noise levels are expected to be greatly diminished at that distance from the launch pads. Estimations of sound levels the KSC Child Development Center would experience during a launch event comparable to that of an Ares 1 or Ares V launch could result in the rise of daycare center exterior sound levels to 80 or 90 dBA. The interior sound levels at this time may differ from 10 to 15 dBA less than the exterior. The duration of these increased sound levels, both interior and exterior, would be less than 30 seconds (NASA 2007c). These sound levels would be shorter in duration and lower in frequency than experienced during the use of gas powered mowers maintaining the grounds at the KSC Child Development Center (Table 3-3). Therefore, the Proposed Action would not pose disproportionately high or adverse impacts to children's environmental health or safety. The No Action Alternative would not impact children.

4.3.11 Orbital and Reentry Debris

Orbital debris is defined as artificial objects, including derelict spacecraft and spent launch vehicle orbital stages, left in orbit and no longer serving a useful purpose. Man-made objects currently circle the Earth, ranging in size from small flecks of paint to bus-sized satellites. It is estimated that there are more than 10,000 objects greater than 4 in (10cm) in size in orbit, (most of which are tracked by Air Force Space Command), tens of millions between 0.039 and 4 in (1 to 10cm) in size, and trillions less than 0.039 in (.99 mm) in size (NRC, 1995). At some point, all will reenter Earth's atmosphere as their orbits decay. The majority of them will be destroyed due to aerodynamic heating. However, some are large enough or constructed of materials strong enough to survive reentry and impact Earth's surface. No one has ever been injured by a reentering piece of space debris, due primarily to the fact that 70 percent of Earth's surface is water. The majority of debris that survives reentry lands in the ocean and sinks. Those objects that have come to rest on land have done so largely in unpopulated areas. The risk that an individual will be hit and injured from re-entering debris is extremely low. Reentry risk estimates are supported by the fact that, over the last 40 years, more than 5,400 metric tons of materials are believed to have survived reentry with no reported casualties (CORDS, 2013).

In February 2011, NASA reported that 382 man-made objects reentered the atmosphere in 2010. Of these, 356, including 22 spacecraft and 27 launch vehicle stages with a total aggregate mass of approximately 54 tonnes (60 tons), reentered in an uncontrolled manner. The number of reentries is normally driven by satellite fragmentations and solar activity. The annual mass of reentries has varied significantly with changes in the world-wide launch rate and solar activity, reaching a high of 350 tonnes (385 tons) in 1988. It can be expected that the greater number of launches from KSC, as compared to the number of launches during the Space Shuttle program, would increase the possibilities for reentry of orbital debris. During atmospheric reentry, the extreme heat generated while descending through the Earth's atmosphere would cause the majority of debris to burn up; however, in some instances, vehicle parts could endure until impact. During a controlled reentry, such debris would land in a predetermined safe ocean area (NASA 2011). NASA Procedural Requirements (NPR) 8715.6, NASA Procedural Requirements for Limiting Orbital Debris and NASA Standard 8719.14, Process for Limiting Orbital Debris, limits the risk of human casualty from reentry debris to 1 in 10,000 and requires that missions be designed to assure that in both controlled and uncontrolled entries, domestic and foreign landmasses are avoided. NPR 8715.6 is currently undergoing an update process.

Impacts from orbital and reentry debris associated with launch activities would be considered to be minimal due to the standards and processes that are in place.

In addition to the risk of direct contact with reentry debris, some vehicle parts would likely break apart upon water impact with a sink time predicted in the minutes. It is estimated that the SLS Block 1 five segment solid rocket boosters could contain up to 22.7 kg (50 lbs) of solid propellant and approximately 4.5 kg (10 lbs) of liquid fuel (SLS Booster Element pers. comm.). There is also the possibility of chromates, lead, asbestos or other hazardous substances on the boosters. All of these pose a hazardous materials threat to the surrounding waters. These impacts are all considered minimal due to the dilution effects of the ocean. Although unlikely, boosters that remain intact would float at or near the surface for longer periods of time, presenting navigation and debris hazards. Vehicle elements that are not planned for recovery, possibly including SRB or SRM segments, would disintegrate slowly, dissipate, and become buried in the ocean bottom. Corrosion of component hardware would contribute various metal ions to the water column. However, due to the slow rate of corrosion in the deep ocean environment and the quantity of water available for dilution, toxic concentrations of metal and fuels are not likely to occur (NASA 2008).

It is likely that the density of marine mammals and sea turtles in the splash down zones would be low and the probability of vehicle elements striking animals is negligible. Also, the potential for harm to marine mammals and sea turtles from discharge of fuels and propellents is insignificant because of the diluting capability of the ocean (Letter from NMFS, 2013, Appendix A).

For most launches, the size and location of the debris fields produced by the jettisoned stages would be specified based on the vehicle's trajectory. NASA or commercial entities would ensure that "Notices to Mariners" and "Notices to Airmen" were provided prior to any launch (for the launch area and downrange zones) to minimize the risk to aircraft and surface vessels.

Recovery of booster stages is expected for the Liberty vehicle, similar to the recovery process that was utilized for Shuttle launch activities. Recovery teams and ships would be pre-deployed to the planned splash down site in the Atlantic Ocean. After splash down, segments would be rendered safe and then prepared for return to KSC. The environment could also be impacted by a recovery ship accident, or as a result of jettisoned components hitting a ship or aircraft. This possibility or risk would be minimized to an acceptable level by the issuance of Notices To Mariners and NOTAM, as described above (NASA 2008) and has proved successful based on historical launch experience in the region.

4.3.12 Aesthetics

This section addresses visual changes to the landscape in the vicinity of the Proposed Action caused by light emissions, facilities that block the view of natural surroundings, or other impacts that are aesthetically unpleasant. Because the sites at KSC considered for the Proposed Action are located in industrialized areas, the visual sensitivity is low. Though the Proposed Action would require some construction and modifications, these additions would be consistent with existing infrastructure and not cause a significant impact to the area. Therefore, the Proposed Action is not expected to have significant impacts related to aesthetics.

4.4 Cumulative Impacts

Cumulative impacts result from the incremental effect of an action when added to other past, present, and reasonable foreseeable future actions, regardless of the proponent undertaking these actions. Minor or negligible impacts from individual projects may, over a period of time, become collectively significant. Past, current, and future launch activities and vehicle processing operations at KSC and CCAFS, along with present and future actions occurring on a regional basis, must be considered when evaluating cumulative impacts. The construction of new facilities and associated infrastructure, modifications of existing facilities and infrastructure, and proposed launch procedures and activities would be consistent with existing KSC activities and pose no new types of impacts. The maximum number of launches would be no more than two per month in any combination of users for the Proposed Action.

Additional current actions at KSC include the GSDO leading the center's transformation from a historically government-only launch complex to a spaceport with activity involving government and commercial vehicles alike. The program's primary objective is to prepare the center to process and launch the next-generation vehicles and spacecraft designed to achieve NASA's goals for space exploration. To achieve this transformation, program personnel are developing the necessary ground systems while refurbishing and upgrading infrastructure and facilities to meet tomorrow's demands. This modernization effort keeps flexibility in mind, in order to accommodate a multitude of government, commercial and other customers (GSDO, 2013).

KSC future actions include the launch of suborbital vehicles from the SLF and LC 39A locations. This would expand KSC’s spaceport capabilities to include the processing, launch, and recovery of horizontally and vertically launched suborbital rocket powered vehicles. The Finding of No Significant Impact (FONSI) for this action was published in December 2012 (NASA 2012c).

A KSC Centerwide EIS is being written and will evaluate additional commercial development at the SLF, expansion of areas for launch operations and support, vertical launch and landing, vehicle assembly and testing, payload processing, space systems testing and processing, and research and development (Exploration Park).

Current actions at CCAFS include the active FAA licenses for vehicle operations of the Atlas V, Falcon 9, Pegasus, Delta II and Delta IV vehicles at CCAFS. In addition, an FAA Launch Site Operator License exists for LC-46. A Launch Site Operator License, which is valid for five years, would allow Space Florida to offer the site for launches of solid- and liquid-propellant launch vehicles to launch operators for several types of vertical launch vehicles, including

Athena-1 and Athena-2, Minotaur, Taurus, Falcon 1, Alliant Techsystems small launch vehicles and launches of Minuteman-derivative booster vehicles. Space Florida proposes to support a maximum of 24 annual launches from LC-46, including 12 solid propellant launches and 12 liquid propellant launches. The proposed launch vehicles and their payloads would be launched into low earth orbit or geostationary orbit. All vehicles are expected to carry payloads, including satellites (FAA, 2008).

Over the course of several years, there could potentially be cumulative impacts to some of the resources evaluated in this EA as a result of the Proposed Action, in conjunction with other current and future actions. These resources are discussed in the sections below.

4.4.1 Cumulative Impacts on Land Use

Development of HIF Options 2, 3, and 4, the RP-1 Common storage site (Option 2), commercial development at the SLF and the GSDO's ground development for center transformation would be expected to have a moderate cumulative effect on land use due to the undisturbed/undeveloped nature of the area. Currently, the land is set aside primarily for conservation and is managed by MINWR for wildlife and habitat diversity. However, relatively few natural areas on KSC are being converted to operational use. Mitigation for impacts to these sites could be accomplished through habitat restoration in other degraded areas of KSC. For example, MINWR is restoring some former citrus groves to native habitats such as scrub oak and pine flatwoods (USFWS 2008). The NASA Environmental Management Branch is coordinating with MINWR staff to identify a variety of mitigation options that would offset habitat impacts. There would also be an impact on prescribed burn management activities, which would require increased coordination between launch site operators and MINWR.

GSDO upgrades to existing infrastructure, launch of suborbital vehicles from the SLF and LC 39A locations, and CCAFS future launches would have minimal impacts on land use as they are utilizing existing operational areas at KSC and CCAFS.

4.4.2 Cumulative Impacts on Utilities and Services

The cumulative effects on utilities and services as a result of launch activities, development, and operation of the Proposed Action and current and future KSC and CCAFS actions would be minimal. The existing electrical supply, communications, natural gas, and solid waste facilities are expected to be able to accommodate any associated increased demand. The future water supply could become more limited. In 2005, City of Cocoa projections called for average daily demand to increase to 138 million liters (36.4 million gallons) by 2023, representing an increase of 34%. In their projections, the city of Cocoa assumed that demand from all U.S. government uses would remain constant at 24.6 million liters (650 million gallons) per day maximum (USAF 2005a). Future operations and personnel could implement water conservation measures and evaluate alternative water sources in order to minimize impacts on this resource.

4.4.3 Cumulative Impacts on Hydrology and Water Quality

With the implementation of a stormwater management system, development of the HIF and RP-1 option locations, commercial development at the SLF and the GSDO's ground development for center transformation would have a moderate cumulative effect on hydrology and water quality. Regionally, vegetated lands are increasingly being covered by impervious surfaces (buildings, roads, parking lots, etc.), which increase runoff and limit replenishment of groundwater. Impervious surfaces have long been implicated in the decline of watershed integrity in urban areas (Brattebo and Booth 2004). Although stormwater management has been implemented for construction efforts since the 1990s, these retention and detention ponds are generally not able to accommodate large amounts of water associated with heavy rainfall, resulting in some excess runoff flowing into canals, wetlands, and frequently, the IRL. However, quantities are generally episodic and can be absorbed by the lagoon system. In addition, regional efforts to manage stormwater and control point-source pollution have been generally successful, with areas of the IRL having improved water quality and an increase in associated seagrass coverage since the early 1990s (SJRWMD 2002).

Acidification of surface waters from launch clouds produced by vehicle launches should not have a substantial cumulative impact. Lowering of pH in surface waters in the vicinity of launch pads is short-term. Alkalinity measurements and pH readings returned to pre-launch levels within 72 hours of Shuttle launches. Surface waters should recover in the same manner following launches of vehicles at the frequency being considered in the Proposed Action. The impact to the Dune (Barrier Island) subaquifer would be minimal. This surficial aquifer subsystem is much larger than the Dune subsystem and lies under land that is relatively undeveloped. The Dune subsystem has previously been impacted by the development of over 40 launch structures, numerous support facilities, parking lots, and roads associated with NASA and DoD activities since the 1950s. In addition, this aquifer subsystem already has relatively high concentrations of chloride, sodium, and other elements associated with sea water or lagoon water intrusion (Edward E. Clark 1987), and a decline in recharge rates will increase the chlorinity of the aquifer. Furthermore, this aquifer will likely become increasingly saline as the result of sea level rise associated with climate change (Bates et al. 2008).

The cumulative effects on surface water quality in the IRL from the development of any of the HIF and RP-1 option locations, commercial development at the SLF and the GSDO's ground development for center transformation would be moderate. Even with stormwater management plans implemented, heavy rains would cause runoff at each site to end up in mosquito control impoundments located along the edges of the Banana River. Eventually, stormwater could reach the IRL, although some of the sediment would have settled out, and the concentrations of other pollutants would be reduced.

GSDO upgrades to existing infrastructure, launch of suborbital vehicles from the SLF and LC 39A locations, and CCAFS future launches would have minimal impacts on surface water quality but would be mitigated as described in the following section 4.4.3.1.

4.4.3.1 Mitigation of water quality impacts

Surface water discharges from the selected site would be managed according to requirements of the SJRWMD conditions for issuance of Environmental Resource Permits. The SJRWMD Applicants Handbook for Management and Storage of Surface Waters, Chapter 10.3 states: "The post-development peak rate of discharge must not exceed the pre-development peak rate of discharge, and the peak discharge requirement shall be met for the 25-year frequency storm. In determining the peak rate of discharge, a 24-hour duration storm is to be used". In addition, the SJRWMD requires wet detention systems to be designed in a manner that meets applicable water quality standards in SJRWMD Rule 40C-42.026(4). Water quality impacts to the OFW associated with the IRL and MINWR would be minimized by the design, operation, and maintenance of a stormwater management system that would meet or exceed all requirements of the SJRWMD.

Construction of facilities at any of the Proposed Action Option locations, SLF and areas for the GSDO's ground development would be conducted following best engineering practices to minimize hydrologic and water quality impacts onsite and to surrounding areas. Stormwater management plans that included stormwater modeling would be developed with conceptual land use plans to determine site design. Stormwater analyses would be conducted to determine the amount of land necessary to provide adequate treatment and storage capacity for both pre- and post-developed conditions. The resulting stormwater storage and treatment areas would help filter much of the suspended solids out of the water percolating into the ground. In addition, the biological and chemical processes that take place in stormwater detention/retention ponds would reduce the amount of contaminants found in runoff, and fewer pollutants would make their way into the water table.

4.4.4 Cumulative Impacts on Air Quality

The most influential air quality fluctuations on a routine basis are created by the emissions from automobiles entering and departing KSC each day. However, an increase in emissions from traffic due to the Proposed Action and foreseeable actions are not expected to exceed that experienced during the Space Shuttle Program or result in cumulative impacts. Since the atmospheric emissions associated with launch activities are brief and sporadic, long-term cumulative air quality impacts in the lower atmosphere are not expected to be significant.

The Proposed Action, in addition to the past, present, and reasonably foreseeable actions in the project area, would result in a minor, temporary increase in air emissions in an area. The emissions of greenhouse gases and ozone depleting substances would be extremely small in the context of national and global emissions. Because these impacts would be minor and temporary, the incremental contribution to cumulative air quality impacts from the Proposed Action would not be significant.

4.4.5 Cumulative Impacts of Noise

The cumulative impacts on the noise environment associated with the Proposed Action include construction and operations, and would vary depending on the launch activity of up to two launches per month. Since launch noise levels are expected to rise to levels described in Section 4.3.4 for approximately 20-30 seconds at a time, there would be no discernable cumulative effects on humans or structures.

Cumulative impacts for current and future Actions would not be significant. The area surrounding the project has a long history of commercial space rocket and NASA Space Shuttle launches resulting in launch-related noise. Noise impacts associated with the multiple launch activities in the area would be brief and temporary. Because these projects have moderate but temporary noise impacts, the incremental contribution to cumulative noise impacts from the Proposed Action would not be significant (FAA, 2008).

Cumulative effects due to noise on wildlife could occur if launch activities from multiple sites in the nearby vicinity (e.g., both pads at LC 39, SLF and future launch sites) took place in a short period of time, preventing animals from returning to their habitats, nest sites, or normal behavior.

4.4.6 Cumulative Impacts on Biological Resources

Cumulative effects resulting from construction in support of the Proposed Action and foreseeable actions would include loss and fragmentation of natural habitats and the potential spread of invasive species. However, the majority of impacts would be limited to ruderal habitats on already disturbed land. Impacts to natural vegetation are limited to small areas, generally constituting less than 1% of the KSC total for each habitat type.

The combination of solid rocket boosters and deluge water during a launch event produces an acid cloud that can damage vegetation (NASA 1998 EELV EIS). Monitoring of forty-six launches of a variety of vehicles from CCAFS between 1995 and 1998 found that deposition scorched vegetation, ignited ground fires, and defoliated trees up to 100 m (328 ft) away for the largest rockets. Space Shuttle launches produce the same effects, with the near-field areas being most highly impacted (Hall et al 2013). A maximum of 24 launches per year is expected from the Proposed Action, and only five of the ten types of launch vehicles being evaluated use solid rocket boosters (SLS, Liberty, Atlas V, Antares, Athena). Therefore, cumulative impacts from acid deposition on the surrounding vegetation are anticipated to be minor.

No cumulative impacts are expected to wildlife resources at KSC because the project area is small compared to the amount of habitat available, and much of what could potentially be developed is already disturbed and adjacent to existing facilities and/or infrastructure. However, cumulative impacts might be expected for some of the protected species (e.g., eastern indigo snakes, Florida scrub-jays, sea turtles). These would be due to species' vulnerability to fragmentation of existing habitat and increased limitations to management techniques that are necessary for stable populations; and increased launch and launch vehicle processing activity. Impacts could be lessened by mitigation and best management practices. Compliance with the current KSC Exterior Lighting Requirements document would lessen potential for disorientation impacts to nesting and hatching marine turtles from facility lighting and night launches. Each facility would be required to develop and implement a Light Management Plan.

4.4.7 Cumulative Impacts on Soils

Soil impacts associated with the Proposed Action are related to construction and launch activities. Cumulative impacts to soils due to land disturbance and construction should not be significant as these soils are common locally and regionally. Soils in the vicinity of the launch complexes have a natural buffering capacity that counteracts the effects of acid deposition from launch. The types of vehicles and frequency of launches proposed for multiple users of LC 39A and LC 39B should not have a cumulative impact to soils.

4.4.8 Cumulative Impacts on Hazardous Materials and Waste

Although many hazardous materials and waste are known to accumulate in the environment, it is not expected that there would be any cumulative effects caused by environmental contamination as a result of the Proposed Action. Safeguards would be in place to minimize the release of toxic chemicals in the environment, and rapid response plans would ensure that accidental spills would be cleaned up quickly. Non-recoverable boosters or stages that sink to the ocean floor would accumulate over time. However, the different launch trajectories that are expected, would result in different splash down zones for these boosters and stages. It is unlikely that multiple non-recoverable items would end up in the same area. Any residual fuel would be diluted over time.

4.4.9 Cumulative Impacts on Climate Change

The Proposed Action is designed to encourage the use of the significant national resources at KSC in support of the developing space industry. This new and growing industry will require the use of energy and has the potential to impact the cumulative regional contributions to climate change. However, these new contributions may be minimized and even offset by regional efforts to modernize energy production and energy conservation (NASA 2012b).

Rocket exhaust emissions from vehicles evaluated in this EA would deposit carbon into the atmosphere and this carbon (i.e., soot) could remain relatively localized. The proposed maximum of two launches per month from LC 39A and LC 39B, in addition to the current and foreseeable launches from the SLF and CCAFS could increase cumulative impacts to climate change if the soot emissions from consecutive launches do not clear between launches and accumulate in the atmosphere.

4.4.10 Cumulative Impacts on Socioeconomics

Cumulative impacts to socioeconomics could potentially be beneficial to KSC and the surrounding communities. These benefits would be two-fold: 1) there would be an increase in activities required to implement and support two launches per month, resulting in increased employment opportunities; and 2) launches and associated publicity would bring additional tourism income to local businesses.

4.5 Impacts of the No Action Alternative

Under the No Action Alternative, additional construction and operational activities at LC 39A, LC 39B, HIF locations, or the RP-1 storage and transfer locations would not occur and the potential for commercial launch operations at KSC would be severely curtailed. Additional workers needed for construction of facilities and infrastructure would not be hired, resulting in no increase to the local or regional economy. Local suppliers and markets (including indirect) would not benefit from launch support activities or increased tourism. Some local markets and businesses are already in decline from the closeout of the Space Shuttle Program and are at a critical point; their persistence may depend on new economic opportunities at KSC.

5.0 ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the U.S. signed Executive Order (EO) 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations". The general purposes of the EO are to: 1) focus the attention of federal agencies on the human health and environmental conditions in minority and low-income communities with the goal of achieving environmental justice; 2) foster non-discrimination in federal programs that substantially affect human health or the environment; and 3) give minority and low income communities greater opportunities for public participation in, and access to, public information on matters relating to human health and the environment. The EO directs federal agencies, including NASA, to develop environmental justice strategies. Further, EO 12898 requires NASA, to the greatest extent practicable and permitted by law, to make the achievement of environmental justice part of NASA's mission. Disproportionately high adverse human health or environmental effects on minority or low-income populations must be identified and addressed. In response, NASA established an Agency-wide strategy which, in addition to the requirements set forth in the EO, seeks to: 1) minimize administrative burdens; 2) focus on public outreach and involvement; 3) encourage implementation plans tailored to the specific situation at each Center; 4) make each Center responsible for developing its own Environmental Justice Plan; and, 5) consider both normal operations and accidents. KSC has developed a plan to comply with the EO and NASA's Agency-wide strategy. This Environmental Justice Plan was completed in March 2010.

The 2010 census resulted in a total population of 543,376 for Brevard County with 20.8% minorities according to the U.S Census Bureau. African-Americans accounted for 10.1% of this minority population and those of Hispanic or Latino origin constituted 8.1% of the minority population. Florida's state average for the minority population in this same year was considerably higher at 41.4%, due to the relatively larger concentration of Hispanics and Latinos in the central and southern Florida study areas. From 2006- 2010, 10.5 % of Brevard County's population reported incomes below the poverty threshold, whereas Florida's state average was 13.5%.

The Proposed Action and alternatives described in this EA would not create adverse human health effects or environmental effects related to Environmental Justice. The action is expected to produce beneficial impacts. The proposed activities would spawn community outreach programs relating to education in space exploration, thus improving opportunities in the general and minority populations. The proposed activities have moderate economic benefits, including increased demand in the workforce, higher revenues, and increased per capita income. While the population under the poverty threshold may not directly benefit through employment and income, it may indirectly benefit as regional economic health is improved through the proposed increase in commercial space exploration activity.

The proposed activities would be implemented within the boundaries of KSC. The closest residential areas are 12 km (7.6 mi.) west in Titusville, and 13 km (9.5 mi) south on Merritt Island. The distances of these areas from the activity sites preclude any direct impacts from construction. Operational impacts, specifically noise, are expected to be negligible in the residential areas, based on data models and surveys. Economic impacts are not expected to adversely affect any particular group. Personnel needed to support construction and launch activities could be drawn from the local workforce. Also, increases in local business due to tourism could provide economic benefits to the area.

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