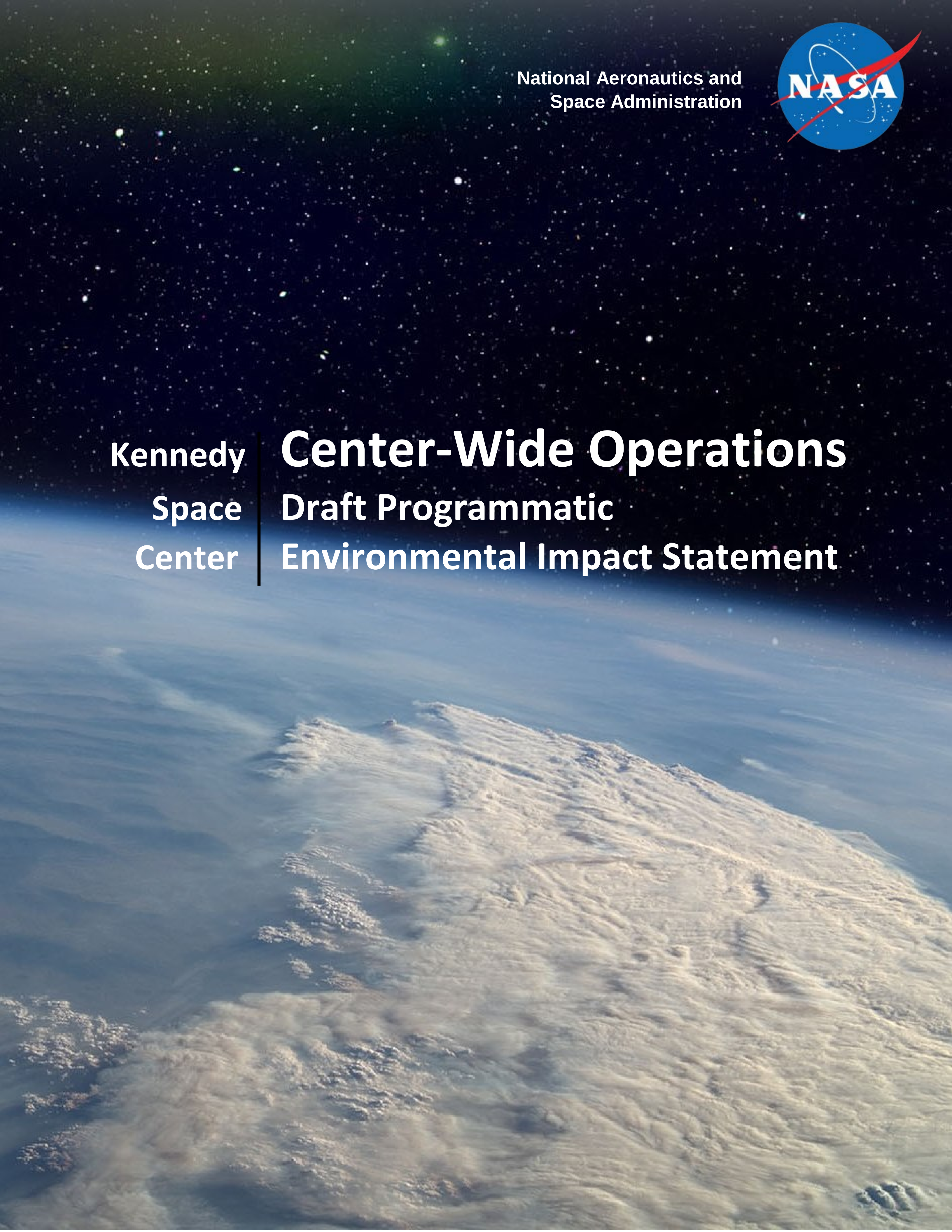

National Aeronautics and
Space Administration

Kennedy
Space
Center

Center-Wide Operations
Draft Programmatic
Environmental Impact Statement

National Aeronautics and Space Administration

Kennedy Space Center

Florida

Center-wide Operations
Draft Programmatic Environmental Impact Statement

March 2016

ABSTRACT

This Programmatic Environmental Impact Statement (PEIS) has been prepared to evaluate the potential environmental impacts from proposed center-wide Kennedy Space Center (KSC) operations, activities, and facilities across a 20-year planning horizon. These operations, activities and facilities are described in the 2013 Center Master Plan (CMP), which has a planning horizon of 2012-2032. It considers a range of future scenarios for repurposing existing facilities and recapitalizing infrastructure, to reorganizing the management of the KSC and its land resources, with potentially various kinds of partnerships, some of which are already in place.

The PEIS has been prepared in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 CFR 1500–1508), and the National Aeronautics and Space Administration's (NASA's) regulations for implementing NEPA. Section 106 of the National Historic Preservation Act (NHPA) and Section 7 of the Endangered Species Act (ESA) are also integrated with the NEPA process, to identify and protect cultural resources and threatened and endangered species, respectively. This PEIS outlines and broadly describes actions associated with KSC's proposed programs in the limited detail with which they are known at present.

The purpose of the proposed action – the CMP – is to provide overall management guidance for KSC to 2032. Implementation of the CMP will facilitate a 20-year transformation from a single, government user launch complex to a multi-user spaceport. This multi-user spaceport will be developed in concert with NASA's programmatic missions and requirements to explore destinations outside of low Earth orbit. The need for the action is to update KSC's CMP in a manner that supports achievement of NASA's programmatic mission objectives, at the same time as maximizing the provision of excess capabilities and assets in support of non-NASA access to space.

As a result of comments received during internal and external (public) scoping, NASA developed three alternatives that are assessed in this PEIS. Under the first of these, the Proposed Action, KSC would transition to a multi-user spaceport. A number of new land uses are proposed, including two seaports and horizontal and vertical launch and landing facilities. There would be changes in the acreage of existing designated land use categories at KSC.

Alternative 1 was crafted as a direct response to concerns expressed in comments received during the PEIS public scoping period in June 2014, as well as other observations and data acquired from stakeholders and other agencies during the scoping process. Alternative 1 is similar to the Proposed Action in many regards, but is differentiated in several key respects: primarily, differences in the siting and size of vertical and horizontal launch and landing facilities. Also, the two new seaports would not be constructed.

In the No Action Alternative, KSC management would continue its emphasis on dedicated NASA Programs and would not transition in the coming years towards a multi-user spaceport controlled by an independent spaceport authority with fully integrated NASA Programs and non-NASA users. Rather, each NASA Program would continue to be operated as an independent entity to a significant degree, to be funded separately, and to manage activities and buildings in support of its own program. There would continue to be a limited non-NASA presence at KSC.

The PEIS broadly predicts and describes the potential environmental consequences resulting from each of the three alternatives. There would be a number of direct and indirect adverse impacts but none that are considered to be significantly adverse. Beneficial impacts would also occur. Under each of the three alternatives evaluated, NASA would continue to work closely with its partners, including the U.S. Fish and Wildlife Service, National Park Service, Federal Aviation Administration, Space Florida, Cape Canaveral Air Force Station, U.S. Army Corps of Engineers, and state agencies.

The 45-day public comment period for this PEIS begins on the day after the Environmental Protection Agency publishes a notice of availability for the Draft PEIS in the *Federal Register*. Comments on the Draft PEIS must be received before the close of business on the last day of the comment period.

Written comments on the Draft PEIS may be submitted to:

National Aeronautics and Space Administration
Kennedy Space Center
ATTN: Donald Dankert
Environmental Management Branch, TA-A4C
Kennedy Space Center, FL 32899

Written comments on the Draft PEIS may be emailed to:

ksc-dl-centerwide-eis@mail.nasa.gov.

EXECUTIVE SUMMARY

Background and Introduction

This Programmatic Environmental Impact Statement (PEIS) has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality (CEQ) regulations for implementing NEPA, the National Aeronautics and Space Administration's (NASA's) regulations for implementing NEPA, the NASA Procedural Requirements for Implementing NEPA, Executive Order (EO) 12114, and as identified in Section 1102 of the NASA Authorization Act of 2010. Section 106 of the National Historic Preservation Act (NHPA) and Section 7 of the Endangered Species Act (ESA) are also integrated with the NEPA process, to identify and protect cultural resources and threatened and endangered (T&E) species, respectively.

The PEIS has been prepared to evaluate the potential environmental impacts from proposed center-wide Kennedy Space Center (KSC) operations, activities, and facilities for a planning horizon that encompasses the next 20 years. These operations, activities and facilities are described in the 2013 Master Plan (Center Master Plan Update, or CMP), which has a planning horizon of 2012-2032. It considers a range of future scenarios for repurposing existing facilities and recapitalizing infrastructure, to reorganizing the management of the KSC and its land resources, with potentially various kinds of partnerships (some of which are already in place). The PEIS is intended to ensure that NASA is in compliance with applicable environmental statutes as it sets program priorities for future operations and activities.

Beginning in the late 1950s the United States embarked upon a new era of human space exploration, an effort which continues to this day more than half a century later. The first human spaceflight initiative in the U.S. was Project Mercury, established in 1958 with crewed spacecraft first launched from Cape Canaveral Air Force Station (CCAFS) in the early 1960s. NASA's Launch Operations Center and the portions of CCAFS that were used by NASA were renamed the John F. Kennedy Space Center (KSC) in 1963. Project Mercury was followed by Project Gemini and the Apollo Program. Ultimately a total of nine Apollo missions reached the Moon, landing 12 astronauts there. The last American strode the surface of the Moon in December 1972.

Early in 1962, NASA began acquiring property for a space center as a base for launch operations in support of the Manned Lunar Landing Program. Approximately 34,000 hectares (ha) (84,000 acres (ac)) were purchased on Merritt Island in the northern part of Brevard County extending into the southernmost tip of Volusia County. An additional 22,660 ha (56,000 ac) of state-owned submerged land (Mosquito Lagoon and part of Indian River Lagoon) were negotiated with the State of Florida for exclusive rights dedicated to the United States. This total area of nearly 56,660 ha (140,000 ac), together with the adjoining water bodies, was considered extensive enough to provide adequate safety for the surrounding communities from the planned vehicle launches.

In the mid-1970s, NASA initiated development of the Space Transportation System (commonly called the Space Shuttle) as the next crewed vehicle. Designed solely for missions to low Earth orbit (99-1,200 miles above the Earth's surface), the Space Shuttle was the first and to date the only winged U.S. spacecraft capable of launching crew vertically into orbit and landing horizontally upon returning to Earth. The Space Shuttle era lasted for 30 years, from the launch of Columbia on April 12, 1981 until the landing of Atlantis on July 21, 2011.

KSC is a major central Florida tourist destination and is approximately one hour's drive from the Orlando area. The Visitor Complex offers public tours of the center and CCAFS. Because much of the installation is a restricted area and only nine percent of the land is developed, the site also serves as an important wildlife sanctuary. The Indian River Lagoon, Merritt Island National Wildlife Refuge (MINWR) and Canaveral National Seashore (CNS) are other natural features of the area. The visiting public can encounter Bald Eagles, American alligators, wild boars, eastern diamondback rattlesnakes, bobcats, and Florida manatees, among other wildlife.

Purpose and Need for the Action

The Space Shuttle has completed its final mission and retirement of the Shuttle Program has been completed. NASA's budget has been reduced from earlier agency planning guidance and NASA anticipates continuing funding challenges in the coming years. Approximately half of KSC's skilled workforce has been being laid off with the conclusion of the Shuttle Program. Resources to sustain and renew existing facilities and capabilities at KSC are severely constrained.

In the coming years, the Kennedy Space Center will remain the world's preeminent launch facility for government and commercial space access. KSC will support NASA, and ultimately, our nation's competitiveness, by investing in next-generation technologies and encouraging innovation. KSC will foster partnerships – intergovernmental, commercial, academic, and international – to expand its ability to support both public and private space initiatives. These institutional efforts and initiatives necessitate changes to the infrastructure, facilities, and operations at the KSC over the coming decade which are identified in a new CMP Update that has been developed by the Center Planning and Development Office.

The purpose of the action – the CMP – is to provide overall management guidance for KSC from 2016 to 2032. Implementation of the CMP will facilitate a 20-year transformation from a single, government user launch complex to a multi-user spaceport. This multi-user spaceport will be developed in concert with NASA's programmatic missions and requirements to explore destinations outside of low Earth orbit.

The need for the action is to update KSC's CMP in a manner that supports achievement of NASA's programmatic mission objectives, at the same time as maximizing the provision of excess capabilities and assets in support of non-NASA access to space.

Overall, KSC is transitioning to a re-focused mission that redefines its relationship with industry and leverages the potential of partnerships. Amid the challenges of an aging and unsustainable asset base, as well as a highly constrained federal budget, NASA must adopt and implement strategies that preserve the institutional infrastructure needed to support its purpose and programs.

In keeping with CEQ guidance, this PEIS outlines and broadly describes actions associated with KSC's proposed programs in the limited detail with which they are known at present. Three programmatic alternatives are described and their potential environmental effects are assessed in fairly general terms. At such time as a given specific project of detailed dimensions and scale is proposed at a specific location, and is in the process of being reviewed and approved, this PEIS can serve as a master NEPA document off which future NEPA compliance documents may be "tiered". That is, having already been addressed at a programmatic level, the action or project can incorporate discussion from the broader PEIS by reference and focus on the issues specific to the subsequent tiered proposal. Ideally, this will serve to expedite the environmental review process and facilitate project approval, funding, and implementation.

Strategic Partnerships

KSC cultivates strategic partnerships with other federal, state, public, private and academic organizations to capitalize on complementary strengths of each organization in managing the Kennedy Space Center. Under the each of the alternatives considered in the PEIS, KSC would continue to invest in existing partnerships, such as those with CCAFS (an installation of the U.S. Air Force Space Command's 45th Space Wing, headquartered at nearby Patrick Air Force Base), U.S. Fish and Wildlife Service (USFWS) – Merritt Island National Wildlife Refuge, National Park Service (NPS) – Canaveral National Seashore, U.S. Department of Energy, Federal Aviation Administration (FAA) Office of Commercial Space Transportation (FAA-AST), Florida Department of Transportation (FDOT), Space Florida, Patrick Air Force Base (PAFB), and Brevard County government.

Scoping and Public Involvement

NEPA requires lead agencies to invite public involvement prior to decision-making on proposed actions that may affect the environment. "Scoping" is the process of soliciting input from "stakeholders" – including Tribes, the public (both private citizens and non-governmental organizations or NGO's), and other agencies – at the outset of an EIS. Not only may the information obtained from interested and knowledgeable parties be of value in and of itself, but the perspectives and opinions as to which issues matter the most, and how, indeed whether, the agency should proceed with a given proposed action are equally important. Input from scoping thus helps shape the direction that analysis takes, helping analysts decide which issues merit consideration. Public input also helps in the development of alternatives to the proposed action, which is an integral part of NEPA.

Appendix B of this PEIS is a Scoping Report that describes and documents the scoping process NASA followed in great detail.

NASA-KSC held an agency Draft PEIS scoping meeting on June 4, 2014 at KSC for cooperating agencies and partners. Participants included the U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), FAA, and Space Florida.

NASA-KSC held two public scoping meetings on June 4, 2014 in Titusville and June 5, 2014 in New Smyrna Beach, using a combined open house and open forum format. In the first hour, an open house format was used to give attendees the chance to speak informally with officials from NASA and its USFWS and NPS partners, sharing information and perspectives. Several stations with exhibits, maps, and materials were staffed by representatives of NASA, USFWS, NPS, and PEIS contractor Solv. In the second hour of both scoping meetings, three short presentations described KSC's mission, goals, updated Master Plan, and the NEPA process. Following these presentations, the public was invited to make oral comments for the record.

A number of stakeholders provided written comments that helped determine the scope of the PEIS.

Alternatives Considered

As a result of comments received during internal and external (public) scoping, NASA developed three alternatives that are assessed in this PEIS. Under the first of these, the **Proposed Action**, KSC would transition to a multi-user spaceport. A number of new facilities would be constructed, including two seaports and horizontal and vertical launch and landing facilities. There would be changes in the acreage of designated land use categories at KSC.

Alternative 1 was crafted as a direct response to concerns expressed in comments received during the PEIS public scoping period in June 2014, as well as other observations and data acquired from stakeholders and other agencies during the scoping process. Alternative 1 is similar to the Proposed Action in many regards, but is differentiated in several key respects: primarily, differences in the siting and size of vertical and horizontal launch and landing facilities. Also, the two new seaports would not be constructed.

In the **No Action Alternative**, KSC management would continue its emphasis on dedicated NASA Programs and would not transition in the coming years towards a multi-user spaceport controlled by an independent spaceport authority with fully integrated NASA Programs and non-NASA users. Rather, each NASA Program would continue to be operated as an independent entity to a significant degree, to be funded separately, and to manage activities and buildings in support of its own program. There would continue to be a limited non-NASA presence at KSC.

Under the three PEIS alternatives, there would be differences in the sizes of the areas of designated land uses at KSC. These varying acreages are a function of the different emphases, priorities, and projects of the three PEIS alternatives. Only in the recreation and water categories are the acreages identical in all three alternatives. These acreages variations are shown in Table ES-1.

Table ES-1. Acreages of designated land uses at KSC under the three alternatives

Land Use	Proposed Action	Alternative 1	No Action
Administration	40.72	40.72	104.76
Assembly, Testing and Processing	1,894.77	1,894.77	475.41
Central Campus	138.75	138.75	NA
Horizontal Launch and Landing	2,838.84	1,806.62	501.25
Launch Operations and Support	506.14	491.59	398.75
Open Space	NA	NA	1,873.64
Operational Buffer/Conservation	40,196.64	41,297.17	44,583.14
Operational Buffer/Public Use	34,824.72	34,824.72	34,844.14
Public Outreach	522.13	522.13	216.01
Recreation	161.36	161.36	161.36
Renewable Energy	1,109.85	1,109.85	66.54
Research and Development	867.49	867.49	88.36
Seaport	317.26	30.92	30.92
Support Services	471.40	471.40	723.91
Utility Systems	1,329.60	1,329.60	1,327.23
Vertical Launch	536.42	728.08	360.32
Vertical Landing	75.73	40.56	NA
Water	55,541.81	55,541.81	55,541.81

Environmental Consequences

Soils and Geology

Impacts of activities under the **Proposed Action** and **Alternative 1** activities on soils and geology would be short-term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, types of soils occurring onsite, and whether impervious surfaces would be placed over soils and geological materials. These impacts would be less than significant. Overall effects of vertical and horizontal launches and landings on soils and geology are expected to be short-term to medium-term, direct, adverse, and minor to moderate. These impacts would also be less than significant. Overall impacts of Alternative 1 on soils and geology would be slightly less than the Proposed Action.

Under the **No Action Alternative**, soils and geology would not be affected by construction or operations from new projects described under the Proposed Action or Alternative 1. Any existing activities or operations would occur in accordance with existing laws and permits and within the footprint of existing developed areas. Effects on soils and geology from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. The No Action Alternative would not have any additional impacts on soils and geology.

Water Resources

Impacts of proposed project activities under the **Proposed Action** and **Alternative 1** on water resources (both water quality and water quantity) would be short- term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, and proximity to surface water. With proper implementation of BMPs and adherence to permit conditions, impacts on water resources would be less than significant.

Vertical and horizontal launches may result in local adverse impacts on freshwater and marine systems, from deposition associated with rocket engine emissions, the deposition of spent launch vehicle equipment, or landing of a reentry vehicle or its associated equipment. Impacts from hydrogen chloride or HCl (formed during rocket launches, and which becomes hydrochloric acid when it dissolves in water) on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A normal launch would have no substantial impacts on local water quality.

Direct cumulative impacts on water resources from reasonably foreseeable projects under the Proposed Action and Alternative 1 are likely to be minor and adverse. To the extent that reasonably foreseeable projects contribute to long-term economic and population growth and development of the Space Coast region, they may contribute indirectly to continuing cumulative impairment of the Indian River Lagoon complex as a result of an increase in the area of impervious surfaces and non-point source loadings of sediments, nutrients, and contaminants.

Overall impacts of Alternative 1 on water resources would be slightly less than the Proposed Action.

Under the **No Action Alternative**, water resources would not be affected by construction or operations from new projects described under the Proposed Action or Alternative 1. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Effects on water resources from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. In sum, there would be no additional impacts on water resources. However, the long-term cumulative impacts on water quality in the IRL described under the Proposed Action could still well occur if other reasonably foreseeable projects were to take place and if population projections and associated development are realized in the decades ahead, fostering increases in non-point source pollution that have already damaged the lagoon.

Hazardous Materials and Waste

Under the **Proposed Action** and **Alternative 1,** the impact of transitioning to a multi-user spaceport on hazardous materials and waste is confined to an increase in quantity, rather than an influx of new materials. These same materials are currently used at KSC. KSC currently handles solvents, surface coatings, propellants and fuels. Procedures for handling, transporting, storing or disposing of hazardous materials would be unaffected by the Proposed Action and Alternative 1. Because of the increase in exposure and the activities related to these materials, the risks associated with them would also be slightly increased. The importance of adhering to proper safety procedures must be viewed as a top priority for future operations to minimize the risks of accidental release and personnel exposure.

The probability of an accidental release would increase due to the increased activities and quantity of materials, but best practices would ensure this increase in risk is small, with the probability of a major spill kept at a minimum. Overall, adverse impacts on hazardous materials and waste would be of slight precedence, negligible to minor magnitude, and long-term duration. Cumulative impacts are not expected. Effects of Alternative 1 would be essentially identical to those of the Proposed Action.

Under the **No Action Alternative**, the status quo would be maintained at KSC. There would be no increase or decrease in the amount of hazardous materials that would be handled, transported, stored or disposed at KSC.

Air Quality

Both the **Proposed Action** and **Alternative 1** would have short- and long-term minor adverse effects. They could also affect air quality in several ways: through airborne dust and other pollutants generated during construction; by the introduction of new stationary sources of pollutants, such as heating boilers and backup generators; and through increases in transportation-based emissions such as launches and automotive traffic. Short-term effects from demolition of aging or obsolete facilities would occur from airborne dust and other pollutants.

Long-term effects would occur from introduction of new stationary sources such as boilers and generators, as well as increases in transportation-based emissions such as launches and automotive traffic. In addition to criteria pollutants, the products of combustion from solid rocket boosters would also include other common products of combustion including aluminum oxide, hydrogen chloride, hydrogen, nitrogen, carbon dioxide, and water. These components are predominately inert and would be emitted in limited amounts.

All components of the Proposed Action and Alternative 1 are completely within an attainment area and would not inherently lead to a violation of any Federal, state, or local air regulation. Therefore, impacts would be less than significant. There would be short- and long-term minor adverse cumulative effects. The impacts of the Proposed Action and Alternative 1would be essentially identical.

The **No Action Alternative** would result in no additional effects on air quality. Because the number and type of activities would remain relatively, similar levels of emissions of air pollutants would be expected. Ambient air quality would remain unchanged when compared to existing conditions.

Climate Change

Climate change impacts globally include overall warmer temperatures, rising sea levels, a melting polar ice cap, changes in rainfall patterns, a greater frequency of extreme weather events (e.g., droughts, deluges, severe storms, floods, prolonged heat waves) and other associated and often interrelated effects. CEQ guidance advises that actions subject to NEPA compliance should be evaluated along two dimensions relative to climate change impacts: (1) the effects of GHG emissions from a proposed action and alternative actions on global climate change; and (2) the effects of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures. With regard to point #1, all three alternatives would add a negligible amount to the U.S. emissions contributing to global climate change.

With regard to point #2, sea level rise is the single largest hazard to continued KSC/CCAFS operations and regional land management activities. Sea level rise may cause loss of usable land and inundation of coastal ecosystems. More frequent and extreme high temperatures and humidity may cause increased risk of heat-related ailments among outdoor workers; higher cooling costs; decreased utility reliability; damage to buildings. More frequent and intense droughts and seasonal shifts in water cycle may cause reduced water availability, higher water costs, salt water intrusion, and ground water changes. More intense precipitation events may cause more frequent flooding of low-lying indoor and outdoor areas. More frequent and intense coastal flood events may cause coastal erosion and have safety implications for surrounding communities.

Hardening, improving, or moving facilities in adaptation to potential climate change impacts will require financial investment and funding, which might reasonably be considered impacts of climate change on the Proposed Action. Consolidation of NASA operations at KSC into a smaller geographic footprint can be expected to lead to further reductions in facilities' energy use, thereby reducing greenhouse gas emissions and producing beneficial impacts to climate change. Continued and increased efforts to power NASA's facilities, programs, and activities using renewable sources of energy will have a beneficial impact on climate change by reducing greenhouse gas emissions.

Both the effect of climate change on **Alternative 1** and the effect of Alternative 1 on climate change would be essentially the same as under the **Proposed Action**.

Under the **No Action Alternative**, KSC would not implement elevation-based zoning and development controls to insure that any future development is constructed at an elevation of six feet above mean sea level, although this would not be consistent with NASA land management practices and Office of Strategic Infrastructure climate adaptation guidance and strategy. NASA operations at KSC would be at somewhat greater risk from the impacts of sea level rise, more frequent and intense coastal flood events, and more intense precipitation events than they be would if the additional actions were taken.

Acoustic Environment (Noise)

Under both the **Proposed Action** and **Alternative 1,** short- and long-term minor adverse effects would be expected. They would result in the continuation of many of the types of noise presently occurring at KSC but potentially in greater amounts. Short-term increases in noise would result from the use of heavy equipment during construction and demolition activities.

Long-term effects would be from the addition of stationary sources of noise such as standby generators, and changes in both vertical and horizontal launch activities.

Increases in traffic volumes and changes in traffic patterns would have insignificant effects related to noise. Neither the Proposed Action nor Alternative 1 would (1) result in the violation of applicable Federal, state, or local noise ordinance; (2) create incompatible land uses for areas with sensitive noise receptors outside the KSC boundary; or (3) be loud enough to threaten or harm human health. In general, the overall effects of the action and its components would be less than significant. Minor short- and long-term cumulative effects would be expected. Noise impacts of Alternative 1 would be very similar if not identical to those of the Proposed Action.

The **No Action Alternative** would result in no changes in the existing level of impact to the ambient noise environment. KSC operations and the current levels of activities would continue without changes, and the noise environment would remain unchanged when compared to existing conditions. Minor short- and long-term cumulative effects would be expected.

<u>Biological Resources</u>

Under the **Proposed Action**, there would be a reduction of 4,406 acres in the size of the operational buffer, both public use and conservation components, meaning that 4,406 acres of native vegetation communities (both upland and wetland) would be converted or lost to development. Vertical and horizontal launches may result in local adverse impacts on native upland and wetland vegetation. Two proposed new seaports would result in the elimination of 286 acres of wetlands vegetation/habitat.

A loss of wildlife habitat would result from the conversion of up to 4,386 acres of operational buffer/conservation to other more developed land uses. This would constitute about five percent of the total non-water land area at KSC, and about 10 percent of the total existing acreage of operational buffer/conservation lands (44,583 acres).

Launches at KSC would likely continue to have recurring, short-term, localized to medium, minor to moderate adverse impacts to aquatic habitats and fish for the duration of the Center Master Plan. Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, and widespread.

The impacts of **Alternative 1** on existing biological resources would be qualitatively similar to those of the Proposed Action, but quantitatively somewhat less. The combined area of operational buffer/conservation and operational buffer/public use – and associated vegetation and wildlife habitat – would be reduced by approximately 3,305 acres, as those lands are committed to more developed uses and facilities. A loss of wildlife habitat would result from conversion of up to 3,286 acres of operational buffer/conservation to other more developed land uses. This would comprise about four percent of the non-water land area at KSC, and about seven percent of the total existing acreage of operational buffer/conservation lands (44,583 acres). However, because under Alternative 1 the two new seaports associated with the Proposed Action would not be built, this would avoid the elimination of 286 acres of wetlands vegetation/habitat that would occur under the Proposed Action.

Under the **No Action Alternative**, upland vegetation would not be affected by construction or operations as described under the Proposed Action and Alternative 1. Any existing activities or operations would occur in accordance with existing laws and permits and existing uses would continue at current levels. The effects on upland vegetation from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. There would not be any additional impacts on upland vegetation.

Wildlife and aquatic species would continue to be affected to a negligible to minor degree from continuation of activities at KSC under the No Action Alternative. Many cumulative impacts on the Indian River Lagoon would be expected with or without implementation of the Proposed Action. That is, the No Action Alternative would neither substantially increase nor decrease their magnitude.

Because of combined habitat loss and fragmentation, potential cumulative impacts on the Florida scrub-jay could be adverse and significant. Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, widespread or large extent, and possibly significant, even under the No Action Alternative.

Cultural Resources

All activities under the **Proposed Action** and **Alternative 1** that may have adverse effects on cultural resources at KSC would be managed in accordance with the KSC Cultural Resources Management Plan. As the locations of specific projects are defined, the NHPA Section 106 process would be initiated and determinations would be made for the APE and potentially impacted cultural resources. Appropriate surveys and studies would be conducted so that the effect of the undertaking upon the cultural resources can be determined. Consultations would be undertaken on a project-by-project basis with the respective SHPO or THPO and interested or affected Native American tribes. Should previously undiscovered artifacts or features be unearthed during any of the proposed projects, work would be stopped in the immediate vicinity of the find, a determination of significance made, and a mitigation plan formulated.

Impacts of the Proposed Action and Alternative 1 would be essentially the same.

Under the **No Action Alternative**, cultural resources would not be affected by construction or operations as described under the Proposed Action and Alternative 1. Any existing activities or operations would occur in accordance with existing laws, regulations, and policies. Effects on cultural resources from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. The No Action Alternative would not have any additional impacts on cultural resources.

Land Use

The **Proposed Action** and **Alternative 1** would consolidate existing NASA operations into a smaller geographic footprint. These possible land use and land cover changes would be minor to moderate in magnitude, of small extent, long-term, and beneficial. The acreage at KSC currently used for administration, open space, and operational buffer (for both conservation and public use), and support services would decrease. There would be no change to acreage associated with water or recreation – as distinct from the Operational Buffer/Public Use category, which may also be used for recreation, but which, as noted, is slated to decrease.

The acreage currently used for Assembly, Testing, and Processing; Central Campus; Horizontal Launch and Landing; Launch Operations and Support; Public Outreach; Renewable Energy; Research and Development; Seaport; Utility Systems; Vertical Launch; and Vertical Landing would all increase. As implementation of the CMP Update occurs, NASA would work closely with the USFWS and NPS to determine the appropriate methods for, locations of, and mitigations pertaining to projects within KSC, MINWR, and CNS.

Due to the proposed changes, construction, and demolition activities that would occur, and BMPs that would be followed, in conjunction with the implementation of all projects, impacts to land use are anticipated to minor to moderate, depending on the acreage impacted, the land cover to be changed, and the number or type of projects to be carried out in that area. Overall cumulative impacts to land use over the coming several decades would likely be moderate in magnitude.

Overall, the impacts from Alternative 1 would be very similar to those of the Proposed Action, but somewhat less pronounced, because the two proposed seaports would not be built and the horizontal launch and landing area north of Beach Road might not be built. Moreover, new vertical launch sites north of LC-39 become “notional” rather than definite.

Under the **No Action Alternative**, current land uses and their configuration at KSC would remain unchanged for the duration of the 20-year planning horizon. Total land and water area under jurisdiction of KSC would remain at approx. 140,000 acres. Of this total area, about 85,000 acres would continue to be owned by NASA and the remaining 55,000 acres by the State of Florida and dedicated for the exclusive use of the U. S. Government. Because there would be no change to existing land uses, there would be no additional impacts on this resource.

Transportation

The **Proposed Action** and **Alternative 1** would result in the continuation of many of the modes of transportation presently occurring at KSC but potentially in greater amounts. Short- and long-term minor adverse effects would be expected. Short-term increases in traffic would result from construction worker commutes during construction and demolition activities. Long-term effects would be primarily due to additional worker commutes and changes in traffic patterns near more centralized activities at KSC. Increased traffic volumes and changes in traffic patterns, and changes in both vertical and horizontal launch activities would have minor effects, and there would be some long-term beneficial effects from upgrades in transportation infrastructure.

The Proposed Action and Alternative 1 are not expected to have appreciable changes in the overall traffic volume at KSC; however, some components could affect the Level of Service (LOS) at intersections or roadways both on and off the facility. With one important exception, the direct, indirect, and cumulative impacts of Alternative 1 would be like those of the Proposed Action. The exception is that under Alternative 1, two proposed new seaports that are part of the Proposed Action would not be constructed and operated. In this respect, Alternative 1 would be like the No Action Alternative.

The **No Action Alternative** would result in no changes in the impact to traffic and transportation. KSC operations and the current levels of activities would continue without changes, and traffic and transportation would remain unchanged when compared to existing conditions.

Utilities

Under the **Proposed Action** and **Alternative 1**, KSC would continue to be a retail electricity, natural gas, and fuel oil customer. Construction of new facilities or sites within KSC would require the construction of new utilities rights-of-way and installation of new utility lines or extensions for power, water, and telecommunications. Depending on the location and size of the systems to be installed or expanded, installation of utility lines could have direct and indirect environmental impacts.

Because a large portion of the KSC site is already developed, impacts from new and utility systems would not be as substantial as they may be if the site were still pristine, undeveloped land. Additionally, over time, the site as a whole may actually consume less energy and water due to the achievement of greater efficiency and right-sizing under the proposed CMP. Overall, impacts from the installation and expansion of utility systems at KSC under the Proposed Action and Alternative 1 are anticipated to be minor to moderate and of small to medium extent.

Development at and near the site by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS may spur further utility needs in the local or regional area, which could create further impacts to soils, water resources, biological resources, and to the local community as a result of noise or visual disturbances during installation of utility corridors/systems. The capacity of regional utility service providers could potentially be exceeded. Impacts could be moderate, of medium extent, long-term, and possible. Direct, indirect and cumulative impacts of Alternative 1 would be very similar to those of the Proposed Action, but on a somewhat smaller scale.

Under the **No Action Alternative**, utility systems would continue to age and would require upgrades or replacements as they become less efficient or fail. However, current utility systems and their configuration at KSC would remain relatively unchanged aside from regular maintenance for the duration of the 20-year planning horizon (2012-2032). Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Individual actions conducted as part of the Proposed Action impacting utilities may proceed, but would have to do so after environmental assessment under separate environmental documentation.

Socioeconomics

Overall, the direct, economic impacts as a result of the **Proposed Action** and **Alternative 1** would be beneficial but not significant. These alternatives would potentially create beneficial impacts of minor to moderate magnitude due to the creation of jobs and labor income, most of which would occur during 2016 as part of the Development Program. The extent of impacts would be medium (localized), since most of the jobs would be filled by area residents. Indirect and long-term impacts from non-NASA (second and third priority) projects on the local economy depend on external factors such as interest and financial commitment from non-NASA entities.

In the long-term, with KSC having leveraged its position as a multi-user spaceport and having positioned itself to attract new tenants, indirect economic impacts would be beneficial and significant for both the Proposed Action and Alternative 1.

Future employees from non-NASA projects at KSC would represent new purchasing power that would support additional jobs and payroll at local retail and service establishments in the Region of Influence (ROI). There is a larger multiplier effect associated with the consumer spending of employees directly supported by KSC (though these future employees would not directly be employed by NASA). Through this spending, the Proposed Action and Alternative 1 could indirectly support thousands of indirect and induced jobs.

Direct, indirect, and cumulative socioeconomic impacts associated with Alternative 1 would be broadly similar to those of the Proposed Action, though on a somewhat smaller scale, because facilities such as two proposed new seaports would not be built, and other notional facilities might not be constructed.

Under the **No Action Alternative**, no socioeconomic changes would occur to Brevard or Volusia counties. Since ongoing activities would be substantially the same as those already occurring, no significant additional change in community character and setting would be anticipated. Existing conditions would remain substantially unchanged and have no effect on the populations of concern. There would be no change to population, housing, employment, income characteristics, economic activity, taxes and revenues, or quality of life conditions. Fluctuations or changes would occur at rates consistent with historical trends.

Recreation

Under the **Proposed Action** and **Alternative 1**, changes in KSC's land use, actions to meet KSC's mission and core competencies, and future development, transportation facilities, and activities would have both adverse and beneficial impacts on recreational resources and ecosystem services. Long-term consolidation of support services and expansion of existing facilities would create impacts of lesser magnitude compared to the construction of new facilities on pristine land, since infrastructure such as access roads and utilities have already been constructed.

Under the Proposed Action, development of horizontal launch infrastructure could hinder or delay access to Playalinda Beach; construction activities would contradict its natural attributes that contribute to its beauty and aesthetic quality, or the cultural services it provides. Launch and landing activities under the Proposed Action would likely generate intermittent, adverse effects on the visitor experience due to beach closures, and would not exceed the threshold of significance. Development north of Beach Road associated with the Proposed Action (vertical landing and horizontal launch and landing facilities) would have adverse, long-term effects on recreation opportunities at Playalinda Beach and CNS.

Under the Proposed Action, future development of two seaports could include the removal of saltwater marsh or mangroves, which would hinder natural flood control, degrade finfish and shellfish spawning grounds and nurseries, impact boating and fishing experiences, and further impact the Florida manatee with the introduction of motorized boating. Adverse impacts of the seaports to ecosystem services would occur in both the short- and long-term and could be significant.

In contrast to the Proposed Action, Alternative 1 might not hinder or delay access to Playalinda Beach because launch and landing facilities might not be constructed north of Beach Road. Also under Alternative 1, future development of two seaports would not occur, so that associated impacts on recreation would be avoided.

Under both the Proposed Action and Alternative 1, local population growth, climate change, and sea level rise will likely have adverse long-term effects on outdoor recreation opportunities such as fishing and wildlife observation.

Under the **No Action Alternative**, land use would not change on Operational Buffer and Public Use areas. Without future development of horizontal launch and vertical landing facilities, vertical launch pads, and seaports, the value of ecosystem services at CNS and MINWR would not change (or would fluctuate with market forces). Over time, the continued increase in visitor numbers, as well as urban development of the area surrounding the national seashore, will likely degrade visitor experience and the uncrowded beach and lagoon experience at CNS.

With more users, noise levels and the demand for services and facilities will likely increase, as well as the likelihood of resource damage. Sea level rise and erosion from climate change, or the need to protect certain areas or species, may alter visitor access to certain parts of CNS and MINWR. Visitation for birding and fishing may change if new species shift northward; or extant species move northward or have dramatic declines in population, as might occur with the temperature-sensitive manatee.

Environmental Justice and Protection of Children

Neither Brevard County nor Volusia County constitutes an environmental justice population because in both counties, neither the percentage of minorities exceeds 50 percent nor is substantially higher than the percentage of minorities in the state. Disproportionate impacts to minorities in both Brevard and Volusia Counties would therefore be negligible under both the **Proposed Action** and **Alternative 1**.

Brevard County and Volusia County do not constitute an environmental justice population since poverty levels coupled with median household income levels are lower or comparable with the rest of Florida. Disproportionate impacts to the health and safety of children in Brevard and Volusia counties would not occur. Impacts of Alternative 1 would be virtually identical to those of the Proposed Action.

The **No Action Alternative** would continue KSC's ongoing program at the current level of operations. No new potential for environmental justice effects or increased risk to children would be anticipated under this alternative. In general, all members of the affected communities would experience both the potential beneficial and adverse effects of the No Action Alternative equally. Minority or low-income individuals would unlikely experience high or disproportionate effects from the actions to be taken under this alterative. Disproportionate impacts to the health and safety of children in Brevard and Volusia counties would not occur.

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Draft Programmatic Environmental Impact Statement Kennedy Space Center Center-wide Operations

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1.0 PURPOSE AND NEED

1.1 Introduction

This Programmatic Environmental Impact Statement (PEIS) has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S. Code [U.S.C.] 4321–4347), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500–1508), the National Aeronautics and Space Administration's (NASA's) regulations for implementing NEPA (14 CFR Subpart 1216.3), the NASA Procedural Requirements for Implementing NEPA, Executive Order (EO) 12114 (NASA Procedural Requirements 8580.1), and as identified in Section 1102 of the NASA Authorization Act of 2010 (Public Law [PL] 111-26, October 11, 2010). Section 106 of the National Historic Preservation Act (NHPA) and Section 7 of the Endangered Species Act (ESA) are also integrated with the NEPA process, to identify and protect cultural resources and threatened and endangered (T&E) species, respectively.

This PEIS has been prepared to evaluate the potential environmental impacts from proposed center-wide Kennedy Space Center (KSC) operations, activities, and facilities for a planning horizon that encompasses the next 20 years. These operations, activities and facilities are described in the 2013 Master Plan (Center Master Plan Update, or CMP, as referenced in the rest of the document), which has a planning horizon of 2012-2032. It will consider a range of future scenarios for repurposing existing facilities and recapitalizing infrastructure, to reorganizing the management of the KSC and its land resources, with potentially various kinds of partnerships (some of which are already in place). The PEIS is intended to ensure that NASA is in compliance with applicable environmental statutes as it sets program priorities for future operations and activities.

Several EIS's are discussed in this document. NASA's EIS (i.e., this document) is the Programmatic EIS (PEIS) that provides NEPA compliance for the KSC Center Master Plan Update covering the 2012-2032 planning horizon. The Federal Aviation Administration (FAA), a cooperating agency for this PEIS, is preparing its own EIS on the proposed Shiloh Launch Complex (described in Chapter 3, Section 3.2.2) put forth by Space Florida. Finally, the Surface Transportation Board is preparing a separate EIS for the proposed Port Canaveral Rail Extension in the southern portion of KSC (described in Chapter 3, Section 3.2.3).

1.2 Background

1.2.1 KSC History and Operations

Beginning in the late 1950s the United States embarked upon a new era of human space exploration (NASA, 2008), an effort which continues to this day more than half a century later. The first human spaceflight initiative in the U.S. was Project Mercury, established in 1958 with crewed spacecraft first launched from Cape Canaveral Air Force Station (CCAFS) in the early 1960s. NASA's Launch Operations Center and the portions of CCAFS that were used by NASA were renamed the John F. Kennedy Space Center (KSC) in 1963. Project Mercury was followed by Project Gemini and the Apollo Program. Project Gemini was announced in 1962 and served to perfect maneuvers in Earth orbit. The Apollo Program was initiated in 1961, successfully landing American astronauts on the Moon with Apollo 11 and returning them safely to the Earth in July 1969. Ultimately a total of nine Apollo missions reached the Moon, landing 12 astronauts there. The last American strode the surface of the Moon in December 1972.

In the mid-1970s, NASA initiated development of the Space Transportation System (commonly called the Space Shuttle) as the next crewed vehicle. Designed solely for missions to low Earth orbit (99-1,200 miles above the Earth's surface), the Space Shuttle was the first and to date the only winged U.S. spacecraft capable of launching crew vertically into orbit and landing horizontally upon returning to Earth. The Space Shuttle era lasted for 30 years, from the launch of Columbia on April 12, 1981 until the landing of Atlantis on July 21, 2011. During this period the Space Shuttle fleet supported 135 missions, recovering and repairing satellites, conducting cutting-edge scientific research under zero gravity conditions, and helping construct and service the International Space Station (ISS), the largest-ever structure built in space (NASA, 2012a).

Early in 1962, NASA began acquiring property for a space center as a base for launch operations in support of the Manned Lunar Landing Program. Approximately 34,000 hectares (ha) (84,000 acres (ac)) were purchased on Merritt Island in the northern part of Brevard County extending into the southernmost tip of Volusia County. An additional 22,660 ha (56,000 ac) of state-owned submerged land (Mosquito Lagoon and part of Indian River Lagoon) were negotiated with the State of Florida for exclusive rights dedicated to the United States. This total area of nearly 56,660 ha (140,000 ac), together with the adjoining water bodies, was considered extensive enough to provide adequate safety for the surrounding communities from the planned vehicle launches.

KSC is located on the east coast of Florida (Figure 1.2-1). The Center itself is situated approximately 242 km (150 miles) south of Jacksonville and 64 km (40 mi) due east of Orlando, on the north end of Merritt Island, adjacent to Cape Canaveral.

KSC is relatively long and narrow, being approximately 56 km (35 mi) in length and varying from 8 to 16 km (5 to 10 mi) in width. It is bordered on the west by the Indian River (a brackish water lagoon) and on the east by the Atlantic Ocean and the CCAFS. The northernmost end of the Banana River (another brackish-water lagoon) lies between Merritt Island and CCAFS and is included as part of KSC submerged lands. The southern boundary of KSC runs east-west along the Merritt Island Barge Canal, which connects the Indian River with the Banana River and Port Canaveral at the southern tip of Cape Canaveral. The northern border lies in Volusia County near Oak Hill across Mosquito Lagoon. The Indian River, Banana River and the Mosquito Lagoon collectively make up the Indian River Lagoon system (Figure 1.2-2).

Only a very small part – about five percent – of the total acreage of KSC has been developed or designated for NASA operational and industrial use (see Figure 2.2-1). Merritt Island consists of prime habitat for unique and endangered wildlife; therefore, in August 1963 NASA entered into an agreement with the U.S. Fish and Wildlife Service (USFWS) to establish a wildlife preserve, known as the Merritt Island National Wildlife Refuge (MINWR), within the boundaries of KSC. Public Law 93-626 created the Canaveral National Seashore (CNS); thereby, an agreement with

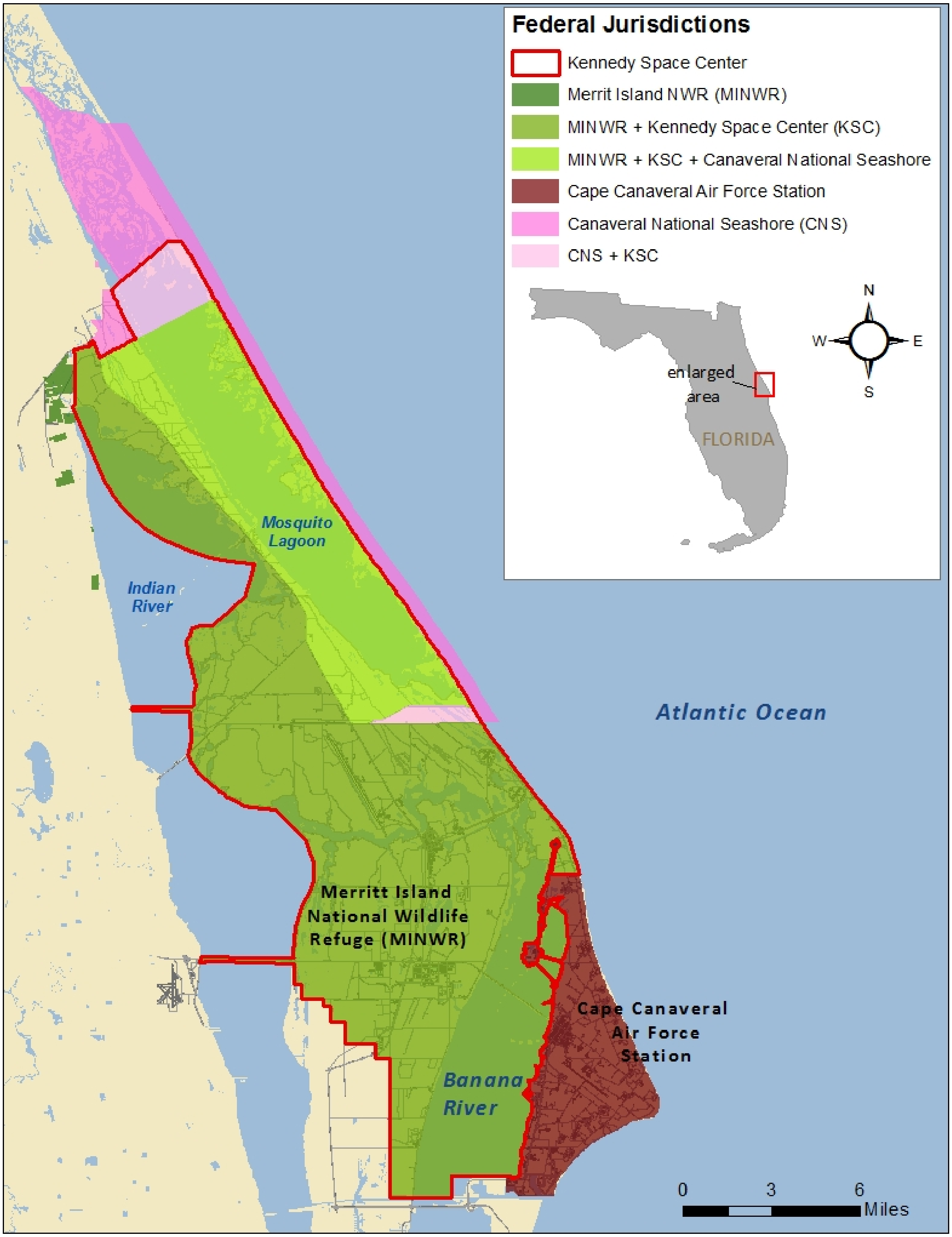

Figure 1.2-1. Location map of the Kennedy Space Center

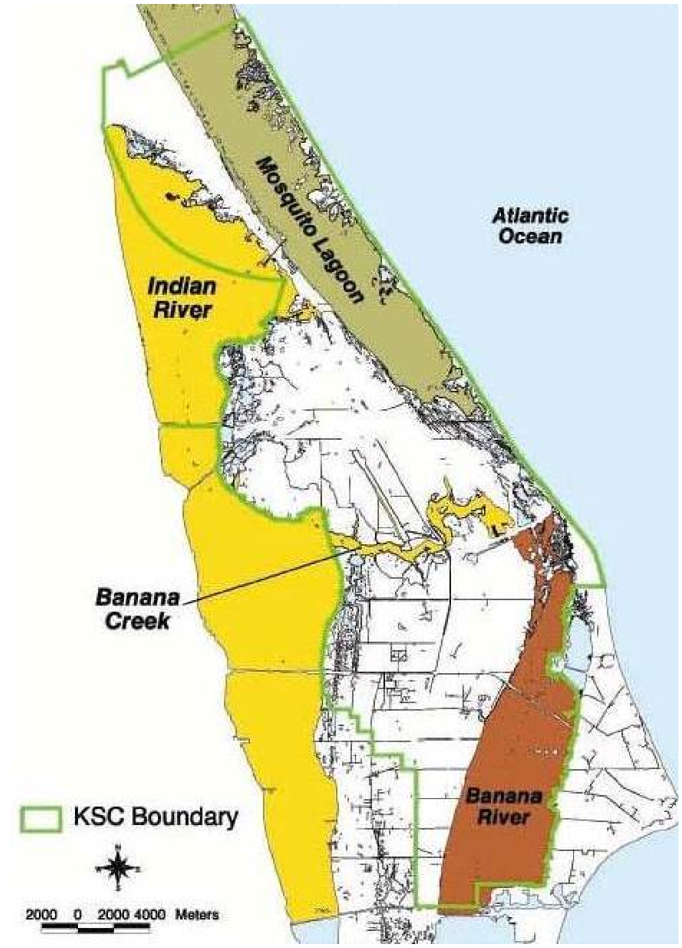

Figure 1.2-2. Major surface water bodies in and surrounding the Kennedy Space Center

the U.S. Department of the Interior (USDOI) was also signed in 1975 due to the location of CNS within KSC boundaries (Figure 1.2-1). CNS and MINWR conducted separate NEPA planning processes to adopt individual management plans: CNS is managed in accordance with its General Management Plan (GMP) and MINWR is managed in accordance with its Comprehensive Conservation Plan (CCP), including key step-down management plans such as a hunt plan.

The 140,000-acre area, in association with adjacent water bodies, provides sufficient buffer zones to afford adequate safety to the surrounding civilian communities for vehicle launches and other KSC activities. A portion of the seashore on the eastern edge of the Center is available for public recreation purposes on a non-interference basis (NASA, 1971).

Since December 1968, all manned launch operations have been conducted from Pads A and B at Launch Complex 39 (LC-39). Both pads are close to the ocean, five km (three miles) east of the Vehicle Assembly Building (VAB). From 1969–1972, LC-39 was the departure point for all six Apollo manned Moon landing missions using the Saturn V rocket, the largest and most powerful operational launch vehicle in history, with more than 7.5 million pounds of thrust. LC-39 was used from 1981–2011 for all Space Shuttle launches. The Shuttle Landing Facility (SLF), located just to the north, was used for most Shuttle landings and, at 4,572 meters (m) (15,000 ft. or 2.8 miles) is among the longest runways in the world.

The KSC Industrial Area, where many of the Center's support facilities are located, is eight km (five miles) south of LC-39. It includes the Headquarters Building, the Operations and Checkout Building and the Central Instrumentation Facility. KSC was also home to the Merritt Island Spaceflight Tracking and Data Network station (MILA), a key radio communications and spacecraft tracking complex. The Center operates its own railroad, the primary function of which is to transport solid rocket boosters to and from various locations on KSC.

KSC is a major central Florida tourist destination and is approximately one hour's drive from the Orlando area. The Visitor Complex offers public tours of the center and CCAFS. Because much of the installation is a restricted area and only nine percent of the land is developed, the site also serves as an important wildlife sanctuary. The Indian River Lagoon, Merritt Island National Wildlife Refuge and Canaveral National Seashore are other natural features of the area. KSC workers and the visiting public can encounter Bald Eagles, American alligators, wild boars, eastern diamondback rattlesnakes, bobcats, and Florida manatees, among other wildlife.

KSC is one of eleven major NASA field centers (Ames, Armstrong, Glenn, Goddard, Jet Propulsion Laboratory, Johnson, Kennedy, Langley, Marshall, Stennis, and Wallops), and it has a number of facilities listed on the National Register of Historic Places (NRHP).

1.2.2 Mission and Core Competencies

KSC's core competencies are rooted in its history of space flight. The future operations performed at KSC will continue to use these competencies, which are unmatched anywhere in the world, having been mastered with over 50 years of successful space launch operations. This unique experience and position within the space launch industry is reflected in its specialized workforce, unique facilities supporting launch preparations and operations, and ideal location for sending payloads to orbit. An essential function of the success of KSC's transformation is that it applies those competencies across new business lines. This is what will enable and attract a broader user base. It's a new way of doing business for a new generation of explorers.

KSC excels in these core competencies:

- **Acquisition and management of launch services and commercial crew development –** Ability to successfully acquire and manage commercial launch services for human and science-related missions is critical to expanding U.S. aerospace markets as we continue to live, learn, and explore in space.

- **Launch vehicle and spacecraft processing, launching, landing and recovery, operations, and sustainment –** Accomplishments range from processing highly complex spacecraft and space telescope optics to the launch and recovery of both manned and unmanned spacecraft and launch vehicles.

- **Payload and flight science experiment processing, integration, and testing –** KSC's ability to develop, integrate, and test a variety of different payloads and research experiments, provide controlled environments to sustain critical science cargo, offer contamination control services, and consistently deliver time-critical launch/landing site payload customer services has earned KSC recognition within the NASA community.

- **Designing, developing, operating, and sustaining flight and ground systems, and supporting infrastructure –** KSC's engineers are skilled in electrical systems, avionics, mechanical accessories, fluids and propulsion, information technology, and pyrotechnics.

- **Development, test and demonstration of advanced flight systems and transformational technologies –** KSC's staff is adept in using real-time prototypes to construct hardware, thus enabling rapid solutions to complex problems. KSC also partners with industry to resolve technical problems, with results that lead to dual-use products or spinoffs.

- **Developing technology to advance exploration and space systems** – KSC's innovations have led to advanced space systems, developing advanced human space flight capabilities required to explore space in a more sustainable and affordable way (NASA, 2011b).

1.3 Purpose and Need for the Action

In the coming years, the Kennedy Space Center will remain the world's preeminent launch facility for government and commercial space access. KSC will support NASA, and ultimately, our nation's competitiveness, by investing in next-generation technologies and encouraging innovation. KSC will foster partnerships – intergovernmental, commercial, academic, and international – to expand its ability to support both public and private space initiatives. These institutional efforts and initiatives necessitate changes to the infrastructure, facilities, and operations at the KSC over the coming decade which are identified in a new Center Master Plan (CMP) Update that has been developed by the Center Planning and Development Office.

1.3.1 Purpose of the Action

The purpose of the action – the CMP – is to provide overall management guidance for KSC from 2016 to 2032. Implementation of the CMP will facilitate a 20-year transformation from a single, government user launch complex to a multi-user spaceport. This multi-user spaceport will be developed in concert with NASA's programmatic missions and requirements to explore destinations outside of low Earth orbit (Figure 1.3-1).

In the years ahead, KSC will transition from a government and program-focused, single-user launch complex to a more capability-centric and cost-effective, multi-user spaceport. KSC's new mission will be to furnish both government and commercial space providers with the facilities, experienced workforce and knowledge necessary to support existing mission sets and new space programs.

In support of these endeavors, KSC is engaged in a master planning process identified in NASA's institutional requirements report to the Congress, pursuant to Section 1102 of the NASA Authorization Act of 2010. The resulting CMP will result in changes to KSC's infrastructure, land uses, customer base of space transportation providers and users, and business model over a 20-year planning horizon extending from 2012-2031.

The CMP addresses:

- Both traditional and non-traditional approaches to the recapitalization, re-development, and future expansion of spaceport capabilities

- Partnerships with industry, the State of Florida, and other public and private entities

Figure 1.3-1. Kennedy Space Center mission in the coming years: exploring destinations beyond low-Earth orbit

- Optimal utilization of physical assets and intellectual capital
- Environmental stewardship, sustainability, and the risks associated with future climate change
- Changes to operations and management structure for optimal performance as a multi-user spaceport.

The CMP will include a number of component plans, including a Future Land Use Plan, Facility Development Plan, Area Development Plans, Transportation Plan, and Utilities Systems Plan.

1.3.2 Need for the Action

The need for the action is to update KSC's CMP in a manner that supports achievement of NASA's programmatic mission objectives, at the same time as maximizing the provision of excess capabilities and assets in support of non-NASA access to space.

The Space Shuttle has completed its final mission and retirement of the Shuttle Program has been completed. NASA's budget has been reduced from earlier agency planning guidance and NASA anticipates continuing funding challenges in the coming years. Approximately half of KSC's skilled workforce has been being laid off with the conclusion of the Shuttle Program. Resources to sustain and renew existing facilities and capabilities at KSC are severely constrained.

Overall, KSC is transitioning to a re-focused mission that redefines its relationship with industry and leverages the potential of partnerships. Amid the challenges of an aging and unsustainable asset base, as well as a highly constrained federal budget, NASA must adopt and implement strategies that preserve the institutional infrastructure needed to support its purpose and programs.

KSC's last major revision to its CMP was performed in 2002, with an update to define Area Development Plans (ADPs) in 2008 (Rivera, 2008). The 2002 plan was a forward-looking, 75-year, unconstrained plan for land uses and facilities to support the evolution of KSC and the neighboring CCAFS into a more unified spaceport community supporting a robust increase in flight rates. The 2002 plan did not, however, provide a clear approach to implementation, or furthermore, anticipate dramatic changes in the pace of space commercialization and the challenging Federal budgetary circumstances that exist at present.

Thus, the current planning environment necessitates a revised baseline (NPR 8810.1A, Center Master Planning). The space transportation industry, both its technology and its economy, is evolving globally. The Space Shuttle Program has run its course. In the context of Government-wide initiatives, NASA is implementing policies to reduce its facilities infrastructure footprint by consolidating for greater efficiency and sustainability, which will reduce operations and maintenance costs, and help meet energy and water conservation goals.

1.4 Scope of this Programmatic EIS

In guidance on the "Effective Use of Programmatic NEPA Reviews" issued on December 18, 2014, the President's Council on Environmental Quality states that:

> "NEPA reviews may be on a site- or project-specific level or on broader – programmatic – level. Programmatic analyses have value by setting out the broad view of environmental impacts and benefits for a proposed decision. That programmatic NEP A review can then be relied upon when agencies make decisions based on the…Programmatic Environmental Impact Statement (PEIS) such as a rulemaking or establishing a policy, program, or plan, as well as when decisions are based on a subsequent – tiered – NEPA review. Programmatic NEPA reviews should result in clearer and more transparent decisionmaking, as well as provide a better defined and more expeditious path toward decisions on proposed actions. Agencies are encouraged to revise or amend their NEPA implementing procedures, if necessary, to allow for analyses at a programmatic level (CEQ, 2014).

The December 2014 CEQ guidance on programmatic NEPA review further states:

> One advantage of a programmatic NEPA review is the ability to tier subsequent reviews, such as site- or proposal-specific reviews. Tiering has the advantage of not repeating information that has already been considered at the programmatic level so as to focus and expedite the preparation of the tiered NEPA review(s). When a…PEIS has been prepared and an action is one anticipated in, consistent with, and sufficiently explored within the programmatic NEPA review, the agency need only summarize the issues discussed in the broader statement and incorporate discussion from the broader statement by reference and concentrate on the issues specific to the subsequent tiered proposal.

In keeping with this guidance, this PEIS outlines and broadly describes actions associated with KSC's proposed programs in the limited detail with which they are known at present. Three programmatic alternatives are described and their potential environmental effects are assessed in fairly general terms. At such time as a given specific project of detailed dimensions and scale is proposed at a specific location, and is in the process of being reviewed and approved, this PEIS can serve as a master NEPA document off which future NEPA compliance documents may be "tiered". That is, having already been addressed at a programmatic level, the action or project can incorporate discussion from the broader PEIS by reference and focus on the issues specific to the subsequent tiered proposal. Ideally, this will serve to expedite the environmental review process and facilitate project approval, funding, and implementation.

1.4.1 Scoping Process for PEIS

NEPA requires lead agencies to invite public involvement prior to decision-making on proposed actions that may affect the environment. "Scoping" is the process of soliciting input from "stakeholders" – including Tribes, the public (both private citizens and non-governmental organizations or NGO's), and other agencies – at the outset of a NEPA (in this case, PEIS) analysis. Not only may the information obtained from interested and knowledgeable parties be of value in and of itself, but the perspectives and opinions as to which issues matter the most, and how, indeed whether, the agency should proceed with a given proposed action are equally important. Input from scoping thus helps shape the direction that analysis takes, helping analysts decide which issues merit consideration. Public input also helps in the development of alternatives to the proposed action, which is an integral part of NEPA.

Appendix B of this EIS is a Scoping Report that describes and documents the scoping process NASA followed in great detail.

1.4.2 Agency Scoping Meeting

NASA-KSC held an agency Draft PEIS scoping meeting on June 4, 2014 at KSC for cooperating agencies and partners. Participants included the U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), Federal Aviation Administration (FAA), and Space Florida.

1.4.3 Public Scoping Meetings

NASA-KSC held two public scoping meetings on June 4, 2014 in Titusville and June 5, 2014 in New Smyrna Beach, using a combined open house and open forum format. In the first hour, an open house format was used to give attendees the chance to speak informally with officials from NASA and its USFWS and NPS partners, sharing information and perspectives. Several stations with exhibits, maps, and materials were staffed by representatives of NASA, USFWS, NPS, and PEIS contractor Solv. In the second hour of both scoping meetings, three short presentations described KSC's mission, goals, updated Master Plan, and the NEPA process. Following these presentations, the public was invited to make oral comments for the record (Figure 1.4-1).

Figure 1.4-1. Commenter speaking at microphone in Titusville public scoping meeting

1.4.4 Additional Opportunities for Public Involvement

This PEIS is being released for public review and there will be public meetings to solicit comments from all interested parties and stakeholders on the CMP and PEIS at that time. The Draft PEIS will be available for viewing and downloading on the KSC website. NASA will respond to all written comments made on the Draft PEIS and consider them in preparing the Final PEIS. A Comment Responses Document (CRD) will be included as an appendix in the Final PEIS.

1.5 Coordination with Other Environmental Reviews

NASA's Environmental Assurance (EAB) and Management (EMB) Branches manage the environmental program and environmental compliance at KSC (NASA, 2015). These offices are responsible for obtaining and maintaining KSC's environmental permits, assuring compliance with environmental laws, regulations, executive orders, and ensuring conservation and environmental stewardship issues are considered for all NASA activities at KSC.

KSC regularly undergoes both internal and external environmental audits and inspections. All onsite regulatory reviews are coordinated through the EAB and EMB with minimum effects on Center operations. EAB and EMB support and are actively involved with the Space Coast Inter-Agency Environmental Partnership working group to ensure long-term regulatory compliance and to provide a conflict resolution forum between KSC, onsite contractors, and the regulatory community. This working group consists of the Florida Department of Environmental Protection (FDEP) office in Orlando, Brevard County Natural Resources Management Department, NASA, United States Air Force (USAF), St. Johns River Water Management District (SJRWMD), as well as representatives of onsite contractors. It meets on a regular basis to discuss issues and concerns associated with planned or proposed regulatory changes, unique actions and findings at the federal facilities, and development of mutually agreeable solutions (NASA, 2015).

The EAB and EMB have primary responsibility for ensuring that all activities at KSC comply with federal, state, and local environmental laws and regulations, including NEPA, the Clean Water Act (CWA), Clean Air Act (CAA), Resource Conservation and Recovery Act (RCRA), and the Endangered Species Act (ESA).

The 2015 Environmental Resources Document (ERD) describes in detail each of the federal and state environmental statutes and regulations with which KSC must comply. These are also discussed under the respective resource topics of this PEIS. In general, this PEIS does not obviate the need for timely regulatory reviews associated with permits and approvals under these federal and state statues.

KSC has a CAA Title V operating permit issued by the FDEP Central District, which is valid for a period of five years and requires a renewal application to be submitted six months prior to the date of expiration. Under this Title V permit, KSC is designated as a major source as the potential to emit (PTE) for the criteria pollutants oxides of nitrogen (NOx), volatile organic compounds (VOCs) and carbon monoxide (CO), each of which exceeds the 100 tons per year (tpy) Title V major source threshold. Air quality issues and permitting are addressed in Section 3.6 of the PEIS.

Section 3.4 of the PEIS addresses water resources, including laws and regulations pertaining to KSC. KSC held a Consumptive Use Permit (CUP) for water issued by the St. Johns River Water Management District (SJRWMD), but in 2014 the CUP was rescinded based on a SJRWMD determination that the type and quantity of water use at KSC did not meet permitting thresholds. SJRWMD's determinations on CUP issues would not be influenced by the PEIS.

The U.S. Army Corps of Engineers (USACE) administers the federal dredge and fill permitting program under Section 404 of the CWA, with assistance and review from other federal agencies including the USFWS, the National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). Future activities at KSC involving discharge of dredge or fill materials into waters of the United States, including wetlands, would have to undergo site-specific Section 404 evaluation by the USACE, including compliance with the Section 404(b) (1) Guidelines and NEPA. Those analyses may be able to tier off of this PEIS.

Section 3.5 of this PEIS discusses hazardous materials and waste at KSC, including relevant statues and regulations. KSC maintains a comprehensive inventory of all RCRA-defined hazardous wastes, and controlled waste not regulated by RCRA. KSC has an FDEP operating permit for the storage, treatment and disposal of hazardous waste. These programs and permitting activities will continue independent of NEPA reviews and compliance.

With regard to consultation under Section 7 of the ESA, KSC environmental staff collaborates closely with the USFWS, including both Ecological Services and MINWR staff, on all matters related to endangered species conservation and management at KSC. This will continue in the future. At a minimum, all site-specific actions that may affect any listed species or designated critical habitats will require informal consultation and collaboration between KSC and USFWS. It may be possible to tier associated analyses off of this PEIS.

Section 3.10 of the PEIS discusses management of cultural and historic resources at KSC. Federal agencies are encouraged to coordinate studies and documents prepared under Section 106 of the National Historic Preservation Act (NHPA) with those completed under NEPA. KSC already has in place a Programmatic Agreement (PA) for the Management of Historic Properties. This agreement streamlines the Section 106 process and allows KSC to conduct normal maintenance and minor modifications, as well as reuse facilities and property. Moreover, it ensures that historic, engineering, and architectural values are recognized and considered in the course of ongoing KSC programs. This PEIS does not include any particular site-specific actions that would trigger the need for a NHPA Section 106 consultation at this time.

With KSC serving as a multiuser spaceport, future commercial space customers would be subject to FAA licensing, including Order 1050.1E, as well as Section 4(f) eventually. Projects that require FAA licensing, and U.S. DOT Section 4(f) review at KSC, with NASA as the jurisdictional authority, would be covered in more specific detail in EAs that tier off of this PEIS.

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This chapter of the Draft Programmatic Environmental Impact Statement for Center-wide operations of the Kennedy Space Center describes three alternatives subjected to detailed analysis in subsequent chapters. The three alternatives being considered are the Proposed Action (Preferred Alternative) and the No Action Alternative. Under each of these three alternatives, partnerships, jurisdictions, and boundaries with the USFWS (MINWR) and NPS (CNS) at KSC would continue as at present.

2.1 Proposed Action

Under the Proposed Action, and as described in the Center Master Plan Update (NASA, 2013e) and associated planning documents, KSC would transition over a 20-year period (2012-2032) to a multi-user spaceport. This section will first summarize KSC's new land use plan included in the Update, and then proceed to describe KSC's mission and core competencies, followed by the proposed institutional arrangements associated with that transition. Section 2.1 continues with generalized descriptions of proposed future development, transportation facilities, and activities.

2.1.1 Land Use Plan

2.1.1.1 Overview

The future land use plan (Figure 2.1-1) promotes the highest, best and most efficient use of land area resources balanced with an understanding of development suitability and development capacity. An understanding of existing land use characteristics forms the basis of an overall development framework to support continuing NASA programs and encourage future non-NASA opportunities (NASA, 2013e). This includes promoting compatible relationships between adjacent land uses, encouraging infill development and preserving environmentally sensitive areas. Figures 2.1-2 through 2.1-6 depict selected key functional areas of KSC in much greater detail than Figure 2.1-1 is able to.

2.1.1.2 Future Land Use

Future Land Use outlines a development framework that would support the growth of the multi-user spaceport model. Building on the development capacity section outlines in the Planning Conditions section, the CMP Update (i.e., the 2013 KSC Master Plan) outlines where development can occur, how land can be used, and how to expand strategic capabilities to support KSC's evolution to a multi-user spaceport. Through this approach, KSC is better able to promote smart development by better separating potentially hazardous operations from less-hazardous operational areas and non-NASA operations from NASA operations.

Table 2.1-1 identifies existing and proposed future land uses at KSC and their proposed acreages under the 2013 KSC Master Plan.

Table 2.1-1. Existing and proposed future land uses at KSC under Proposed Action

Land Use	Existing Acreage	Future Acreage	Change in Acreage*
Administration	104.76	40.72	**-64.03**
Assembly, Testing and Processing	475.41	1,894.77	**1,419.36**
Central Campus	NA	138.75	**138.75**
Horizontal Launch and Landing	501.25	2,838.84	**2,336.94**
Launch Operations and Support	398.75	506.14	**107.39**
Open Space	1,873.64	NA	**-1,873.64**
Operational Buffer/Conservation	44,583.14	40,196.94	**-4,386.20**
Operational Buffer/Public Use	34,844.14	34,824.72	**-19.42**
Public Outreach	216.01	522.13	**306.12**
Recreation	161.36	161.36	**0.00**
Renewable Energy	66.54	1,109.85	**1,043.31**
Research and Development	88.36	867.49	**779.13**
Seaport	30.92	317.26	**286.34**
Support Services	723.91	471.40	**-252.51**
Utility Systems	1,327.23	1,329.60	**2.37**
Vertical Launch	360.32	536.42	**176.10**
Vertical Landing	NA	75.73	**75.73****
Water	55,541.81	55,541.81	**0.00**
Total	**141,297.54**	**141,373.28**	**75.73****

Total difference in size between each existing land use category and future land use category. Numbers in red represent a future land use category that is* ***SMALLER* *than its existing category while numbers in green signify that the future land use category contains a* ***LARGER*** *amount of acres than its existing land use category.*
***Difference in Total Acreage is due to addition of Vertical Landing category, which lies within same geographical footprint as Horizontal Launch and Landing Category.*

2.1.1.2.1 Center-wide Strategy

Implementing the future land considerations outlined in the KSC Master Plan would promote the right-sizing of NASA operations at KSC and attract non-NASA investment by providing them more operational autonomy. The consolidation of NASA operations into a smaller geographic footprint is a major component of the Future Land Use Plan. Applying the Central Campus concept, for example, would allow NASA to recapitalize, over time, functions and capabilities into more efficient facilities on a smaller footprint and combine once spread-out non-hazardous functions into a smaller, more efficiently secured geographic footprint. Likewise, directing future NASA and non-NASA development into functional areas with defined allowable operations would streamline safety and security considerations while promoting the maximum utilization of KSC's horizontal infrastructure capacities. Additionally, the Future Land Use Plan supports the expansion of the quinti-modal capabilities to provide increased support for the users of the multi-user spaceport (quinti-modal refers to the capability of five separate modes of transportation, specifically: roads, water, air, rail and space).

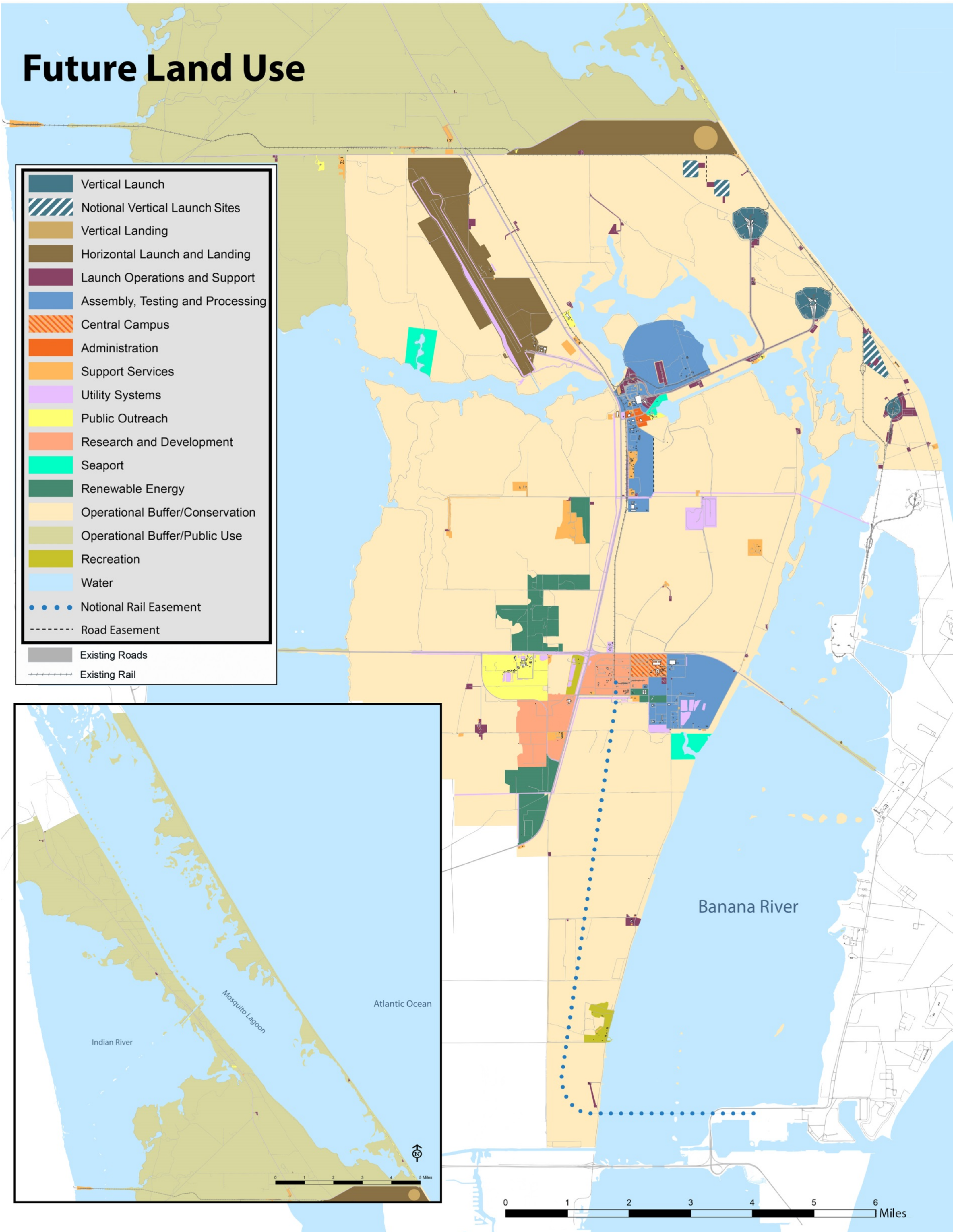

Figure 2.1-1. Proposed future land use at the Kennedy Space Center (Proposed Action)

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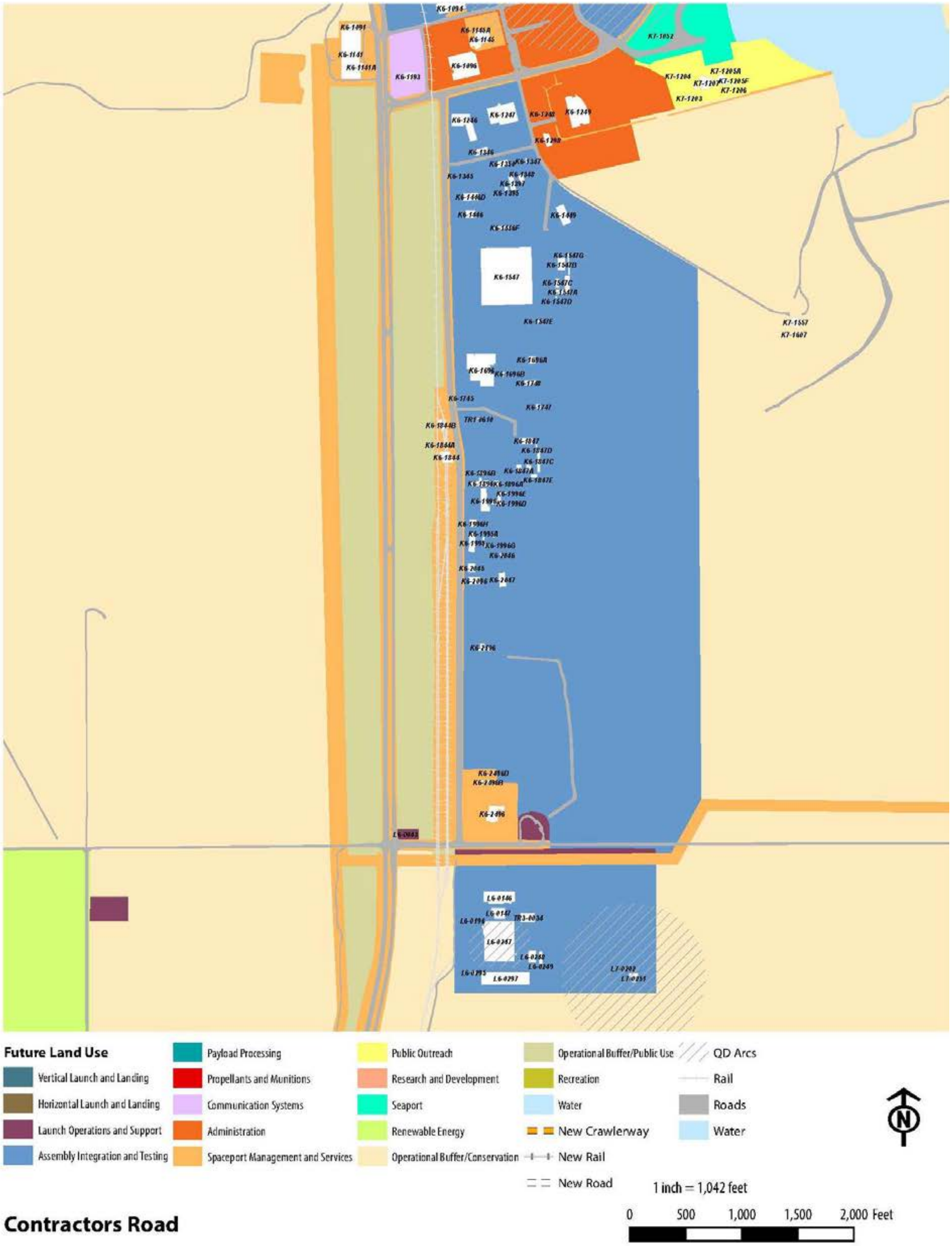

Figure 2.1-2. Contractors Road Functional Area

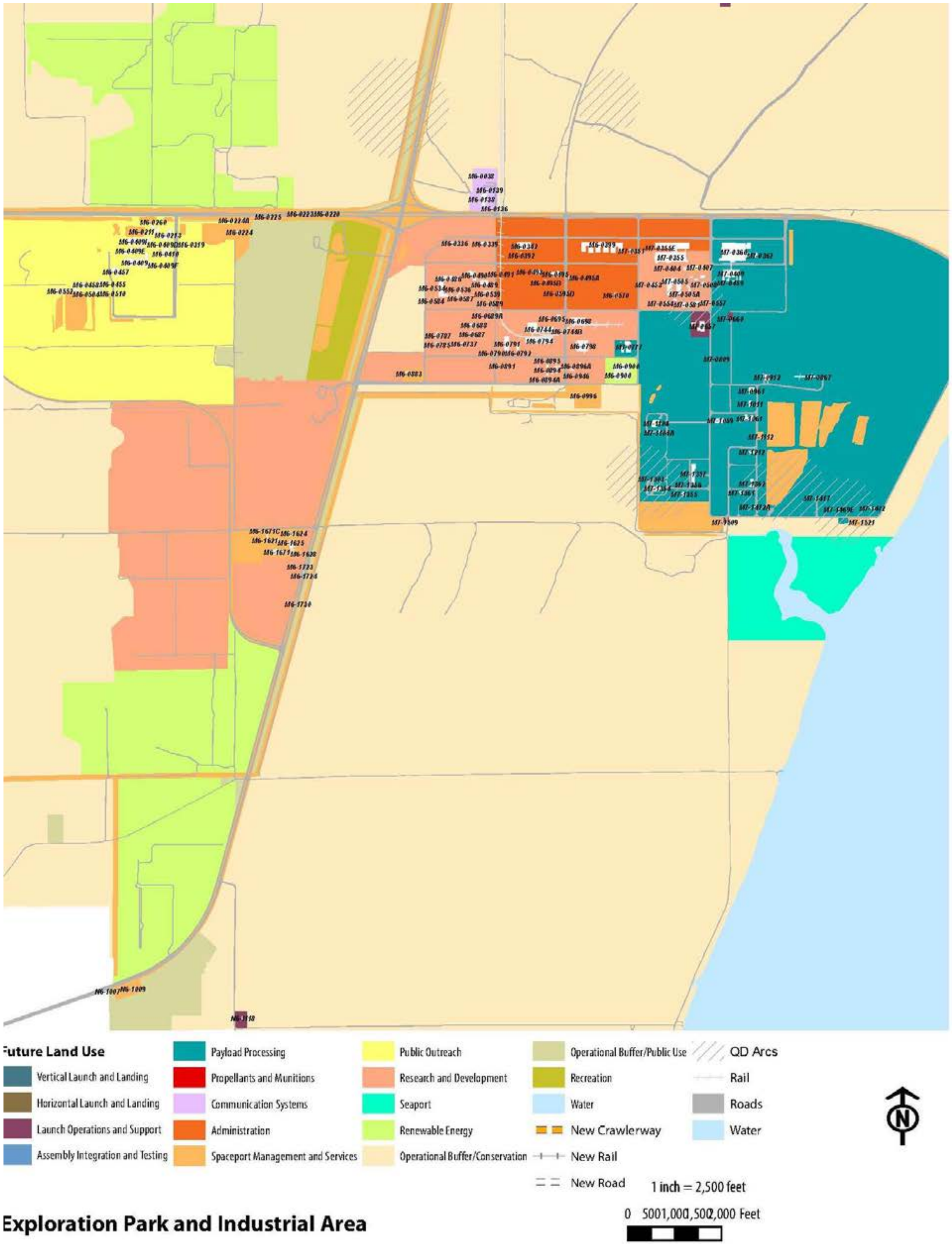

Figure 2.1-3. Exploration Park. Industrial Area, and Visitor Center

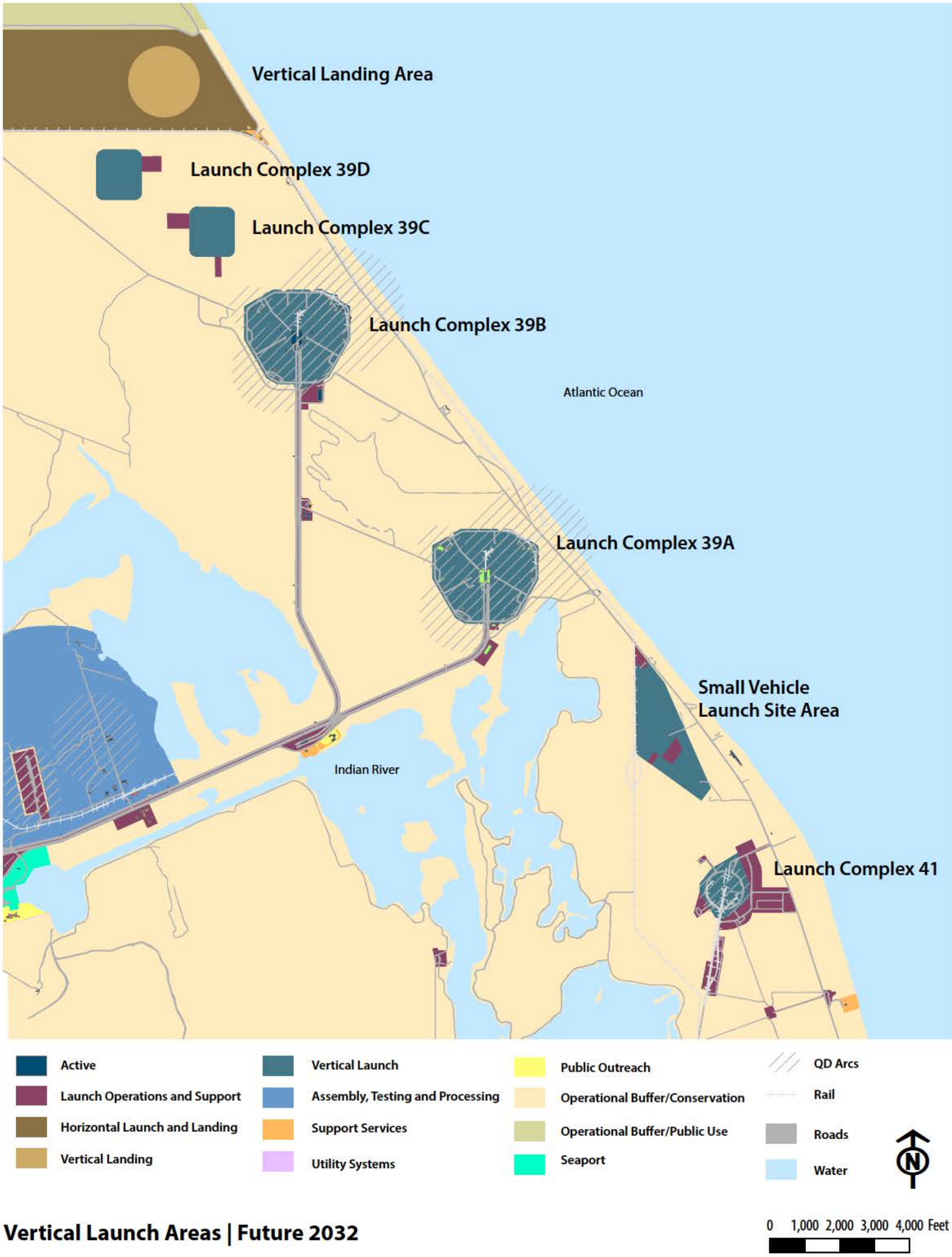

Figure 2.1-4. Vertical Launch Areas

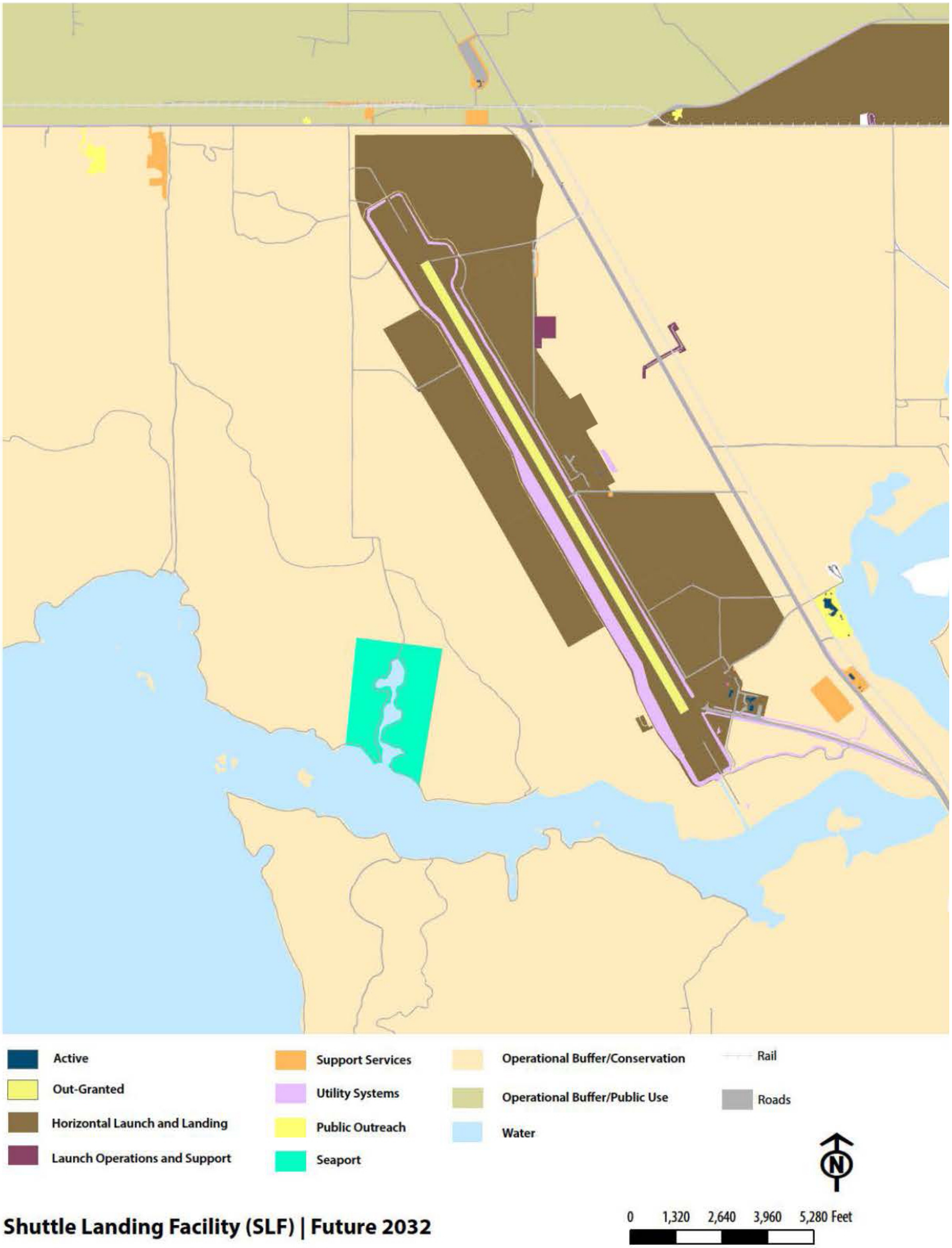

Figure 2.1-5. Shuttle Landing Facility (SLF) Functional Area

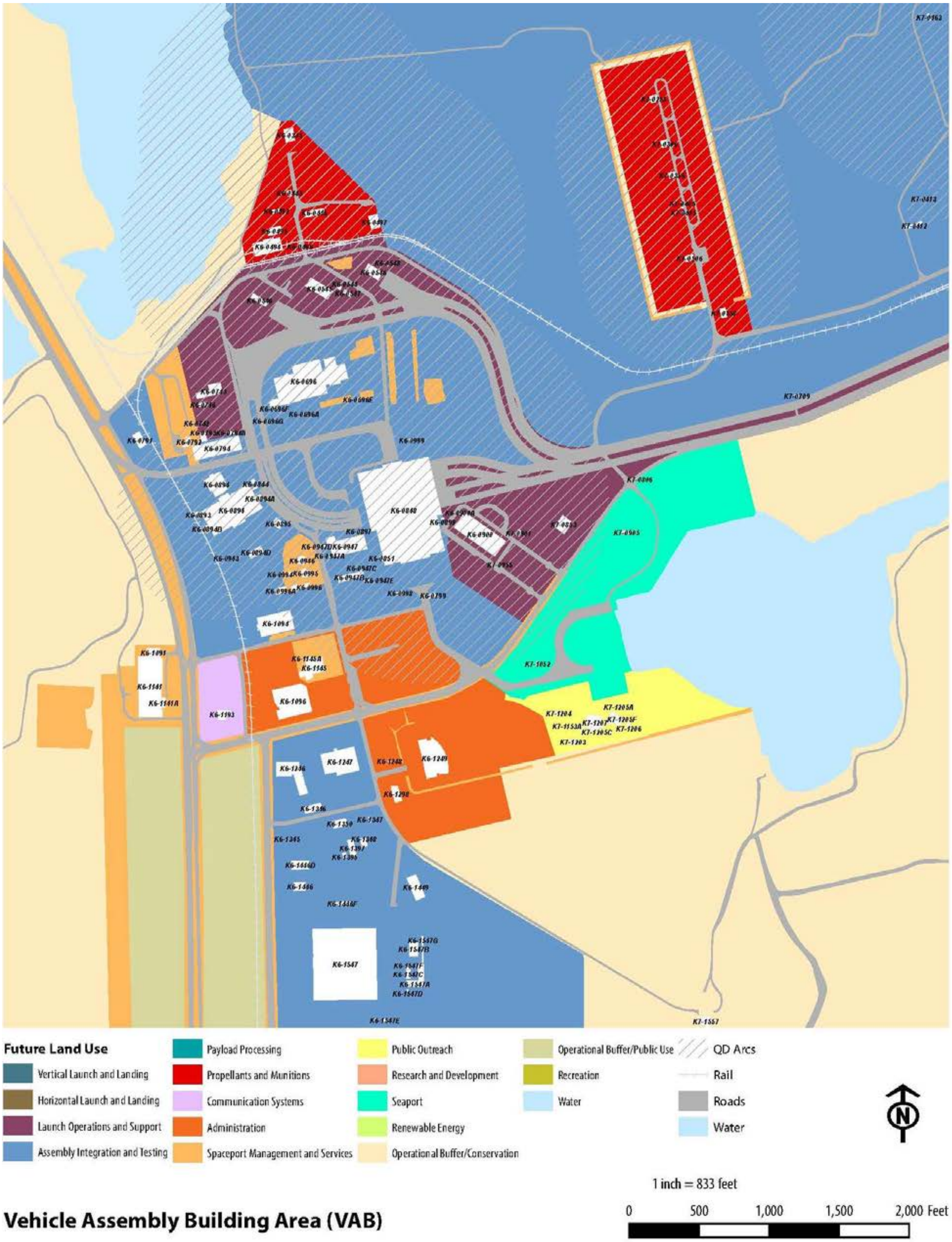

Figure 2.1-6. Vehicle Assembly Building (VAB) Functional Area

2.1.1.2.2 Vertical Launch

Land Use Description
Vertical launch includes all facilities and land area directly related to vertical launch operations, including launch pads 39A, 39B and 41, as well as future vertical launch notional areas. It also includes immediately adjacent launch support facilities and countdown facilities required to be operational at the time of launch. Quantity Distance (QD) arcs and other related safety setback and exposure limits are considered restrictions on the use of land adjacent to vertical launch complexes. Land within these QD arcs limits is not designated part of the vertical launch use.

Future Development
In keeping with previous recommendations from the 1966, ‘72 and ‘77 KSC Master Plans, when the market demands an expansion of vertical launch capacity this Plan recommends additional vertical launch pads to be sited to the north of existing 39B, as pads 39C and 39D respectively (see Figure 2.1-4). In addition, a 2007 Vertical Launch Site Evaluation Study also concluded that a vertical pad could also be sited to the south of 39A and to the north of pad 41.

2.1.1.2.3 Vertical Landing

Land Use Description
Accommodating vertical landing capability, both powered and unpowered, would promote reusability of space flight hardware and significantly lower the price point for access to space. In anticipation of these advances, KSC has designated areas along its northeastern secure boundary as lands that could accommodate such activity. These areas could accommodate the return of first stage boosters or possibly vehicles returning from orbit.

Future Development
The proposed vertical landing facility would be on a site 75.73 acres in area, all of which lies within the same geographical footprint as Horizontal Launch and Landing Category.

2.1.1.2.4 Horizontal Launch and Landing

Land Use Description
Horizontal Launch and Landing includes pavements, infrastructure, facilities and land area directly related to horizontal launch and landing operations. Horizontal Launch and Landing includes all paved runway surfaces, aprons, or similar runway features primarily associated with the SLF. Imaginary surfaces related to airfield safety clearances consistent with Federal Aviation Administration (FAA) clearance criteria and requirements, as well as QD arcs and related safety setback criteria, are considered restrictions on the use of land in and adjacent to Horizontal Launch and Landing areas. Land within those surface areas, setback, and limits is not designated as part of Horizontal Launch and land use classification.

Future Development
Apron areas supporting the SLF are intended to be expanded to accommodate future horizontal launch and landing activities and customers along with associated support facilities. Expansion

of these capabilities is expected to be consistent with the recommendations outlined in the 21st Century Launch Complex ADP (April 2012). Initial development would be focused on the east side of the runway and future development, if required, would be accommodated on the west side.

Over the long term, as the market and emerging technology may demand, additional horizontal launch infrastructure can be constructed in an area identified just south of Beach Road that would support an east-west horizontal launch capability.

2.1.1.2.5 Launch Operations and Support

Land Use Description
Launch Operations and Support includes facilities and associated land areas essential to supporting a mission during launch and flight, including command, control and compilation, evaluation and communication of the data associated with launch vehicle activities. Storage of propellants and munitions is also included in this classification.

Future Development
Launch Operations and Support areas would be expanded, if needed, to accommodate future launch activities and the requirements of NASA and non-NASA operations.

2.1.1.2.6 Assembly, Testing and Processing

Land Use Description
Assembly, Testing and Processing includes facilities, operations and land areas that are essential to space vehicle component assembly, integration and processing prior to launch. Laboratories, material support and interface testing to achieve final assembly, test and closeout to prepare and test payloads, space systems and systems components for flight and integration, which may include hazardous commodities, are also included in this clarification. Primary uses and facilities support both government and commercial capabilities for payload assembly, integration, and processing; the development and testing of launch vehicle or spacecraft equipment at the component or system level; post-flight servicing and refurbishment activities; and spaceport infrastructure and operations. Secondary uses and facilities include associated and compatible manufacturing, logistics, or technical support functions.

Future Development
Assembly, Testing and Processing areas can be expanded to the north of the existing developed areas in the VAB Area to accommodate future Assembly, Testing and Processing functions. Development in the expanded areas would require seawall construction to comply with sea level rise criteria. Land areas in the vicinity of Contractors Road previously designed as Support Services are designated as Assembly, Integration and Processing in support of future needs and requirements. In the Industrial Area, Assembly, Testing, and Processing payload functions can be expanded to the north and east of their current concentration to accommodate increased payload processing and testing. Due to the nature these activities, QD arcs requirements would be imposed for safe operations.

2.1.1.2.7 Utility Systems

Land Use Description

Utilities Systems land use classification includes land and facilities associated with KSC utilities infrastructure and systems (i.e., water, wastewater, natural gas, electrical, chilled water, medium temperature hot water (350^{o}F (177^{o}C) or less), communications and sewer systems). Utility easements help to define patterns and impacts associated with the development of utility systems and the overall land use pattern. Communications lines for line-of sight are identified visual corridors associated with communications components.

Future Development

Utility corridors would be established as needed.

2.1.1.2.8 Administration

Land Use Description

Administration includes facilities supporting operations management and oversight activities. Administrative functions/uses associated with management are more focused in the Industrial Area. A subset of administration applies to administrative functions that are adjacent to and in support of assembly, integration and processing operations.

Future Development

Facilities supporting Administration functions are planned to be recapitalized into the Central Campus area over the near, medium, long-term and beyond. Consolidation of non-hazardous facilities, such as administration facilities, is a necessary precursor to the consolidation of NASA operational areas to support a multi-user spaceport.

2.1.1.2.9 Central Campus

Land Use Description

The area identified as Central Campus would be utilized as a means to consolidate NASA operations into a smaller more cost-effective operational footprint. The Central Campus land use includes all non-hazardous NASA operations that occur in support of NASA missions and programs. Ideal Land Uses for consolidation include: Administration, Research and Development, and non-hazardous Support Services.

Future Development

The area would be populated over the planning horizon and beyond to support any non-hazardous new NASA development in support of NASA programming and/or as part of the KSC's recapitalization process. Facilities that are meant to be relocated to Central Campus through recapitalization efforts are NASA facilities being utilized for Administration, Research and Development, and non-hazardous Support Services functions that have aging-related operational inefficiencies and excessive maintenance requirements whose relocation would support decreased Current Replacement Value (CRV) and Operations and Maintenance (O&M) costs.

2.1.1.2.10 Support Services

Land Use Description
Support Services includes all functions other than administration that provide management and oversight of KSC operations and services provided for overall KSC benefit, including operations and maintenance. Operations and maintenance land uses include supply, storage, facilities maintenance, motor pool, service stations, railroad, reclamation areas, roads and grounds maintenance and sanitary landfill facilities. Service land uses include: access control and entry gates; fire protection facilities and training areas; security facilities and related training areas; child development and care; training and conference; dispensary; data processing; environmental and occupational health; food service and photo operations facilities.

Future Development
Future development of non-hazardous Support Services facilities and recapitalization of inefficient existing facilities are intended to occur in the Central Campus area to support right-sizing efforts and the consolidation of NASA operational areas.

2.1.1.2.11 Public Outreach

Land Use Description
The Public Outreach land use classification includes facilities and associated land areas that promote an educational, research or informational connection between the community and KSC. Examples of Public Outreach use include public reception/welcome centers, tour facilities, display and education areas, museums, memorials, launch viewing areas, recreation areas and conference centers.

Future Development
Existing Public Outreach areas are retained and designated in the Future Land Plan, promoting educational, research or informational connections between the community and KSC. Total Public Outreach area is doubled in size (216.01 to 522.13 acres). This includes public reception/welcome centers, tour facilities, display and education areas, museums, memorials, launch viewing areas, and recreation areas. The MINWR CCP (2007) and the CNS GMP (2014) outline existing and proposed management for each; future development of public outreach facilities on the Refuge or Seashore would be planned and implemented by FWS and/or NPS, outside of this NASA PEIS process.

2.1.1.2.12 Recreation

Land Use Description
Recreation areas include parks, outdoor fitness, athletic fields, recreation buildings, centers and clubs for use by KSC employees. Examples of recreation land uses include KARS Park North and KARS Park South complexes (KARS I and KARS II). Coastal beaches and supporting facilities are part of the Canaveral National Seashore and are classified as Operational Buffer/Public Use. Hunting, fishing, wildlife observation and photography, environmental education and interpretation associated with the Merritt Island National Wildlife Refuge are also classified as Operational Buffer/Public Use.

Future Development
Additional Recreational land use areas are not planned, so future development and/or expansion of recreational functions, if necessary, would occur within the already established recreational land areas.

2.1.1.2.13 Research and Development

Land Use Description
The Research and Development (R&D) land use classification includes non-program specific laboratories, related facilities and associated land areas that perform research, experimentation and testing in support of developing new technologies, procedures and products to enhance existing and future programs at KSC.

Light industrial and manufacturing functions, as well as commercial uses, may also be accommodated within R&D land use areas. Integration of educational institutions offering advanced degrees in disciplines supporting space-related research and development activities provide added enhancement and support reinforcing R&D collaboration between KSC, private industry and the educational community. Examples of R&D land uses include chemical and physical standards and laser testing laboratories; missile research and testing facilities; centers for experimentation; innovative science and technology; and life science activities accommodated in Exploration Park.

Future Development
Additional R&D development would be directed to the Industrial Area with non-NASA development designated for west of C Avenue or within Exploration Park in order to provide separation from NASA operational areas. New NASA R&D facilities and recapitalization of existing NASA R&D facilities would be directed to Central Campus in the designated area east of C Avenue.

2.1.1.2.14 Seaport

Land Use Description
The Seaport land use classification includes: port, harbor, wharves, docks and associated land areas to accommodate authorized delivery or embarkation of materials, equipment or people via access to the mainland through means of seagoing vessels. Land areas contiguous to wharves and docks that are used for the staging, off-loading, transfer and storage/processing of materials, equipment or people are also classified as Seaport land use.

Future Development
Additional land areas are designated as Seaport to support future development of the sea-based transportation capability to further leverage quinti-modal functionality and to also capitalize on surrounding area water accessibility and linkage to Port Canaveral.

A future seaport is designated to the west of the SLF to provide water access in support of horizontal launch and landing operations via the Indian River.

An additional seaport is designated to the south of the Assembly, Integration and Processing Area on the east side of the Industrial Area. This seaport would provide water access to support all operations and functional areas within the Industrial Area.

2.1.1.2.15 Renewable Energy

Land Use Description
Land areas designated to accommodate varying forms of renewable energy are designated Renewable Energy land use. Corresponding to fallow agricultural land and other underutilized property, land areas designated as Renewable Energy also includes research and production facilitating KSC's goal for achieving increased on-site generation of its power from renewable sources. This includes current and future accommodation of solar array fields, as well as other emerging renewable energy technologies that may be developed in the future.

Future Development
Former citrus groves that have now become fallow are designated as future land areas to accommodate Renewable Energy uses. Additional land for renewable energy use is also designated in the Industrial Area and can be accommodated as secondary uses in parking lots. Surface parking lots may also produce electricity as a secondary use, as many will become increasingly underutilized as the central campus concept matures.

2.1.1.2.16 Operational Buffer

Land Use Description
Buffer zones provide adequate safety to the surrounding civilian communities for vehicle launches and other KSC activities. The buffer land and water area includes the beach; hunting and fishing areas; trails; submerged areas; areas vulnerable to inundation by rising waters under storm events and/or climate change impacts; and areas of high value for species of critical concern such as Florida scrub-jay, red knot, West Indian manatees, and sea turtles. The two sub-categories of Operational Buffer are: Public Use and Conservation.

Operational Buffer/Public Use
Operational Buffer/Public Use areas correspond to publically accessible areas of Merritt Island NWR and the Canaveral National Seashore for recreational use in the northern portion of KSC, as a conditional use subject to the operational activities associated with KSC's mission.

Operational Buffer/Conservation
Operational Buffer/Conservation areas correspond to land areas in the southern portion of KSC that may never have been developed, or sites that may have reverted to a natural environment over the years. The proposed Port Canaveral Rail Extension would cross Operational Buffer/Conservation lands.

Future Development
Development in Operational Buffer areas totals nearly 4,000 acres and may include infrastructure, operations of low impact, or small footprint facilities that may be required for support of space launch or landing operations. Although not part of KSC's Master Plan and this

PEIS, Space Florida's proposed Shiloh Launch Complex is located within KSC's Operational Buffer/Public Use zone; Space Florida's proposal is currently being evaluated in a separate EIS by the FAA. See Section 3.2.2.

2.1.2 Future Development Plan

The Future Development Plan builds upon the core strategies described in the Future Development Concept (FDC) (NASA, 2011a), including:

- **Evolving toward a multi-user spaceport**: Moving from a monolithic NASA program field installation to a multi-user spaceport on federal property. The evolution to a multi-user spaceport is not necessarily timeline dependent, but rather based on increased users and operators in line with space market demand.

- **Going leaner and greener**: Operational, fiscal and environmental sustainability.

- **Divesting without diminishing**: Divesting of assets without eliminating capability to serve both critical government missions and programs while encouraging the growth of commercial space transportation market needs.

- **Ensuring the successful implementation of NASA Programs**. Such as the Launch Services Program, International Space Station, Space Launch System and Multi-Purpose Crew Vehicle.

Building upon this strategic foundation, the Future Development Plan describes the stages that would facilitate KSC's transformation to an economically sustainable multi-user spaceport. To support this transformation, the Future Development Plan outlines a comprehensive strategy that integrates development, land use, the consolidation of NASA assets, and transportation and utility infrastructure in order to support a multi-user spaceport which meets the strategies of the FDC by:

- Right-sizing NASA operations without impacting mission objectives
- Supporting the proliferation of non-NASA aerospace opportunities and partnerships at KSC.

2.1.2.1 Development Program

The CMP Update's Development Program describes the strategy that NASA must undertake to support the expansion of non-NASA operations at KSC (NASA, 2013e). A multi-user spaceport model is the foundation of KSC's future operational state, and the Development Program, used as an extension of the Asset Plan, outlines a strategy to sustain KSC's ability to meet current and future mission requirements; consolidate NASA's operations in fewer, more efficient and cost-effective facilities while maintaining technical capabilities; and address agency footprint reduction goals.

In support of this multi-user spaceport model it is essential that an analysis be completed to "right size" NASA operations at KSC in an effort to reduce NASA's footprint and consolidate operations into specific functional areas. The Development Program expands this analysis to the anticipated future list of users and their activities to describe possible future facility usage patterns at KSC. Development of the Central Campus is a major component in supporting the right-sizing efforts of KSC as a means to reduce operational overhead and support the transition to the multi-user model.

The Development Program describes continuing NASA programs and missions in the context of the planning horizon. These timeframes correspond to a phased approach that is not time-specific but dependent on federal funding, economic influences, and financial commitment from non-NASA entities:

- Baseline (2010)
- Near-Term
- Medium-Term
- Long-Term

NASA Programs that would be carried out at the KSC include:

- **Launch Services Program (LSP)**: provides safe, reliable, and cost-effective scheduled launch services for NASA and NASA-sponsored payloads seeking launch on expendable launch vehicles (ELVs).

- **International Space Station (ISS)**: is a habitable artificial satellite in Low Earth Orbit (LEO) whose first component was launched in 1998. Its mission is currently slated to conclude in the medium-term but could be extended into the long-term time frame.

- **Commercial Resupply Services (CRS)**: Provide for agreements between NASA and commercial entities to deliver cargo in support of ISS operations

- **Orion Multi-Purpose Crew Vehicle (Orion MPCV)**: The Orion MPCV is a spacecraft that would serve as the primary crew vehicle for mission beyond LEO. The spacecraft would serve as the exploration vehicle that would carry the crew to space, provide emergency abort capability, sustain the crew during the space travel, and provide safe re-entry from deep space return velocities. NASA conducted a successful unmanned test flight of the Orion spacecraft on December 5, 2014 (Figure 2.1-7).

- **Space Launch System (SLS)**: SLS is an advanced, heavy-lift launch vehicle that would carry the Orion/MPCV, as well as important cargo, equipment and science experiments, to deep space destinations.

- **Commercial Crew Program (CCP)**: Operating out of KSC, CCP supports the development of a commercial capability to safely launch crew to the ISS and low-earth orbit.

NASA administrative uses that would take place at KSC include such functions as executive management, operations support, and human resources.

Figure 2.1-7. Launch of Orion MPCV unmanned test flight, December 5, 2014

2.1.3 Launch, Landing, Operations and Support

2.1.3.1 Vertical Launch and Landing

2.1.3.1.1 Associated Activities

KSC plans on using a variety of areas around the Center for the vertical launch and landing of vehicles. This EIS will discuss the possible environmental impacts that performing vertical launches and landings would have at different areas across KSC.

Vertical launch is described as the activities that occur at the launch pad. These activities and characteristic events can include:

- Preparation for launch including fueling and testing operations
- Launch operations
- Noise and acoustics
- Recovery operations

Vertical landing is described as the activities that occur when a vehicle lands at a designated landing site. These activities can include:

  - Noise and acoustics
  - Safing operations
  - Transportation operations

Four possible classes of launch vehicles would perform vertical launch and landing at KSC: small, medium, heavy and super heavy class.

2.1.3.1.2 Small Class Launch Vehicle (SCLV)
SCLV's weigh up to 200,000 lbs. and have a thrust range up to 496,000 pound force (lbf). (The lfb is a unit of force equal to the gravitational force exerted on a mass of one avoirdupois pound on the surface of Earth.) Propellants used include Solid, RP-1, LOX, MMH, N2O4, N2H4, IPA, and LCH4. SCLV's can have from one to five stages.

2.1.3.1.3 Medium Class Launch Vehicle (MCLV)
MCLV's weigh between 200,000 - 798,000 lbs. and have a thrust range between 496,000 and 1.4 million lbf. Propellants used include Solid, RP-1, LH2, LOX, MMH, A-50, N2H4, N2H2, N2O4, and LCH4. MCLV's can have from one to four stages.

2.1.3.1.4 Heavy Class Launch Vehicle (HCLV)
HCLV's weigh between 798,000 lbs. and 1.2 million lbs. and have a thrust range between 1.4 million lbf and 1.9 million lbf. Propellants used include LOX, LH2, and RP-1.

2.1.3.1.5 Super Heavy Class Launch Vehicle (SHCLV)
SHCLV's weigh between 1.2 million and 2.4 million lbs. and have a thrust range between 1.9 million and 7.2 million lbf. Propellants used include Solid, LOX, LH2, RP-1, and LCH4. They have two stages.

Table 2.1-2 summarizes the major features of Vertical Launch Vehicle Classes.

Table 2.1-2. General characteristics of vertical launch vehicle classes

	SCLV	MCLV	HCLV	SHCLV
Max. Weight (lbs.)	200,000	798,000	1,200,000	2,400,000
Max Thrust (lbf)	496,000	1,400,000	1,900,000	7,200,000
Propellant Used	Solid/RP-1/LOX/ MMH/N2O4/N2H4/ IPA/ LCH4	Solid/RP-1/ LH2/ LOX/ MMH/A-50/ N2H4/N2H2/N2O4/LCH4	LOX/LH2/RP-1	Solid/LOX/LH2/RP-1/LCH4
Gases Used (up to 6,000 psi)	GN2/GHe/GH, Tridyne	GN2/GHe/GH, Tridyne	GN2/GHe/GH, Tridyne	GN2/GHe/GH, Tridyne
Launch Sites	USAF WR/USAF ER/ NASA's WFF/ Canary Islands/ Kwajalein	USAF WR/USAF ER/ NASA's WFF/ Canary Islands/ Kwajalein	USAF WR/USAF ER	USAF ER

2.1.3.2 Horizontal Launch and Landing

There are many different configurations and sizes of horizontally launched vehicles. Horizontal launch and landing of vehicles by Space Florid would increase SLF operations in the following broad categories: commercial spaceflight program and mission support aviation, aviation test operations including Unmanned Aerial Systems (UAS), airborne research and technology development and demonstration, parabolic flight missions, experimental spacecraft testing (e.g. Project Morpheus), and ground-based research and training. To take full advantage of the capabilities of the SLF, new construction by Space Florida would occur at both the south-field and mid-field sites. This EIS will discuss the possible environmental impacts of performing horizontal launches and landings across different areas of KSC.

Horizontal launch consists of those activities and events that occur at a horizontal spaceport before, during, and after a vehicle has taken off from the runway. These activities can include fueling and launch operations.

Horizontal landing consists of those activities and events that occur at a horizontal spaceport before, during, and after a vehicle has landed on the runway. These activities may include landing and safing operations.

Table 2.1-3. General characteristics of potential horizontal launch vehicles*

	Rocket Launch	Carrier Assist
Maximum Weight	600,000 lbs.	1,300,000 lbs.
Stages	3	1
Propellant Used	Solid(TP-H1260, class 1.3, HTPB)/RP-1/ LH2/ LOX/ MMH/A-50/N2H4/N2H2/N2O4/LCH4	Aviation Fuel, Jet A
Gases Used (up to 6000 psi)	GN2/GHe/GH, Tridyne	N/A
Launch Sites	SLF	SLF

Source: EIS Launch Vehicle Info (KSC, 2013a).
* Since the horizontal launch vehicle market is still in its early stages, this is an example of potential types of vehicles that could utilize this capability.

2.1.3.3 Launch Operations and Support

KSC plans on using a variety of areas around the Center for launch operations and support. Launch Operations apply to launch vehicles as well as the payload/spacecraft. Please see Figure 2.1-1 for these potential locations.

2.1.3.3.1 Launch Vehicle Operations

Launch vehicle operations entail transportation to the launch complex, command, control and telemetry feedback during the final launch operation. They also include the ancillary support operations such as security, SCAPE (self-contained atmospheric protective ensemble) team support, wildlife control, public viewing, theodolite shoots.

During launch operations, Mission Command & Control (MCC) broadcasts and receives Radio Frequency (RF) communications around KSC. Other operations around the Center must stand down as to not interfere with the launch or vice versa; the launch operations RF may interfere with other operations activities and potentially could ignite ordnance or create erroneous test results. During final alignment for Guidance, Navigation, and Control, there can be theodolite shoots which entail low power laser measuring devices. Lasers are pointed from specific points on the ground to points on the launch vehicle to help ensure that it is properly aligned.

2.1.3.3.2 Payload Operations

Payload operations entail the transportation to the launch complex for final integration or stowage, command, control and telemetry feedback from the payload/spacecraft during the final launch operations. Payloads fueled with hydrazine are transported across KSC to the launch complex. There may potentially be SCAPE support for fuel/oxidizer spills as well as security for transportation. Payloads with science experiments are transported for late stowage; these can include animals or other sensitive biological elements.

2.1.3.4 Assembly, Testing and Processing

KSC plans on using a variety of areas around the Center for manufacture, assembly, testing and processing. These activities include component testing, vibration analyses and ground support systems verification and validation. Please see Figure 2.1-1 for potential locations of these facilities.

2.1.4 Climate Change

Much of KSC land areas are low-lying, poorly drained, and vulnerable to inundation by periodic storm events. These low-lying areas are also most at risk to be affected by global climate change in future decades. Consistent with NASA land management practices and the Office of Strategic Infrastructure addressing a climate adaptation strategy, KSC would implement elevation-based zoning and development controls to insure that any future development is constructed at an elevation of six feet above mean sea level. Land areas that do not naturally offer this condition should be avoided or incur the cost of fill and drainage improvements, potentially making them economically less attractive. Areas of existing facilities or structures that are in 0-3 foot above mean sea level zones must be hardened or raised to accommodate future climate and weather or relocated to ground six feet or above. Critical facilities are to be moved outside the 500-year flood plain or, if not practicable, hardened to withstand a hurricane event.

2.1.5 Functional Area Plans

Existing development is characterized by concentrations of similar functions and activities, that is, by functional areas. Functional areas are also a means to describe future asset and facility strategies. Facility and asset specific planning actions corresponding to planning timeframes, providing additional detail within land use areas/districts correlated to facility footprints and site plans area organized by functional area.

Concentrations of functions and uses correspond to the following functional areas:

- Industrial Area
- Exploration Park
- Vehicle Assembly Building (VAB) Area
- Contractors Road Area
- Launch Complex - 39B
- Launch Complex - 39A
- Launch Complex - 41
- Shuttle Landing Facility (SLF) Area
- Central Telemetry Area (TEL IV)
- KSC Visitor Complex
- Kennedy Athletic & Recreation Social Park (KARS) Area
- CCAFS - Industrial Area

2.1.6 Future Transportation Plan

2.1.6.1 Overview

The Transportation Plan component outlines opportunities and planning initiatives that would build upon the quinti-modal baseline to expand the strategic advantage of the transportation network as a mechanism of KSC's evolution to a multi-user spaceport. These future transportation planning initiatives are intended to guide the decision-making process with the primary purpose of right-sizing NASA operations at KSC while meeting the expected transportation and logistics demands of both the NASA and non-NASA users. To achieve these ends, the Master Plan Update furthers the existing discussion of transportation infrastructure divestiture and has identified additional transportation elements and modifications that would support the expansion of transportation capabilities to meet the demands of future operations at KSC (NASA, 2013e).

2.1.6.2 Roads and Bridges

2.1.6.2.1 Roads

Road Improvements
Over the next five years, repair and resurfacing of over 29 miles of Kennedy Parkway is anticipated. Repair and resurfacing is also planned for over three miles of NASA Parkway east of Kennedy Parkway. The two and four-lane sections east of the Industrial Area toward the Banana River Bridge would also be repaired.

Central Campus
In support of the Central Campus concept, the near term would see the elimination of D Avenue access between NASA Parkway and 2nd Street SE to clear the way for construction on Central Campus Phase 1. The north segment of this road would be used for access to parking to the new facility.

As the Central Campus concept develops over the medium and long term, additional infrastructure changes may be required to support the consolidation and security of NASA operations in the area.

Road Easements

<u>Contractor's Road Expansion</u>
A road easement should be recognized that would make it possible, if future demand requires, having access to new development capabilities contributing to non-NASA vertical launch support operations. This easement would support access to new development and serve as a barrier to further development east.

<u>Access to New Vertical Launch Capabilities</u>
To further promote KSC's multi-user concept, a commercial entity may require the development of new vertical launch capabilities that meet their specific needs. Should the market necessitate this expansion, the development would be directed to areas north of LC39B along Beach Road. To support this added capability, a road easement is proposed that would support access from Beach Road to the pad location with such a road expansion being funded by a Non-NASA entity.

2.1.6.2.2 Bridges
Current plans call for a complete replacement of both the eastbound and westbound spans of the Indian River Bridge by fiscal year 2025. The current bascule configuration is planned to be replaced with a fixed high-span configuration meeting Coast Guard regulations. These regulations require a minimum of 65 feet of vertical clearance above the mean high water line and a required horizontal clearance of 125 feet.

The Haulover Canal Bridge (Figure 2.1-8) and the Banana River Bridge are also scheduled for replacement by 2032.

Figure 2.1-8. Haulover Canal Bridge

2.1.6.2.3 Divestiture

Road Divestiture
A majority of the roads at KSC are the product of the intense federal investment in infrastructure that was made at the dawn of the space program in the 1960's. At that time, Merritt Island was sparsely populated and the space program required significant federal dollars to achieve its ends. However, at present, many miles of those federal roads have uses that other than NASA programs and operations. In efforts to right-size NASA and decrease the funding allocated to infrastructure – that is used by the Space Center and the community as a whole – it is essential that the agency dedicate its attention and energies to supporting the divestiture of the road infrastructure as long as it meets two criteria:

1. Divestiture would not impact the security of NASA programmatic activities, including launches
2. Divestiture would not impact the operations of NASA programs

The identified roads that that meet these criteria are:

- Titusville Road
- Beach Road
- Space Commerce Way

Additionally, the following road segments have also been identified as candidates for divestiture with only the portions of the road outside of the secured perimeter meeting both criteria. These segments include:

- Kennedy Parkway North from the north property line to Beach Road
- Kennedy Parkway South from the south property line to Space Commerce Way
- NASA Parkway from the western property line to Space Commerce Way

While the initial exercise of this divestiture process would be complicated, it would provide the benefit of allowing NASA to redirect resources to programmatic objectives and provide a process that would support additional transportation divestiture activities as the multi-user spaceport model evolves. The advantages of a quinti-modal spaceport are both accessibility related and financial in nature. Leveraging federal, state and other public funding options increases the viability and sustainability of the multi-user spaceport.

Bridge Divestiture

All of the bridges serving KSC are close to the end of their design life and require increasing resources to support operations and maintenance activities in order to prolong that design life. Currently, recapitalization plans call for replacement of most bridges during the medium and long term planning horizons at a large expense to NASA. In the near term, it is necessary to begin dialogue to divest bridge infrastructure to a non-NASA, public entity. Divesting these assets would allow NASA to reinvest some, or all, of these resources to meeting programmatic and operational objectives.

Currently, the assets which, if divested, would have the least impact on NASA missions have been identified as:

- Indian River Bridge, eastbound
- Indian River Bridge, westbound
- Haulover Canal Bridge

Rail Divestiture

The KSC rail system, including the Jay Jay Railroad Bridge, is not a requirement of NASA Programs until approximately 2017 at the earliest. Replacement possibilities are currently being determined and would be based on the functional requirements of the SLS Program. However, there is an opportunity to leverage the cost of replacement with the granting of a rail easement that would provide a rail connection between the Florida East Coast railway and Port Canaveral via the KSC railroad. Such an approach would support Port Canaveral's ability to increase market competitiveness while potentially retaining a strategic transportation asset and allowing for greater rail and sea access to KSC for the emerging market. The environmental impacts of this divestiture and the construction and operation of a rail connection between Port Canaveral and KSC are the subject of a separate environmental impact statement that is currently underway by the U.S. Surface Transportation Board. See Section 3.2.3 in this PEIS for a description of that EIS.

2.1.6.2.4 Parking

In the near term, as developable land is limited due to environmental concerns, underutilized parking areas should be identified as possible sites for non-NASA entities to build parking facilities (e.g., multi-level structures) to support their operations.

The possibility of utilizing partnerships in the near term to repurpose underutilized parking areas in support of agency sustainability goals is an ideal alternative. One such opportunity would involve leasing space to commercial companies who can develop solar-powered electrical vehicle charging stations that would be available to employees and visitors of NASA facilities. Such infrastructure would support the utilization of alternative fueled vehicles amongst the workforce at minimal cost to the agency.

Underutilized parking facilities that are unable to be repurposed should, ideally, be demolished to increase permeable land on Center as a suitable alternative to being abandoned in place.

2.1.6.3 Water

Access via waterways is a primary transportation capability at KSC. Currently, waterway access is limited to the Turn Basin in the VAB Area and the wharf at Hangar AF on the CCAFS. The expansion of this capability to other functional areas at KSC would be appropriate if the market demands such a capability. To support the expansion of this transportation capability, the Master Plan has identified three areas with potential future rail spurs that would be ideal for the development of additional seaports to support future Non-NASA spaceport operations.

- An area adjacent to the Industrial Area provides water access to future manufacturing and research and development areas on the east side of the Center.
- A seaport accessing the west side of the SLF would provide access to the mode for operations there.
- An expansion of the Turn Basin capability could provide increased access from the Banana River Channel to the VAB area.

These new seaports, if future market demand exists, would be funded by non-NASA sources.

2.1.6.4 Air

2.1.6.4.1 Runways

It is anticipated that over the near, medium, and long term, the SLF would be utilized mainly for Horizontal Launch and Landing activities. The 2012 update to the Horizontal Launch and Landing ADP recommended improvements to the SLF in four phases at 5-year, 10-year, and 20-year intervals. Modifications to facilities, infrastructure, the runway, and other airfield systems are planned to primarily support commercial aerospace activities. Plans include an expansion of hangars and taxiways, new fuel storage facilities, and updated storm water systems.

To support the expansion of the Horizontal Launch and Landing capability, a location for a new east-west runway east of the SLF has been identified south of Beach Road should the non-NASA operator of the SLF determine an expansion of capacity is necessary.

2.1.6.4.2 Airspace

Airspace and safety criteria for the SLF would continue to be in accordance with Federal Aviation Regulation (FAR) Part 77 Airport Aeronautical Surfaces and Airspace.

2.1.7 Environmental Remediation

Numerous sites are known to have been environmentally contaminated by past practices, which under the Proposed Action, would continue to be monitored and remediated proportional to available funding. Environmental baseline studies documenting existing conditions and identification of any past contamination would be carried out by NASA prior to allowing any new uses to develop or redevelop KSC property and facility sites. Any new users would accept liability for their future activities, outlined in a corresponding commercial agreement.

2.1.8 Strategic Partnerships

KSC cultivates strategic partnerships with other federal, state, public, private and academic organizations to capitalize on complementary strengths of each organization in managing the Kennedy Space Center. Under the Proposed Action, KSC would continue to invest in existing partnerships, such as those with Cape Canaveral Air Force Station (CCAFS, an installation of the U.S. Air Force Space Command’s 45th Space Wing, headquartered at nearby Patrick Air Force Base), Brevard County government, National Park Service – Canaveral National Seashore, U.S. Department of Energy, Federal Aviation Administration (FAA) Office of Commercial Space Transportation (FAA-AST), Florida Department of Transportation (FDOT) , U.S. Fish and Wildlife Service – Merritt Island National Wildlife Refuge, and Patrick Air Force Base (PAFB).

Some of these partnering agencies have permitting authority. Under the Proposed Action, for example, as a multiuser spaceport, future commercial space customers would be subject to FAA licensing, including Order 1050.1E, as well as Section 4(f) eventually. Projects that require FAA licensing, and U.S. DOT Section 4(f) review at KSC, with NASA as the jurisdictional authority, would be covered in more specific detail in EAs that tier off of this PEIS.

2.2 Alternative 1

Section 1.4 1 of this PEIS states: “Input from scoping thus helps shape the direction that analysis takes, helping analysts decide which issues merit consideration. Public input also helps in the development of alternatives to the proposed action, which is an integral part of NEPA.”

The KSC Center-wide PEIS began once the KSC Master Plan was released in May 2014. As a part of this process, the Master Plan and the proposed future land use map were reviewed by cooperating agencies and the general public. As a direct result of input and feedback received from the public and stakeholders the PEIS scoping process, an alternative to the proposed action was developed. This alternative is illustrated on Future Land Use Map Alternative 1 (Figure 2.2-1). Alternative 1 was crafted as a direct response to concerns expressed in comments received during the PEIS public scoping period in June 2014, as well as other observations and data acquired from stakeholders and other agencies during the scoping process. Future Land Use Map Alternative 1 consists of four major land use changes:

- <u>Vertical Launch</u>: The two vertical launch areas northwest of Pad 39-B were consolidated into one contiguous notional area, LC-49, with greater separation from 39-B. The launch area south of 39-A has been designated LC-48. Based on public and cooperating agency comments, Spaceport Planning determined that two launch pads in this area were not feasible; one larger notional area also provides a wider range of development options for a non-NASA entity to develop vertical launch capabilities based on its concept of operations, launch trajectory, rocket type, etc.

- <u>Vertical Landing</u>: The vertical landing area was condensed and moved farther south away from the Canaveral National Seashore to potentially reduce impacts to recreational access and park operations. Relocating this land use closer to the vertical launch area provides opportunities to co-locate this capability next to a vertical launch area for more efficient operations.

- <u>Horizontal Launch & Landing</u>: The horizontal launch and landing area adjacent to Beach Road was condensed and changed to “Notional Future Horizontal Launch Area.” Based on public and agency comments, this large area of a land use could potentially deter recreational access to the Canaveral National Seashore and also duplicate capabilities that exist elsewhere. Establishing this as “notional future horizontal launch” preserves the ability to develop this area in the future once/if horizontal launch technological capabilities advance to the point of making this area feasible to develop.

- <u>Seaport</u>: Two areas designated as seaports, one southwest of the SLF along the Indian River and one southeast of the Industrial Area along the Banana River, were eliminated. Based on public and cooperating agency comments, the development of these two seaports would require additional dredging of the Indian and Banana Rivers. Along with upgrades occurring at the turn basin, the Spaceport Planning Office determined that the environmental costs associated with the construction of two additional seaports were too great.

All other elements of Alternative 1 would be essentially same as the Proposed Action. That is, under Alternative 1, KSC would also transition over a 20-year period (2012-2032) to a multi-user spaceport. The revised KSC Master Plan in this alternative would continue to promote the right-sizing of NASA operations at KSC – consolidation into a smaller geographic footprint – and aim to attract non-NASA investment by providing them more operational autonomy. The Future Development Plan; Launch, Landing, Operations and Support; climate change adaptations; Functional Area Plans (except as noted above) and Transportation Plan under Alternative 1 would be essentially the same as under the Proposed Action.

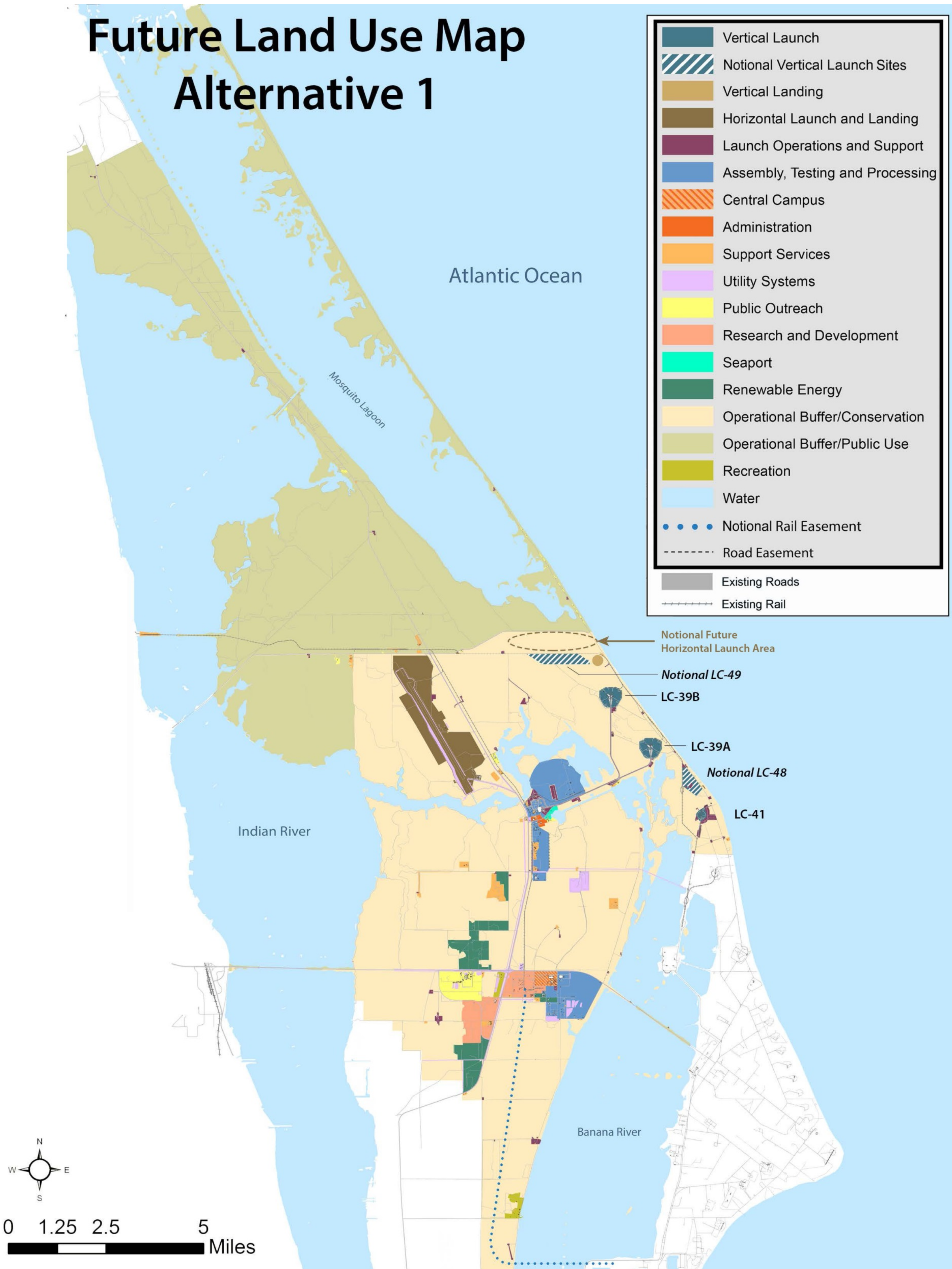

Figure 2.2-1. Proposed future land use at the Kennedy Space Center under Alternative 1

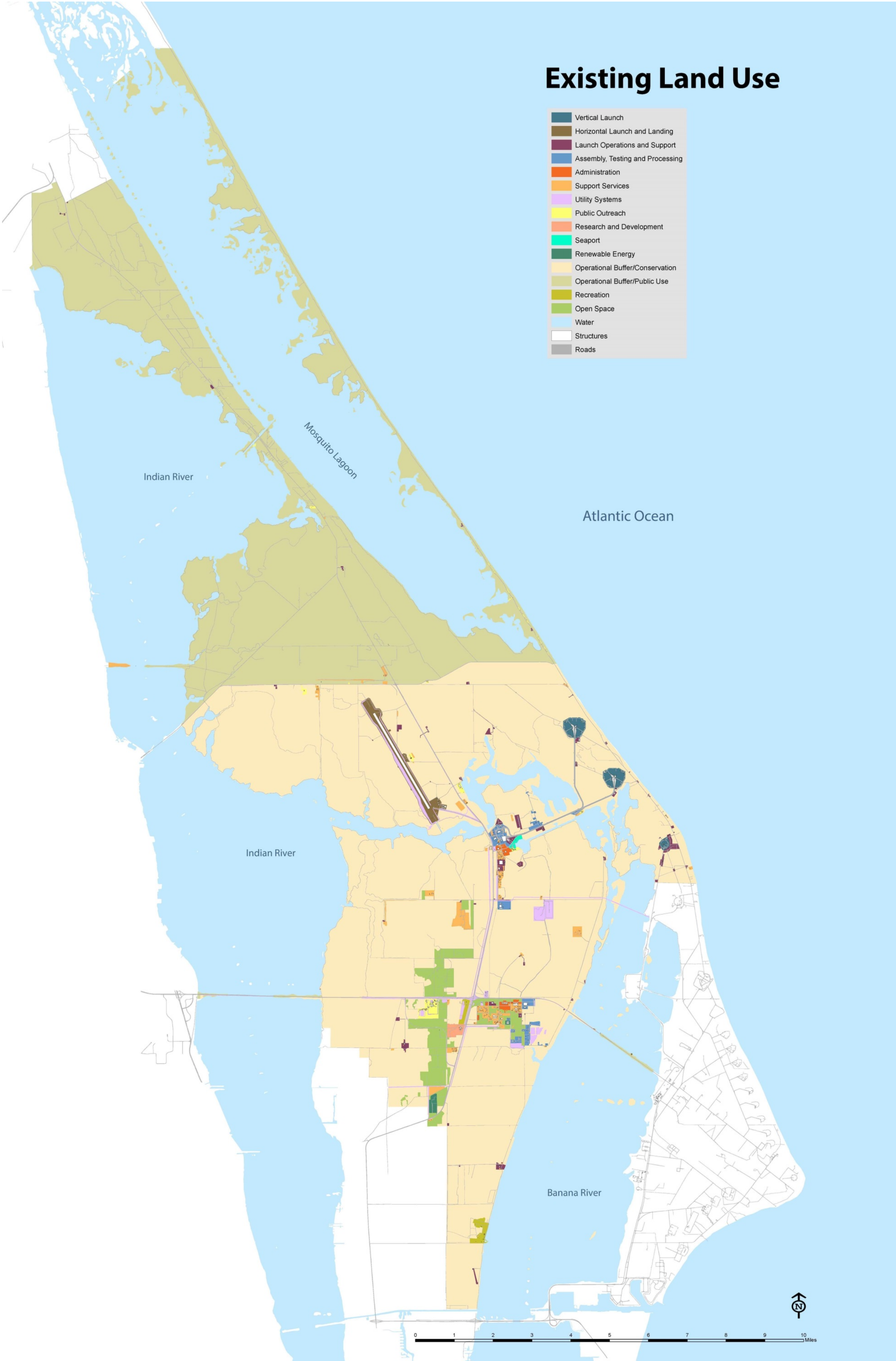

Figure 2.3-1. Existing land use at the Kennedy Space Center – maintained under the No Action Alternative

Table 2.2-1. Existing and proposed future land uses at KSC under Alternative 1

Land Use	Existing Acreage	Future Acreage	Change in Acreage*
Administration	104.76	40.72	**-64.03**
Assembly, Testing and Processing	475.41	1,894.77	**1,419.36**
Central Campus	NA	138.75	**138.75**
Horizontal Launch and Landing	501.25	1,806.62	**1,305.37**
Launch Operations and Support	398.75	491.59	**92.84**
Open Space	1,873.64	NA	**-1,873.64**
Operational Buffer/Conservation	44,583.14	41,297.17	**-3,285.97**
Operational Buffer/Public Use	34,844.14	34,824.72	**-19.42**
Public Outreach	216.01	522.13	**306.12**
Recreation	161.36	161.36	**0.00**
Renewable Energy	66.54	1,109.85	**1,043.31**
Research and Development	88.36	867.49	**779.13**
Seaport	30.92	30.92	**0**
Support Services	723.91	471.40	**-252.51**
Utility Systems	1,327.23	1,329.60	**2.37**
Vertical Launch	360.32	728.08	**367.76**
Vertical Landing	NA	40.56	**40.56**
Water	55,541.81	55,541.81	**0.00**
Total	**141,297.54**	**141,297.54**	**0**

Total difference in size between each existing land use category and future land use category. Numbers in red represent a future land use category that is **SMALLER than its existing category while numbers in green signify that the future land use category contains a **LARGER** amount of acres than its existing land use category.*

2.3 No Action Alternative

2.3.1 Overview

The National Environmental Policy Act requires that an agency "include the alternative of no action" as one of the alternatives it considers (40 CFR 1502.14[d]). The No Action Alternative serves as a baseline against which the impacts of the Proposed Action and other action alternatives are compared. Under the No Action Alternative for this PEIS, the status quo at KSC would be maintained and the proposed future (2012-2032) developments described in the 2013 Center Master Plan Update (the Proposed Action) would not proceed or be implemented.

In the No Action Alternative (Figure 2-3.1), KSC management would continue its emphasis on dedicated NASA Programs and would not transition in the coming years towards a multi-user spaceport controlled by an independent spaceport authority with fully integrated NASA

Programs and non-NASA users. Rather, each NASA Program would continue to be operated as an independent entity to a significant degree, to be funded separately, and to manage activities and buildings in support of its own program. There would continue to be a limited non-NASA presence at KSC.

Under the KSC-MINWR agreement between NASA and USFWS, the USFWS manages all non-operational areas of KSC (both inside and outside of the Security Area) and maintains some wildlife responsibilities within the operational areas. Further, both NPS and USFWS have management responsibilities in the CNS/MINWR overlap area, with the USFWS generally managing east of Beach Road and with NPS taking the lead on cultural resources in the overlap. Thus, the USFWS/MINWR has management lead for approximately135,000 acres of non-operational areas and has some responsibilities within the extracted areas (approximately 5,000 acres) at KSC. CNS and MINWR overlap on approximately 34,345 acres.

An Interagency Management Agreement is the current vehicle under which the USFWS and NASA operate at MINWR; an original permit was replaced by this agreement, which has been updated over time. Jurisdictional overlaps and overlays at KSC, MINWR, and CNS are complicated and can be confusing, but the three agencies have collaborated successfully as partners for decades. As shown in Figure 1.2-1, areas may be KSC/MINWR, KSC/CNS, KSC/MINWR/CNS, CNS only, or MINWR only.

Under the No Action Alternative (as well as the Proposed Action and Alternative 1), these institutional arrangements and agreements would stay in place. The total land and water area under jurisdiction of KSC would remain at approximately 140,000 acres. Of this total area, about 85,000 acres would continue to be owned by NASA and the remaining 55,000 acres by the State of Florida and dedicated for the exclusive use of the U. S. Government under Deeds of Dedication. This entire 140,000-acre area, in association with adjacent water bodies, would continue to serve as buffer zones to afford adequate safety to the surrounding civilian communities for vehicle launches and other KSC activities. A portion of the seashore on the eastern edge of the Center would continue to be available for public recreation purposes on a non-interference basis. It is further assumed that the KSC workforce would remain under 13,000, of which approximately 2,100 are employees of the federal government, and the remainder employees of companies working under contract to NASA or other federal agencies.

The environmental, social, and economic conditions described as the affected environment would not be affected by construction or operations as described under the Proposed Action or Alternative 1. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Individual actions proposed from the Proposed Action or any of the alternatives may proceed but would have to do so after environmental assessment under separate environmental documentation.

2.3.2 Land Use

Under the No Action Alternative, current land uses and their configuration at KSC would remain unchanged for the duration of the 20-year planning horizon (2012-2032). Existing land uses are shown in Figure 2.2-1. The same land use classifications are used to describe the primary activity of all existing facilities and associated land areas as are used in the Proposed Action above.

2.3.3 Transportation

KSC's transportation infrastructure is one of the most unique systems in the world, incorporating five modes of transportation: roads, rail, air, sea and space. This quinti-modal transportation system is an integral component of Florida's Strategic Intermodal System (SIS), which integrates individual facilities, services, forms of transportation (modes) and linkages into a single, integrated transportation network (NASA, 2013e).

Under the No Action Alternative, the existing KSC transportation system would remain essentially unchanged except for routine maintenance.

2.3.4 Environmental Remediation

Numerous sites are known to have been environmentally contaminated by past practices, which under the No Action Alternative (as well as the Proposed Action and Alternative 1), would continue to be monitored and remediated proportional to available funding. Environmental baseline studies documenting existing conditions and identification of any past contamination would be carried out by NASA prior to allowing any new uses to develop or redevelop KSC property and facility sites. Any new users would accept liability for their future activities, outlined in a corresponding commercial agreement.

2.3.5 Climate Change

Much of KSC's land area is low-lying, poorly drained, and vulnerable to inundation by periodic storm events. Low-lying areas are also most at risk to be affected by global climate change and sea level rise in future decades. Under the No Action Alternative, KSC would not implement elevation-based zoning and development controls to insure that any future development is constructed at an elevation of six feet above mean sea level, although this would not be consistent with NASA land management practices and Office of Strategic Infrastructure climate adaptation guidance and strategy. Areas of existing facilities or structures that are in 0-3 foot above mean sea level zones would not be hardened or raised to accommodate future climate and weather, nor would they be relocated to ground at or above six feet MSL. Critical facilities would not be moved outside the 500-year flood plain or hardened to withstand a hurricane activity.

2.3.6 Strategic Partnerships

KSC cultivates strategic partnerships with other federal, state, public, private and academic organizations to capitalize on complementary strengths of each organization in managing the Kennedy Space Center. Under the No Action Alternative, KSC would continue to invest in existing partnerships, such as those with Cape Canaveral Air Force Station (CCAFS, an installation of the U.S. Air Force Space Command's 45th Space Wing, headquartered at nearby Patrick Air Force Base), Brevard County government, National Park Service – Canaveral National Seashore, U.S. Department of Energy, Federal Aviation Administration (FAA) Office of Commercial Space Transportation (FAA-AST), Florida Department of Transportation (FDOT) , U.S. Fish and Wildlife Service – Merritt Island National Wildlife Refuge, and Patrick Air Force Base (PAFB).

2.3.7 NASA Programs

In the No Action Alternative, the following continuing NASA Programs would be the principal users of KSC facilities. These are existing programs that are also listed and described briefly above as part of the Proposed Action.

- Launch Services Program (LSP)
- International Space Station (ISS)
- Commercial Resupply Services (CRS)
- Orion Multi-Purpose Crew Vehicle (Orion MPCV)
- Space Launch System (SLS)
- Commercial Crew Program (CCP)

Ongoing NASA administrative uses that would continue to occur at KSC under the No Action Alternative include such functions as executive management, operations support, and human resources.

2.3.8 Launch, Landing, Operations and Support

Under the No Action Alternative, KSC would continue to use a variety of areas around the Center for the vertical launch and landing of vehicles. In general, vertical launch and landing of NASA missions and non-NASA commercial missions under the No Action Alternative would take place at a reduced rate or frequency (launches/landings per year) from that anticipated under the Proposed Action.

Under the No Action Alternative, in contrast to the Proposed Action, no new construction would occur at both the south-field and mid-field sites along the SLF.

All existing vehicles that currently launch and/or land at KSC (and are listed and described under the Proposed Action) would continue to do so under the No Action Alternative, and at current levels of activity.

KSC would continue to use a variety of areas around the Center for assembly, testing and processing (described above in Section 2.1.4.4) under the No Action Alternative.

2.4 Agency-Preferred Alternative

NASA's preferred alternative is Alternative 1. This alternative would allow for implementation of the CMP while at the same time protecting natural resources and the environment to a greater extent than the Proposed Action.

2.5 Alternatives Considered But Eliminated

NEPA provides guidance on alternatives development. Reasonable alternatives include those that are practical or feasible from technical and economic standpoints and using common sense, rather than simply being desirable. All reasonable alternatives must fulfill the program's purpose and need, as well as address significant environmental issues. The selection of alternatives under NEPA criteria includes consideration of a reasonable range of alternatives that meet the program purpose and need and that are economically and technically feasible.

A number of alternatives suggested during scoping or otherwise developed have been eliminated from detailed study. These alternatives were evaluated using the following criteria to determine which alternatives would be addressed in detail in the Draft PEIS and which would be eliminated from detailed study:

1. Does the alternative meet the program purpose and need?
2. Does the alternative resolve environmental or resource conflicts?
3. Is the alternative available? and/or
4. Is the alternative feasible, in terms of cost, current technology, and logistical capability?

These criteria were used to narrow the list of potential alternatives for consideration in the Draft PEIS and based upon these criteria, the following alternatives were considered but eliminated from further study:

Alternatives Based on Differential Flight Rates. One of the possible ways of delineating action and no-action alternatives would have been to base them on the High, Assumed, and Low Flight Rates shown for the different categories of operations/missions in the table labeled "2012-2031 Planning Envelope Forecasts, Average Annual Launch/Landing Flight Operations Departing from or Arriving at KSC" in the Future Development Concept. However, the figures shown in this table were too conjectural.

Alternative Based on Shifting Activities, Facilities and Infrastructure to CCAFS. It was suggested in certain comments received during public scoping that NASA could reduce future impacts to biological resources and outdoor recreation at Merritt Island National Wildlife Refuge and Canaveral National Seashore by shifting a portion of its activities (e.g., launches), facilities and infrastructure to already-developed sites at the CCAFS.

This alternative was considered but not subjected to detailed analysis along with the Proposed Action and No Action Alternatives because of the different overall mission of the Department of

Defense (DOD). While CCAFS and KSC coexist successfully on a daily, routine basis, sharing close proximity and several leased facilities, as well as interconnected infrastructure systems, CCAFS abides by different operational standards with different primary objectives than NASA and its commercial partners. These differing missions and philosophies do not support shifting a high number of NASA activities to land and facilities operated on CCAFS.

2.6 Comparison of Alternatives

This section compares the three alternatives – Proposed Action, Alternative 1, and No Action – considered and evaluated in some detail in Chapter 3. Table 2.5-1 compares the acreages of the designated land uses at KSC proposed under each of the three alternatives. Table 2.5-2 is the impact comparison matrix, which summarizes the environmental consequences discussed for each of the alternatives in Chapter 3.

Table 2.6-1. Acreages of designated land uses at KSC under the three alternatives

Land Use	Proposed Action	Alternative 1	No Action
Administration	40.72	40.72	104.76
Assembly, Testing and Processing	1,894.77	1,894.77	475.41
Central Campus	138.75	138.75	NA
Horizontal Launch and Landing	2,838.84	1,806.62	501.25
Launch Operations and Support	506.14	491.59	398.75
Open Space	NA	NA	1,873.64
Operational Buffer/Conservation	40,196.64	41,297.17	44,583.14
Operational Buffer/Public Use	34,824.72	34,824.72	34,844.14
Public Outreach	522.13	522.13	216.01
Recreation	161.36	161.36	161.36
Renewable Energy	1,109.85	1,109.85	66.54
Research and Development	867.49	867.49	88.36
Seaport	317.26	30.92	30.92
Support Services	471.40	471.40	723.91
Utility Systems	1,329.60	1,329.60	1,327.23
Vertical Launch	536.42	728.08	360.32
Vertical Landing	75.73	40.56	NA
Water	55,541.81	55,541.81	55,541.81

Table 2.6-2. Impact comparison matrix

Impact Topic	Proposed Action	Alternative 1	No Action
Soils and Geology	• Impacts on upland and wetland soils and geology from clearing, grubbing, grading, excavating, and filling. • Ground-disturbing construction activities would occur in some areas where soils have previously been disturbed, but activities would also occur in undisturbed areas. • Soil erosion from use of heavy equipment could occur as a result of ground disturbance leading to detachment of soils and transport of freshly disturbed surfaces in wind and storm flow runoff. • Disturbing soils could create habitat for colonization by invasive species. • Spills and leaks of hazardous materials during construction could lead to soil contamination and toxicity. • Best Management Practices (BMPs) would be implemented during project activities to prevent or reduce soil erosion into water surfaces and minimize adverse soil impacts. • Potential indirect effects of soil destabilization and erosion would be dust generation and	• Impacts on upland and wetland soils and geology from clearing, grubbing, grading, excavating, and filling. • Ground-disturbing construction activities would occur in some areas where soils have previously been disturbed, but activities would also occur in undisturbed areas. • Soil erosion from use of heavy equipment could occur as a result of ground disturbance leading to detachment of soils and transport of freshly disturbed surfaces in wind and storm flow runoff. • Disturbing soils could create habitat for colonization by invasive species. • Spills and leaks of hazardous materials during construction could lead to soil contamination and toxicity. • Best Management Practices (BMPs) would be implemented during project activities to prevent or reduce soil erosion into water surfaces and minimize adverse soil impacts. • Potential indirect effects of soil destabilization and erosion would be dust generation and off-site	• Soils and geology would not be affected by construction or operations from new projects described under the Proposed Action. • Any existing activities or operations would occur in accordance with existing laws and permits and within the footprint of existing developed areas. • Effects on soils and geology from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. • The No Action Alternative would not have any additional impacts on soils and geology.

Impact Topic	Proposed Action	Alternative 1	No Action
Soils and Geology (continued)	off-site deposition. • Impacts of proposed project activities on soils and geology would be short-term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, types of soils occurring onsite, and whether impervious surfaces would be placed over soils and geological materials. • Impacts on soils and geology would be less than significant. • Vertical and horizontal launches may result in local adverse impacts on soils and geology from the deposition of rocket engine emissions (e.g., acids, various metals, and other substances); elevated metal concentrations and changes in soil pH would be expected from such deposition within a small radius of the launch pad. • Overall effects of vertical and horizontal launches and landings on soils and geology are expected to be short-term to medium-term, direct, adverse, and minor to moderate. Impacts would be less than significant. • On a regional scale, there would	deposition. • Impacts of proposed project activities on soils and geology would be short-term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, types of soils occurring onsite, and whether impervious surfaces would be placed over soils and geological materials. • Impacts on soils and geology would be less than significant. • Vertical and horizontal launches may result in local adverse impacts on soils and geology from the deposition of rocket engine emissions (e.g., acids, various metals, and other substances); elevated metal concentrations and changes in soil pH would be expected from such deposition within a small radius of the launch pad. • Overall effects of vertical and horizontal launches and landings on soils and geology are expected to be short-term to medium-term, direct, adverse, and minor to moderate. Impacts would be less than significant. • On a regional scale, there would	

Impact Topic	Proposed Action	Alternative 1	No Action
Soils and Geology (continued)	be additional minor, adverse cumulative effects on soils and geology. With the utilization of BMPs that are a requirement of any major construction project, these adverse impacts, though widespread, would not be significant.	be additional minor, adverse cumulative effects on soils and geology. With the utilization of BMPs that are a requirement of any major construction project, these adverse impacts, though widespread, would not be significant. • Overall impacts of Alternative 1 on soils and geology would be slightly less than the Proposed Action.	
Water Resources	• Erosion caused by site runoff and contamination by chemical spills could impact surface water quality. • Non-point sources could potentially impact surface and ground water quality, such as oil and grease from paved street and road surfaces that wash into a water body or are absorbed into the water table. • Impervious or semi-impervious surfaces would likely contribute to more surface drainage than at present. • Elevated levels of turbidity from erosion could also lead to decreases in primary production and dissolved oxygen levels. There could also be increased short-term fine sediment and loss	• Erosion caused by site runoff and contamination by chemical spills could impact surface water quality. • Non-point sources could potentially impact surface and ground water quality, such as oil and grease from paved street and road surfaces that wash into a water body or are absorbed into the water table. • Impervious or semi-impervious surfaces would likely contribute to more surface drainage than at present. • Elevated levels of turbidity from erosion could also lead to decreases in primary production and dissolved oxygen levels. There could also be increased short-term fine sediment and loss	• Water resources would not be affected by construction or operations from new projects described under the Proposed Action. • Any existing activities or operations would occur in accordance with existing laws and permits. • Existing uses would continue at current levels. Effects on water resources from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. • Would not have any additional impacts on water

Impact Topic	Proposed Action	Alternative 1	No Action
Water Resources (continued)	of benthic food resources. • Some risk of an accidental fuel or chemical spill, which could adversely affect water quality if the spill were to enter ground or surface water. • BMPs limiting the amount of disturbance to just the project footprint would be implemented to reduce adverse impact to wetlands, floodplains, and riparian areas, but there could still be some adverse effects that would be inevitable. • Impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, and proximity to surface water. • Impacts on water resources would be less than significant with implementation of BMPs and adherence to permit conditions. • Vertical & horizontal launches may result in local adverse impacts on freshwater and marine systems, from deposition associated with rocket engine emissions, the deposition of	of benthic food resources. • Some risk of an accidental fuel or chemical spill, which could adversely affect water quality if the spill were to enter ground or surface water. • BMPs limiting the amount of disturbance to just the project footprint would be implemented to reduce adverse impact to wetlands, floodplains, and riparian areas, but there could still be some adverse effects that would be inevitable. • Impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, and proximity to surface water. • Impacts on water resources would be less than significant with implementation of BMPs and adherence to permit conditions. • Vertical & horizontal launches may result in local adverse impacts on freshwater and marine systems, from deposition associated with rocket engine emissions, the deposition of spent	resources. • However, the long-term cumulative impacts on water quality in the IRL described under the Proposed Action could still well occur if other reasonably foreseeable projects were to take place and if population projections and associated development are realized in the decades ahead, fostering increases in non-point source pollution that have already damaged the lagoon.

Impact Topic	Proposed Action	Alternative 1	No Action
Water Resources (continued)	spent launch vehicle equipment, or landing of a reentry vehicle or its associated equipment. • At launches, deluge and washdown water would be supplied by the existing water distribution system and would have a negligible impact on system capacity or surface and groundwater resources. • Wastewater would be processed through the existing wastewater handling and treatment systems. Local and regional water resources would not be affected since there would be no substantial increase in use of surface or groundwater supplies. • Minimal adverse impacts to water resources from contaminated water are expected to result from launch operations. • Impacts from HCl (formed during rocket launches) on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A normal launch would	launch vehicle equipment, or landing of a reentry vehicle or its associated equipment. • At launches, deluge and washdown water would be supplied by the existing water distribution system and would have a negligible impact on system capacity or surface and groundwater resources. • Wastewater would be processed through the existing wastewater handling and treatment systems. Local and regional water resources would not be affected since there would be no substantial increase in use of surface or groundwater supplies. • Minimal adverse impacts to water resources from contaminated water are expected to result from launch operations. • Impacts from HCl (formed during rocket launches) on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A normal launch would have no substantial	

Impact Topic	Proposed Action	Alternative 1	No Action
Water Resources (continued)	have no substantial impacts on local water quality. • Launch accidents could result in impacts on local water bodies due to contamination from rocket propellant. • Overall, impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of water to the launch or landing sites. Impacts on water resources would be less than significant. • Direct cumulative impacts from reasonably foreseeable projects are likely to be minor and adverse. • To the extent that reasonably foreseeable projects contribute to long-term economic and population growth and development of the Space Coast region, they may contribute indirectly to continuing cumulative impairment of the Indian River Lagoon complex as a result of an increase in the area of impervious surfaces and non-point source loadings of	impacts on local water quality. • Launch accidents could result in impacts on local water bodies due to contamination from rocket propellant. • Overall, impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of water to the launch or landing sites. Impacts on water resources would be less than significant. • Direct cumulative impacts from reasonably foreseeable projects are likely to be minor and adverse. • To the extent that reasonably foreseeable projects contribute to long-term economic and population growth and development of the Space Coast region, they may contribute indirectly to continuing cumulative impairment of the Indian River Lagoon complex as a result of an increase in the area of impervious surfaces and non-point source loadings of sediments, nutrients, and contaminants.	

Impact Topic	Proposed Action	Alternative 1	No Action
Water Resources (continued)	sediments, nutrients, and contaminants.	• Overall impacts of Alternative 1 on water resources would be slightly less than the Proposed Action.	
Hazardous Materials and Waste	• The impact of transitioning to a multi-user spaceport on hazardous materials and waste is confined to an increase in quantity, rather than an influx of new materials. Those materials considered as part of the proposed action are materials that are currently used at KSC. • KSC currently handles solvents, surface coatings, propellants and fuels. Procedures for handling, transporting, storing or disposing of hazardous materials would be unaffected by the Proposed Action. • Because of the increase in exposure and the activities related to these materials, the risks associated with them are also slightly increased. The importance of adhering to proper safety procedures must be viewed as a top priority for future operations to minimize the risks of accidental release and personnel exposure. • The probability of an accidental release would increase due to the	• The impact of transitioning to a multi-user spaceport on hazardous materials and waste is confined to an increase in quantity, rather than an influx of new materials. Those materials considered as part of the proposed action are materials that are currently used at KSC. • KSC currently handles solvents, surface coatings, propellants and fuels. Procedures for handling, transporting, storing or disposing of hazardous materials would be unaffected by the Proposed Action. • Because of the increase in exposure and the activities related to these materials, the risks associated with them are also slightly increased. The importance of adhering to proper safety procedures must be viewed as a top priority for future operations to minimize the risks of accidental release and personnel exposure. • The probability of an accidental release would increase due to the	• Under the No Action alternative, the status quo would be maintained at KSC. • There would be no increase or decrease in the amount of hazardous materials that would be handled, transported, stored or disposed at KSC.

Impact Topic	Proposed Action	Alternative 1	No Action
Hazardous Materials and Waste (continued)	increased activities and quantity of materials, but best practices would ensure this increase in risk is small, with the probability of a major spill kept at a minimum. • Overall, adverse impacts on hazardous materials and waste would be of slight precedence, negligible to minor magnitude, and long-term duration. • Cumulative impacts are not expected.	increased activities and quantity of materials, but best practices would ensure this increase in risk is small, with the probability of a major spill kept at a minimum. • Overall, adverse impacts on hazardous materials and waste would be of slight precedence, negligible to minor magnitude, and long-term duration. • Cumulative impacts are not expected. • Effects of Alternative 1 would be essentially identical to those of the Proposed Action.	
Air Quality	• Would have short- and long-term minor adverse effects. • Could affect air quality in several ways: through airborne dust and other pollutants generated during construction; by the introduction of new stationary sources of pollutants, such as heating boilers and backup generators; and through increases in transporta-tion-based emissions such as launches and automotive traffic. • Short-term effects from demolition of aging or obsolete facilities would be from airborne dust and other pollutants. • Long-term effects would be from introduction of new stationary	• Would have short- and long-term minor adverse effects. • Could affect air quality in several ways: through airborne dust and other pollutants generated during construction; by the introduction of new stationary sources of pollutants, such as heating boilers and backup generators; and through increases in transporta-tion-based emissions such as launches and automotive traffic. • Short-term effects from demolition of aging or obsolete facilities would be from airborne dust and other pollutants. • Long-term effects would be from introduction of new stationary	• Would result in no additional effect on air quality. • Involves continuing existing activities and environmental programs at KSC. Because the number and type of activities would remain relatively constant under the No Action Alternative, similar levels of emissions of air pollutants would be expected. • Ambient air quality would remain unchanged when compared to existing conditions.

Impact Topic	Proposed Action	Alternative 1	No Action
Air Quality (continued)	sources such as boilers and generators, as well as increases in transportation-based emissions such as launches and automotive traffic. • In addition to criteria pollutants, the products of combustion from solid rocket boosters would also include other common products of combustion including aluminum oxide, hydrogen chloride, hydrogen, nitrogen, carbon dioxide, and water. These components are predominately inert and would be emitted in limited amounts. • Liquid hydrazine fuels typically use dinitrogen tetroxide as the oxidizer; while these fuels are hypergolic and are very hazardous, when burned as fuel the products of combustion are mostly non-hazardous. • Future launches at a re-tasked KSC could possibly result in an increase in the production of criteria pollutants over levels that have been emitted in under past KSC operations. However, vehicle launches alone would only exceed *de minimis* levels if a large number of SHCLV launches, coupled with numerous	sources such as boilers and generators, as well as increases in transportation-based emissions such as launches and automotive traffic. • In addition to criteria pollutants, the products of combustion from solid rocket boosters would also include other common products of combustion including aluminum oxide, hydrogen chloride, hydrogen, nitrogen, carbon dioxide, and water. These components are predominately inert and would be emitted in limited amounts. • Liquid hydrazine fuels typically use dinitrogen tetroxide as the oxidizer; while these fuels are hypergolic and are very hazardous, when burned as fuel the products of combustion are mostly non-hazardous. • Future launches at a re-tasked KSC could possibly result in an increase in the production of criteria pollutants over levels that have been emitted in under past KSC operations. However, vehicle launches alone would only exceed *de minimis* levels if a large number of SHCLV launches, coupled with numerous	

Impact Topic	Proposed Action	Alternative 1	No Action
Air Quality (continued)	other classes of vehicle launches, were to be conducted during the calendar year. • All components of the Proposed Action are completely within an attainment area and would not inherently lead to a violation of any Federal, state, or local air regulation. Therefore, effects would be less than significant. • Would have short- and long-term minor adverse cumulative effects.	other classes of vehicle launches, were to be conducted during the calendar year. • All components of the Proposed Action are completely within an attainment area and would not inherently lead to a violation of any Federal, state, or local air regulation. Therefore, effects would be less than significant. Would have short- and long-term minor adverse cumulative effects. • Overall effects on air quality would be essentially identical to those of the Proposed Action.	
Climate Change	• Climate change impacts globally include overall warmer temperatures, rising sea levels, a melting polar ice cap, changes in rainfall patterns, a greater frequency of extreme weather events (e.g., droughts, deluges, severe storms, floods, prolonged heat waves) and other associated and often interrelated effects. • CEQ guidance advises that actions subject to NEPA compliance should be evaluated along two dimensions relative to climate change impacts: (1) the effects of GHG emissions from a proposed action and alternative actions on global climate change;	• Climate change impacts globally include overall warmer temperatures, rising sea levels, a melting polar ice cap, changes in rainfall patterns, a greater frequency of extreme weather events (e.g., droughts, deluges, severe storms, floods, prolonged heat waves) and other associated and often interrelated effects. • CEQ guidance advises that actions subject to NEPA compliance should be evaluated along two dimensions relative to climate change impacts: (1) the effects of GHG emissions from a proposed action and alternative actions on global climate change;	• KSC would not implement elevation-based zoning and development controls to insure that any future development is constructed at an elevation of six feet above mean sea level, although this would not be consistent with NASA land management practices and Office of Strategic Infrastructure climate adaptation guidance and strategy. • Areas of existing facilities or structures that are in 0-3 foot above mean sea level zones would not be hardened or raised to accommodate future

Impact Topic	Proposed Action	Alternative 1	No Action
Climate Change (continued)	and (2) the effects of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures. • Sea level rise is the single largest hazard to continued KSC/CCAFS operations and regional land management activities. • More frequent and extreme high temperatures and humidity may cause increased risk of heat-related ailments among outdoor workers; higher cooling costs; decreased utility reliability; damage to buildings. • More frequent and intense droughts and seasonal shifts in water cycle may cause reduced water availability, higher water costs, salt water intrusion, and ground water changes. • More intense precipitation events may cause more frequent flooding of low-lying indoor and outdoor areas. • Sea level rise may cause loss of usable land and inundation of coastal ecosystems. • More frequent and intense coastal flood events may cause coastal	and (2) the effects of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures. • Sea level rise is the single largest hazard to continued KSC/CCAFS operations and regional land management activities. • More frequent and extreme high temperatures and humidity may cause increased risk of heat-related ailments among outdoor workers; higher cooling costs; decreased utility reliability; damage to buildings. • More frequent and intense droughts and seasonal shifts in water cycle may cause reduced water availability, higher water costs, salt water intrusion, and ground water changes. • More intense precipitation events may cause more frequent flooding of low-lying indoor and outdoor areas. • Sea level rise may cause loss of usable land and inundation of coastal ecosystems. • More frequent and intense coastal flood events may cause coastal	climate and weather, nor would they be relocated to ground at or above six feet MSL. • Critical facilities would not be moved outside the 500-year flood plain or hardened to withstand a hurricane activity. • NASA would continue to update plans to integrate consideration of climate change into agency operations and overall mission objectives. • KSC would also continue to implement its Strategic Sustainability Performance Plan (SSPP), which established a Scope 1 & 2 GHG emissions reduction target of 18.3 percent relative to an FY 2008 baseline estimate. • NASA operations at KSC would be at somewhat greater risk from the impacts of sea level rise, more frequent and intense coastal flood events, and more intense precipitation events than they be would if the additional actions were taken.

Impact Topic	Proposed Action	Alternative 1	No Action
Climate Change (continued)	erosion and have safety implications for surrounding communities. • Hardening, improving, or moving facilities in adaptation to potential climate change impacts will require financial investment and funding, which might reasonably be considered impacts of climate change on the Proposed Action. • Consolidation of NASA operations at KSC into a smaller geographic footprint can be expected to lead to further reductions in facilities' energy use, thereby reducing greenhouse gas emissions and producing beneficial impacts to climate change. • Continued and increased efforts to power NASA's facilities, programs, and activities using renewable sources of energy will have a beneficial impact on climate change by reducing greenhouse gas emissions. • Would add a negligible amount to the U.S. emissions contributing to global climate change.	erosion and have safety implications for surrounding communities. • Hardening, improving, or moving facilities in adaptation to potential climate change impacts will require financial investment and funding, which might reasonably be considered impacts of climate change on Alternative 1. • Consolidation of NASA operations at KSC into a smaller geographic footprint can be expected to lead to further reductions in facilities' energy use, thereby reducing greenhouse gas emissions and producing beneficial impacts to climate change. • Continued and increased efforts to power NASA's facilities, programs, and activities using renewable sources of energy will have a beneficial impact on climate change by reducing greenhouse gas emissions. • Would add a negligible amount to the U.S. emissions contributing to global climate change. • Both the effect of climate change on Alternative 1 and the effect of Alternative 1 on climate change	• Would add a negligible amount to the U.S. emissions contributing to global climate change.

Impact Topic	Proposed Action	Alternative 1	No Action
Climate Change (continued)		would be essentially the same as under the Proposed Action.	
Acoustic Environment (Noise)	• Short- and long-term minor adverse effects would be expected. • Would result in the continuation of many of the types of noise presently occurring at KSC but potentially in greater amounts. • Short-term increases in noise would result from the use of heavy equipment during construction and demolition activities. • Long-term effects would be from the addition of stationary sources of noise such as standby generators, and changes in both vertical and horizontal launch activities. • Increases in traffic volumes and changes in traffic patterns would have insignificant effects. • The Proposed Action would not (1) result in the violation of applicable Federal, state, or local noise ordinance; (2) create incompatible land uses for areas with sensitive noise receptors outside the KSC boundary; or (3) be loud enough to threaten or harm human health. • In general, the overall effects of	• Short- and long-term minor adverse effects would be expected. • Would result in the continuation of many of the types of noise presently occurring at KSC but potentially in greater amounts. • Short-term increases in noise would result from the use of heavy equipment during construction and demolition activities. • Long-term effects would be from the addition of stationary sources of noise such as standby generators, and changes in both vertical and horizontal launch activities. • Increases in traffic volumes and changes in traffic patterns would have insignificant effects. • Alternative 1 would not (1) result in the violation of applicable Federal, state, or local noise ordinance; (2) create incompatible land uses for areas with sensitive noise receptors outside the KSC boundary; or (3) be loud enough to threaten or harm human health. • In general, the overall effects of	• The No Action Alternative would result in no changes in the impact to the ambient noise environment. • KSC operations and the current levels of activities would continue without changes, and the noise environment would remain unchanged when compared to existing conditions. • Minor short- and long-term cumulative effects would be expected.

Impact Topic	Proposed Action	Alternative 1	No Action
Acoustic Environment (continued)	the action and its components would be less than significant. • Minor short- and long-term cumulative effects would be expected.	the action and its components would be less than significant. • Minor short- and long-term cumulative effects would be expected. • Noise impacts of Alternative 1 would be very similar if not identical to those of the Proposed Action.	
Biological Resources	• Reduction of 4,406 acres of operational buffer, both public use and conservation components, meaning that 4,406 acres of mostly native vegetation communities (both upland and wetland) would be eliminated. • Some native trees, shrubs, and ground cover located in the project footprint may need to be cleared, which would cause long-term adverse impacts on existing vegetation. • Disturbance from construction may allow invasive plant establishment, soil erosion or compaction, a lessened litter layer, decreased soil microbial activity, reduced plant biomass and cover of native species, decreased reproductive success, changes in genetic structure of plant populations, and alteration of wildlife habitats.	• Reduction of 3,305 acres of operational buffer, both public use and conservation components, meaning that 3,305 acres of native vegetation communities (both upland and wetland) would be eliminated. • Some native trees, shrubs, and ground cover located in the project footprint may need to be cleared, which would cause long-term adverse impacts on existing vegetation. • Disturbance from construction may allow invasive plant establishment, soil erosion or compaction, a lessened litter layer, decreased soil microbial activity, reduced plant biomass and cover of native species, decreased reproductive success, changes in genetic structure of plant populations, and alteration of wildlife habitats.	• Upland vegetation would not be affected by construction or operations as described under the Proposed Action. • Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. • Effects on upland vegetation from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. • Would not have any additional impacts on upland vegetation. • Wildlife and aquatic species would continue to be affected to a negligible to minor

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	• Impacts of proposed project activities on native upland vegetation would be short- term and long-term, direct, adverse, and negligible to moderate depending on whether the site is already disturbed or not, extent of the project area, and type of vegetation occurring onsite. • Impacts on native upland vegetation would be less than significant. • Impacts to native vegetation from invasive species would be long-term, direct, adverse, and minor to moderate, but not significant. • Impacts on special status species would be short-term and long-term, direct and indirect, adverse, and minor to moderate, but less than significant. • Vertical and horizontal launches may result in local adverse impacts on native upland and wetland vegetation. Such impacts would result from the deposition of rocket engine emissions, but would not likely result in the permanent removal or loss of a particular vegetative community. • Overall, the effects of vertical and horizontal launches and landings on upland and wetland	• Impacts of proposed project activities on native upland vegetation would be short- term and long-term, direct, adverse, and negligible to moderate depending on whether the site is already disturbed or not, extent of the project area, and type of vegetation occurring onsite. • Impacts on native upland vegetation would be less than significant. • Impacts to native vegetation from invasive species would be long-term, direct, adverse, and minor to moderate, but not significant. • Impacts on special status species would be short-term and long-term, direct and indirect, adverse, and minor to moderate, but less than significant. • Vertical and horizontal launches may result in local adverse impacts on native upland and wetland vegetation. Such impacts would result from the deposition of rocket engine emissions, but would not likely result in the permanent removal or loss of a particular vegetative community. • Overall, the effects of vertical and horizontal launches and landings on upland and wetland	degree from continuation of activities at KSC under the No Action Alternative. • Many cumulative impacts on the IRL would be expected with or without implementation of the Proposed Action. That is, the No Action Alternative would neither substantially increase nor decrease their magnitude. • Because of combined habitat loss and fragmentation, potential cumulative impacts on the Florida scrub-jay could be adverse and significant. • Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, widespread or large extent, and possibly significant, even under the No Action Alternative.

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	vegetation are expected to be short-term to medium-term, direct, adverse, and minor to moderate. • Impacts on native upland vegetation would be less than significant. • Adverse upland vegetation impacts associated with proposed actions would be minor as compared to cumulative past, present, and foreseeable future effects. • When all projects are considered in combination, cumulative impacts on upland vegetation may shift from minor and adverse to moderate and adverse, but they would still not likely be major or significantly adverse. • Construction of two new seaports would take place in wetlands and waters of the U.S, occupying 286 additional acres, much or most of which is wetlands. Unless mitigated, this would constitute a permanent, adverse, medium-scale, moderate to major, potentially significant impact on wetlands and waters of the U.S. • Under its Section 404 Clean Water Act permitting authority, the U.S. Army Corps of	vegetation are expected to be short-term to medium-term, direct, adverse, and minor to moderate. • Impacts on native upland vegetation would be less than significant. • Adverse upland vegetation impacts associated with proposed actions would be minor as compared to cumulative past, present, and foreseeable future effects. • When all projects are considered in combination, cumulative impacts on upland vegetation may shift from minor and adverse to moderate and adverse, but they would still not likely be major or significantly adverse. • Alternative 1 would avoid impacts to wetlands and wetland wildlife of the Proposed Action because it does not include two proposed seaports. • Impacts of proposed project activities on native wetland vegetation would be short- term and long-term, direct and indirect, adverse, and minor to moderate depending on the extent of the project area and whether or not the wetland has been	

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	Engineers would require avoidance or compensatory mitigation for construction in wetlands on this scale, which would reduce impacts to below the level of significance. • Except for the case of the seaports, impacts of proposed project activities on native wetland vegetation would be short- term and long-term, direct and indirect, adverse, minor to moderate, and less than significant. • Impacts of proposed project activities on invasive wetland vegetation would be long-term, direct, adverse, minor to moderate, and less than significant. • Impacts of proposed project activities on wetland special status species would either not occur, or would be short- term and long-term, direct and indirect, adverse, minor to moderate, and less than significant. • Adverse wetland vegetation impacts associated with proposed actions would be minor and adverse as compared to cumulative past, present, and	previously disturbed. • Impacts on wetland vegetation are likely to become negligible to minor with mitigation and less than significant. • Impacts of Alternative 1's activities on invasive wetland vegetation would be long-term, direct, adverse, minor to moderate, and less than significant. • Impacts of proposed project activities on wetland special status species would either not occur, or would be short- term and long-term, direct and indirect, adverse, and minor to moderate, but less than significant. • Adverse wetland vegetation impacts associated with proposed actions would be minor and adverse as compared to cumulative past, present, and foreseeable future effects. • Overall, the largest loss of wildlife habitat would result from conversion of up to 3,286 acres of operational buffer/conserva-tion to more developed land uses. These 3,286 acres constitute 7.4% of the total existing acreage of operational buffer/conserva-	

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	foreseeable future effects. • Overall, the largest loss of wildlife habitat would result from conversion of up to 4,386 acres of operational buffer/ conservation to more developed land uses. These 4,386 acres constitute 9.8% of the total existing acreage of operational buffer/ conservation lands as well as 5.1% of the future non-water land uses at KSC, making it a substantive but likely minor, adverse, long-term impact on KSC habitats in general for wildlife species whose populations are currently well-distributed and not stressed by other factors across KSC. • Habitat quality changes would result where new facilities are sited in previously unbroken areas of uniform habitat. Fragmentation would be greatest where linear features such as roads or pipeline/cable rights-of-way are cut through larger areas of relatively uniform habitat. • Some benefit would be derived in terms of habitat recovery as well as improvements in habitat quality from reducing the footprint of Administration facilities and Support Services	tion lands as well as 3.8% of the future non-water land uses at KSC, making it a substantive but likely minor, adverse, long-term impact on KSC habitats in general for wildlife species whose populations are currently well-distributed and not stressed by other factors across KSC. • Habitat quality changes would result where new facilities are sited in previously unbroken areas of uniform habitat. Fragmentation would be greatest where linear features such as roads or pipeline/cable rights-of-way are cut through larger areas of relatively uniform habitat. • Some benefit would be derived in terms of habitat recovery as well as improvements in habitat quality from reducing the footprint of Administration facilities and Support Services facilities which would result in a net gain of 317 acres of unused land that could be restored to wildlife habitat. • Special status terrestrial species may be adversely affected by the land use changes under the Proposed Action including the federally protected Eastern indigo	

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	facilities which would result in a net gain of 317 acres of unused land that could be restored to wildlife habitat. • Special status terrestrial species may be adversely affected by the land use changes under the Proposed Action including the federally protected Eastern indigo snake and Florida scrub-jay, the southeastern beach mouse, piping plover, and Roseate tern. • Many invasive species may benefit from habitat disturbance and the presence of human development so their numbers may slightly increase due to new construction. • Overall, the effects of vertical and horizontal launches and landings on upland wildlife and habitat are expected to be direct, adverse, localized, short-term to medium-term, and minor to moderate. • It is unlikely that Florida scrub-jay, least tern, or wood stork populations would incur long-term adverse impacts from launches. • Although launches could cause short-term effects on two protected bird species, five	snake and Florida scrub-jay, the southeastern beach mouse, piping plover, and Roseate tern. • Many invasive species may benefit from habitat disturbance and the presence of human development so their numbers may slightly increase due to new construction. • Overall, the effects of vertical and horizontal launches and landings on upland wildlife and habitat are expected to be direct, adverse, localized, short-term to medium-term, and minor to moderate. • It is unlikely that Florida scrub-jay, least tern, or wood stork populations would incur long-term adverse impacts from launches. • Although launches could cause short-term effects on two protected bird species, five protected reptiles or amphibians, and two protected mammals, the launches would not be likely to adversely affect the long-term well-being, reproduction rates, or survival of any of these species. • Launches at KSC would likely continue to have recurring, short-term, localized to medium, minor	

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	protected reptiles or amphibians, and two protected mammals, the launches would not be likely to adversely affect the long-term well-being, reproduction rates, or survival of any of these species. • Launches at KSC would likely continue to have recurring, short-term, localized to medium, minor to moderate adverse impacts to aquatic habitats and fish for the duration of the Center Master Plan. These impacts would not be significant because aquatic habitats and wildlife have proved resilient in the face of these environmental stresses over the past 50 years. • Would add incrementally and cumulatively to the impacts of numerous other factors affecting the wildlife and aquatic species of KSC. • With the exception of the Florida scrub-jay, overall cumulative impacts on wildlife would be long-term, of medium extent and moderate magnitude, but not significant. • Because of combined habitat loss and fragmentation, potential cumulative impacts on the Florida scrub-jay could be	to moderate adverse impacts to aquatic habitats and fish for the duration of the Center Master Plan. These impacts would not be significant because aquatic habitats and wildlife have proved resilient in the face of these environmental stresses over the past 50 years. • Would add incrementally and cumulatively to the impacts of numerous other factors affecting the wildlife and aquatic species of KSC. • With the exception of the Florida scrub-jay, overall cumulative impacts on wildlife would be long-term, of medium extent and moderate magnitude, but not significant. • Because of combined habitat loss and fragmentation, potential cumulative impacts on the Florida scrub-jay could be adverse and significant. • Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, widespread, and possibly significant.	

Impact Topic	Proposed Action	Alternative 1	No Action
Biological Resources (continued)	adverse and significant. • Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, widespread, and possibly significant.		
Cultural Resources	• All activities under the Proposed Action that may have adverse effects on cultural resources at KSC would be managed in accordance with the KSC Cultural Resources Management Plan. • As the project locations are defined, the NHPA Section 106 process would be initiated and determinations would be made for the APE and potentially impacted cultural resources. • Appropriate surveys and studies would be conducted so that the effect of the undertaking upon the cultural resources can be determined. • Consultations would be undertaken on a project-by-project basis with the respective SHPO or THPO and interested or affected Native American tribes. • Should previously undiscovered artifacts or features be unearthed	• All activities under Alternative 1 that may have adverse effects on cultural resources at KSC would be managed in accordance with the KSC Cultural Resources Management Plan. • Appropriate surveys and studies would be conducted so that the effect of the undertaking upon the cultural resources can be determined. • Consultations would be undertaken on a project-by-project basis with the respective SHPO or THPO and interested or affected Native American tribes. • Should previously undiscovered artifacts or features be unearthed during any of the proposed projects, work would be stopped in the immediate vicinity of the find, a determination of significance made, and a mitigation plan formulated.	• Cultural resources would not be affected by construction or operations as described under the Proposed Action. • Any existing activities or operations would occur in accordance with existing laws, regulations, and policies. • Effects on cultural resources from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. • Would not have any additional impacts on cultural resources.

Impact Topic	Proposed Action	Alternative 1	No Action
Cultural Resources (continued)	during any of the proposed projects, work would be stopped in the immediate vicinity of the find, a determination of significance made, and a mitigation plan formulated.	• As the project locations are defined, the NHPA Section 106 process would be initiated and determinations would be made for the APE and potentially impacted cultural resources. • Impacts would be essentially the same as those of the Proposed Action.	
Land Use	• Would consolidate existing NASA operations into a smaller geographic footprint. • These possible land use and land cover changes would be minor to moderate in magnitude, of small extent, long-term, and beneficial. • Acreage at KSC currently used for administration, open space, and operational buffer (for both conservation and public use), and support services would decrease. • No change to acreage associated with water or recreation - as distinct from the Operational Buffer/Public Use category, which may also be used for recreation, but which, as noted above, is slated to decrease. • Acreage currently used for Assembly, Testing, and Processing; Central Campus; Horizontal Launch and Landing; Launch Operations and Support;	• Would consolidate existing NASA operations into a smaller geographic footprint. • These possible land use and land cover changes would be minor to moderate in magnitude, of small extent, long-term, and beneficial. • Acreage at KSC currently used for administration, open space, and operational buffer (for both conservation and public use), and support services would decrease. • No change to acreage associated with water or recreation - as distinct from the Operational Buffer/Public Use category, which may also be used for recreation, but which, as noted above, is slated to decrease. • Acreage currently used for Assembly, Testing, and Processing; Central Campus; Horizontal Launch and Landing; Launch Operations and Support;	• Current land uses and their configuration at KSC would remain unchanged for the duration of the 20-year planning horizon. • Total land and water area under jurisdiction of KSC would remain at approx. 140,000 acres. Of this total area, about 85,000 acres would continue to be owned by NASA and the remaining 55,000 acres by the State of Florida and dedicated for the exclusive use of the U. S. Government. • Because there would be no change to existing land uses, there would be no additional impacts on this resource.

Impact Topic	Proposed Action	Alternative 1	No Action
Land Use (continued)	Public Outreach; Renewable Energy; Research and Development; Seaport; Utility Systems; Vertical Launch; and Vertical Landing would increase. • As implementation of the CMP Update occurs, NASA would work closely with USFWS and NPS to determine the appropriate methods for, locations of, and mitigations pertaining to projects within KSC, MINWR, and CNS. • Due to the proposed changes, construction, and demolition activities that would occur, and BMPs that would be followed, in conjunction with the implementation of all projects, impacts to land use are anticipated to minor to moderate, depending on the acreage impacted, the land cover to be changed, and the number or type of projects to be carried out in that area. • Impacts are anticipated to be of small to medium extent, long-term, and possible. • Overall cumulative impacts to land use over the coming several decades would likely be moderate in magnitude.	Public Outreach; Renewable Energy; Research and Development; Seaport; Utility Systems; Vertical Launch; and Vertical Landing would increase. • As implementation of the CMP Update occurs, NASA would work closely with USFWS and NPS to determine the appropriate methods for, locations of, and mitigations pertaining to projects within KSC, MINWR, and CNS. • Due to the proposed changes, construction, and demolition activities that would occur, and BMPs that would be followed, in conjunction with the implementation of all projects, impacts to land use are anticipated to minor to moderate, depending on the acreage impacted, the land cover to be changed, and the number or type of projects to be carried out in that area. • Impacts are anticipated to be of small to medium extent, long-term, and possible. • Overall cumulative impacts to land use over the coming several decades would likely be moderate in magnitude. • Overall, impacts from Alternative	

Impact Topic	Proposed Action	Alternative 1	No Action
Land Use (continued)		1 would be very similar to those of the Proposed Action, but somewhat less pronounced, because the two proposed seaports would not be built and the horizontal launch and landing area north of Beach Road might not be built. Moreover, new vertical launch sites north of LC-39 become "notional" rather than definite.	
Transportation	• Would result in the continuation of many of the modes of transportation presently occurring at KSC but potentially in greater amounts. • Short- and long-term minor adverse effects would be expected. • Short-term increases in traffic would result from construction worker commutes during construction and demolition activities. • Long-term effects would be primarily due to additional worker commutes and changes in traffic patterns near more centralized activities at KSC. • Increased traffic volumes and changes in traffic patterns, and changes in both vertical and horizontal launch activities would	• Would result in the continuation of many of the modes of transportation presently occurring at KSC but potentially in greater amounts. • Short- and long-term minor adverse effects would be expected. • Short-term increases in traffic would result from construction worker commutes during construction and demolition activities. • Long-term effects would be primarily due to additional worker commutes and changes in traffic patterns near more centralized activities at KSC. • Increased traffic volumes and changes in traffic patterns, and changes in both vertical and horizontal launch activities would	• Would result in no changes in the impact to traffic and transportation. • KSC operations and the current levels of activities would continue without changes, and traffic and transportation would remain unchanged when compared to existing conditions.

Impact Topic	Proposed Action	Alternative 1	No Action
Transportation (continued)	have minor effects, and there would be some long-term beneficial effects from upgrades in transportation infrastructure. • The Proposed Action is not expected to have appreciable changes in the overall traffic volume at KSC; however, some components could affect the LOS at intersections or roadways both on and off the facility.	have minor effects, and there would be some long-term beneficial effects from upgrades in transportation infrastructure. • The Proposed Action is not expected to have appreciable changes in the overall traffic volume at KSC; however, some components could affect the LOS at intersections or roadways both on and off the facility. • With one important exception, the direct, indirect, and cumulative impacts of Alternative 1 would be like those of the Proposed Action. • Exception is that under Alternative 1, two proposed new seaports that are part of the Proposed Action would not be constructed and operated. • In this respect, Alternative 1 would be like the No Action Alternative.	

Impact Topic	Proposed Action	Alternative 1	No Action
Utilities	• KSC would continue to be a retail electricity, natural gas, and fuel oil customer. • Construction of new facilities or sites within KSC would require the construction of new utilities rights-of-way and installation of new utility lines or extensions for power, water, and telecommunications. • Depending on the location and size of the systems to be installed or expanded, the land clearing, trenching, excavation, and other activities associated with the preparation of ROWs and installation of utility lines could have direct and indirect environmental impacts. • Because a large portion of the KSC site is already developed, impacts from new and utility systems would not be as substantial as they may be if the site were still pristine, undeveloped land. Additionally, over time, the site as a whole may actually consume less energy and water due to the achievement of greater efficiency and right-sizing under the proposed CMP. • Overall, impacts from the	• KSC would continue to be a retail electricity, natural gas, and fuel oil customer. • Construction of new facilities or sites within KSC would require the construction of new utilities rights-of-way and installation of new utility lines or extensions for power, water, and telecommunications. • Depending on the location and size of the systems to be installed or expanded, the land clearing, trenching, excavation, and other activities associated with the preparation of ROWs and installation of utility lines could have direct and indirect environmental impacts. • Because a large portion of the KSC site is already developed, impacts from new and utility systems would not be as substantial as they may be if the site were still pristine, undeveloped land. Additionally, over time, the site as a whole may actually consume less energy and water due to the achievement of greater efficiency and right-sizing under the proposed CMP. • Overall, impacts from the	• Utility systems would continue to age and would require upgrades or replacements as they become less efficient or fail. • However, current utility systems and their configuration at KSC would remain relatively unchanged aside from regular maintenance for the duration of the 20-year planning horizon (2012-2032). • The affected environment as described in this resource section would not be affected by the construction or operations described under the Proposed Action. • Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. • Individual actions conducted as part of the Proposed Action impacting utilities may proceed, but would have to do so after environmental assessment under separate environmental document-ation.

Impact Topic	Proposed Action	Alternative 1	No Action
Utilities (continued)	installation and expansion of utility systems at KSC under the Proposed Action are anticipated to be minor to moderate and of small to medium extent. • Development at and near the site by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS may spur further utility needs in the local or regional area, which could create further impacts to soils, water resources, biological resources, and to the local community as a result of noise or visual disturbances during installation of utility corridors/systems. The capacity of regional utility service providers could potentially be exceeded. • Impacts could be moderate, of medium extent, long-term, and possible.	installation and expansion of utility systems at KSC under the Proposed Action are anticipated to be minor to moderate and of small to medium extent. • Development at and near the site by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS may spur further utility needs in the local or regional area, which could create further impacts to soils, water resources, biological resources, and to the local community as a result of noise or visual disturbances during installation of utility corridors/systems. The capacity of regional utility service providers could potentially be exceeded. • Impacts could be moderate, of medium extent, long-term, and possible. • Direct, indirect and cumulative impacts of Alternative 1 would be very similar to those of the Proposed Action, but on a somewhat smaller scale.	

Impact Topic	Proposed Action	Alternative 1	No Action
Socioeconomics	• Overall, the direct, economic impacts as a result of the Proposed Action would be beneficial but not significant. • Would potentially create beneficial impacts of minor to moderate magnitude due to the creation of jobs and labor income, most of which would occur during 2016 as part of the Development Program. • Extent of impacts would be medium (localized), since most of the jobs would be filled by area residents. • Indirect and long-term impacts from non-NASA (second and third priority) projects on the local economy depend on external factors such as interest and financial commitment from non-NASA entities. • In the long-term, with KSC having leveraged its position as a multi-user spaceport and positioned itself to attract new tenants, indirect economic impacts would be beneficial and significant. • Future employees from non-NASA projects at KSC would represent new purchasing power that would support additional	• Overall, the direct, economic impacts as a result of the Proposed Action would be beneficial but not significant. • Would potentially create beneficial impacts of minor to moderate magnitude due to the creation of jobs and labor income, most of which would occur during 2016 as part of the Development Program. • Extent of impacts would be medium (localized), since most of the jobs would be filled by area residents. • Indirect and long-term impacts from non-NASA (second and third priority) projects on the local economy depend on external factors such as interest and financial commitment from non-NASA entities. • In the long-term, with KSC having leveraged its position as a multi-user spaceport and positioned itself to attract new tenants, indirect economic impacts would be beneficial and significant. • Future employees from non-NASA projects at KSC would represent new purchasing power that would support additional	• No socioeconomic changes would occur to Brevard or Volusia counties. • Since ongoing activities would be substantially the same as those already occurring, no significant additional change in community character and setting would be anticipated. • Existing conditions would remain substantially unchanged and have no effect on the populations of concern. • There would be no change to population, housing, employment, income characteristics, economic activity, taxes and revenues, or quality of life conditions. • Fluctuations or changes would occur at rates consistent with historical trends.

Impact Topic	Proposed Action	Alternative 1	No Action
Socioeconomics (continued)	jobs and payroll at local retail and service establishments in the ROI. • There is a larger multiplier effect associated with the consumer spending of employees directly supported by KSC (though these future employees would not directly be employed by NASA). Through this spending, the Proposed Action could indirectly support thousands of indirect and induced jobs.	jobs and payroll at local retail and service establishments in the ROI. • There is a larger multiplier effect associated with the consumer spending of employees directly supported by KSC (though these future employees would not directly be employed by NASA). Through this spending, the Proposed Action could indirectly support thousands of indirect and induced jobs. • Direct, indirect, and cumulative socioeconomic impacts associated with Alternative 1 would be broadly similar to those of the Proposed Action, though on a somewhat smaller scale, because facilities such as two proposed new seaports would not be built, and other notional facilities might not be constructed.	
Recreation	• Changes in KSC's land use, actions to meet KSC's mission and core competencies, and future development, transportation facilities, and activities would have both adverse and beneficial impacts on recreational resources and	• Changes in KSC's land use, actions to meet KSC's mission and core competencies, and future development, transportation facilities, and activities would have both adverse and beneficial impacts on recreational resources and	• Land use would not change on Operational Buffer and Public Use areas. • Without future development of horizontal launch and vertical landing facilities, vertical launch pads, and seaports, the value of

Impact Topic	Proposed Action	Alternative 1	No Action
Recreation (continued)	ecosystem services. • Long-term consolidation of support services and expansion of existing facilities would create impacts of lesser magnitude compared to the construction of new facilities on pristine land, since infrastructure such as access roads and utilities have already been constructed. • Development of horizontal launch infrastructure could hinder or delay access to Playalinda Beach; construction activities would contradict its natural attributes that contribute to its beauty and aesthetic quality, or the cultural services it provides. • Launch and landing activities would likely generate intermittent, adverse effects on the visitor experience due to beach closures, and would not exceed the threshold of significance. • Future development of two seaports could include the removal of saltwater marsh or mangroves, which would hinder natural flood control, degrade finfish and shellfish spawning grounds and nurseries, impact boating and fishing experiences,	ecosystem services. • Long-term consolidation of support services and expansion of existing facilities would create impacts of lesser magnitude compared to the construction of new facilities on pristine land, since infrastructure such as access roads and utilities have already been constructed. • Might not hinder or delay access to Playalinda Beach because launch and landing facilities might not be constructed north of Beach Road. • Future development of two seaports would not occur, so that associated impacts on recreation would be avoided. • Potential cumulative impacts including the proposed Shiloh complex would include adverse effects on visitor experience, access, hunting and fishing activities, and wildlife observation at MINWR, as well as negative impacts to recreation at CNS. • Local population growth, climate change, and sea level rise will likely have adverse long-term effects.	ecosystem services at CNS and MINWR would not change (or would fluctuate with market forces). • The continued increase in visitor numbers, as well as urban development of the area surrounding the national seashore, will likely degrade visitor experience and the uncrowded beach and lagoon experience at CNS. • With more users, noise levels and the demand for services and facilities will likely increase, as well as the likelihood of resource damage. • Sea level rise and erosion from climate change, or the need to protect certain areas or species, may alter visitor access to certain parts of CNS and MINWR. • Visitation for birding and fishing may change if new species shift northward; or extant species move northward or have dramatic declines in population, as might occur with the temperature-sensitive

Impact Topic	Proposed Action	Alternative 1	No Action
Recreation (continued)	and further impact the Florida manatee with the introduction of motorized boating. • Adverse impacts of the seaports to ecosystem services would occur in both the short- and long-term and could be significant. • Development north of Beach Road associated with the Proposed Action (vertical landing and horizontal launch and landing facilities) would have adverse, long-term effects on recreation opportunities at Playalinda Beach and CNS. • Negative impacts to Playalinda would also mean adverse impacts to Bio Lab Road and adverse impacts to access to Eddy Creek Boat Ramp and Mosquito Lagoon (MINWR). • Potential cumulative impacts including the proposed Shiloh complex include adverse effects on visitor experience, access, hunting and fishing activities, and wildlife observation at MINWR, as well as negative impacts to recreation at CNS. • Local population growth, climate change, and sea level rise will likely have adverse long-term effects.		manatee.

Impact Topic	Proposed Action	Alternative 1	No Action
Environmental Justice and Protection of Children	• Neither Brevard County nor Volusia County constitutes an environmental justice population because in both counties, neither the percentage of minorities exceeds 50 percent nor is substantially higher than the percentage of minorities in the state. • Disproportionate impacts to minorities in both Brevard and Volusia Counties would therefore be negligible. • Brevard County and Volusia County do not constitute an environmental justice population since poverty levels coupled with median household income levels are lower or comparable with the rest of Florida. • Disproportionate impacts to the health and safety of children in Brevard and Volusia counties would not occur.	• Neither Brevard County nor Volusia County constitutes an environmental justice population because in both counties, neither the percentage of minorities exceeds 50 percent nor is substantially higher than the percentage of minorities in the state. • Disproportionate impacts to minorities in both Brevard and Volusia Counties would therefore be negligible. • Brevard County and Volusia County do not constitute an environmental justice population since poverty levels coupled with median household income levels are lower or comparable with the rest of Florida. • Impacts of Alternative 1 would be virtually identical to those of the Proposed Action. • Disproportionate impacts to the health and safety of children in Brevard and Volusia counties would not occur.	• Would continue KSC's ongoing program at the current level of operations. • No new potential for environmental justice effects or increased risk to children would be anticipated under this alternative. • In general, all members of the affected communities would experience both the potential beneficial and adverse effects of the No Action Alternative equally. • Minority or low-income individuals would unlikely experience high or disproportionate effects from the actions to be taken under this alterative. • Disproportionate impacts to the health and safety of children in Brevard and Volusia counties would not occur.

3.0 ENVIRONMENTAL ANALYSIS

This chapter of the EIS describes the environment in and around the KSC that could be affected by the Proposed Action and alternatives and analyzes the impacts of implementing each alternative on that environment. Much of the information here is derived from the most recent Environmental Resources Document (NASA, 2010a, 2015), a report which contains comprehensive data on the natural resources, environmental features, and programs at KSC.

3.1 Methodology

The interdisciplinary study team (see "Chapter 6. List of Preparers") followed a structured process to analyze the potential environmental impacts, or effects, resulting from the No Action and Proposed Action alternatives. This procedure, called the cause-effects-questions (C-E-Q®) process, is described in the text box below.

Causes-Effects-Questions:
A Structured Analytic Process

Step 1: Identify the specific activities, tasks, and subtasks involved in the proposed action(s) and alternative(s).

Step 2: For each specific activity, task, and subtask, determine the full range of direct effects that each could have on any environmental resource. For example, removing vegetation could cause soil erosion.

Step 3: For each conceivable direct effect, identify which further effects could be caused by the direct effects. For example, soil erosion could cause stream sedimentation, which could harm or kill aquatic macroinvertebrates, which could diminish the food supply for fish, leading to decreased fish populations. This inquiry can identify multistepped chains of potential causes and effects.

Step 4: Starting at the beginning of each chain of causes and effects, work through a series of questions for each potential effect:

- Would this effect actually occur from this project? If not, why not?
- What would preclude it from happening?
- If the effect cannot be ruled out, characterize which types of data, other information, and analyses are needed to determine the parameters of the effect, including its extent, duration, and intensity.
- Identify the sources from which the data are to be obtained.

Step 5: Gather the data and conduct the analyses identified by the above steps, utilizing only relevant information.

Step 6: Document the results of this study process.

Using this process, both direct and indirect effects that could occur as a result of implementing the proposed action were identified. As mentioned above, direct effects are immediate impacts caused by an action at approximately the same time and place as the action. Indirect effects are impacts caused by the action(s) that occur at some distance in space and/or time from the action, or, as described above, by means of a longer chain of cause-and-effect linkages.

Environmental Impact Statement Significance Criteria

A project such as the proposed Kennedy Space Center Master Plan can have a wide variety of impacts on different components of the environment. The importance, or "significance," of each of these diverse impacts depends on several factors. Some of these factors are matters of objective fact. For example, if a Federal law would clearly be violated by any aspect of the proposed action, then that would obviously be a significant impact. Other factors affecting significance are matters of judgment, such as the importance of losing some amount of wildlife habitat. The Council on Environmental Quality (CEQ) regulations on NEPA provide a list of factors to be considered in determining impact significance. These factors are presented in the text box at the right.

The EIS study team used an assessment methodology that combines these multiple factors into an overall assessment of significance. During the planning stage of the EIS study, the study team reviewed similar projects and documentation to ascertain the activities associated with the proposed action, and the types of impacts they could cause. Research was supplemented by professional judgment concerning impacts of typical concern for any large construction project. A preliminary environmental evaluation diagram (i.e., the C-E-Q diagram) which lists the potential impacts for that activity, was developed for each activity associated with the proposed action.

CEQ Regulations on Significance (40 CFR 1508.27)

The rating of an impact as "significant" in NEPA requires consideration of both the context and intensity of the impact.

Context: The significance of an action must be analyzed in several contexts, including society as a whole, the affected region, the affected interests, and the locality. Both short- and long-term effects on an action should be analyzed.

Intensity: Intensity refers to the severity of an impact. In evaluating the intensity of an impact of the proposed action, the following should be considered:

- Impacts that may be both beneficial and adverse;
- Effects on human health and safety;
- Unique characteristics of the geographic area;
- Highly controversial effects;
- Highly uncertain or risky effects;
- Potential for the action to set a precedence for future actions with significant effects;
- Cumulative effects;
- Adverse effects on significant scientific, cultural, or historic resources;
- Adverse effects on a threatened or endangered species or its habitat; and
- Whether the action violates or threatens a Federal, State, or local law or requirement.

Factors considered in the impact analysis and in determinations of significance include:

- Magnitude of the impact (how much);
- Duration or frequency of the impact (how long or how often);
- Extent of the impact (how far);
- Likelihood of the impact occurring (probability); and
- Precedence and uniqueness of the impact (e.g., unique setting, unprecedented impacts, uncertain impacts, and controversiality).

For these factors, the team identified several useful levels of that factor, as shown below:

Magnitude:
- major
- moderate
- minor
- negligible

Duration:
- permanent
- long term
- medium term (intermittent)
- short term

Areal Extent:
- large
- medium (localized)
- small (limited)

Likelihood:
- probable
- possible
- unlikely

Precedence and Uniqueness:
- severe
- moderate
- slight

The team then identified which combinations of these factors would constitute various overall ratings of significance. Given this general structure, applied to all types of impacts on all environmental resources, each member of the study team then determined which of these terms best demonstrate the level of impact, and the significance or non-significance of that impact.

For the fifth major factor presented above—Precedence and Uniqueness—the study team developed a set of definitions, based on intensifying factors, for each level that are applicable to impacts in essentially all resources areas. In other words, no resource-specific definitions are needed for intensity. These definitions are as follows:

Severe:

Impacts occur in such close proximity to national parks, properties eligible to the National Register of Historic Places, or national historic landmark sites, or other especially valued, unique, or protected sites, that the valued features of those nearby sites are severely jeopardized;

OR

Impacts are completely unprecedented; no similar impacts have ever been known to occur;

OR

The types, extent, or probability of the impacts cannot be reasonably predicted;

OR

There is substantial and sustained dispute among subject matter experts, agencies, organizations, and/or citizens about the nature or importance of the impacts.

Moderate:
Impacts would occur at sufficient distance from any protected site that the valued features would be perceptibly altered but not severely compromised or jeopardized;

OR

There is moderate confidence in the accuracy of the predictions as to types, extent, and likelihood of the impacts;

OR

There is moderate dispute among subject matter experts, agencies, organizations, and/or citizens about the nature or importance of the impacts.

Slight:
Impacts would occur at sufficient distance from any protected site that the valued features would be imperceptibly altered;

OR

The types, extent, or probability of the impacts can be reasonably predicted with only slight uncertainty;

OR

There is very limited dispute among subject matter experts, agencies, organizations, and/or citizens about the nature or importance of the impacts.

With this structure established for this study, the team then conducted the EIS study. Through the use of this approach, diverse impacts will be assessed on a common footing. If a biological impact is rated by the study team as “very significant,” the team intends that rating to have approximately the same meaning as a “very significant” impact rating in any other resource area; however, depending on the type of proposed action and its setting and context, some similarly rated impacts would in fact be weighted differently by the public and decision makers.

As indicated above, assessing significance does involve discretion and professional judgment, as well as some degree of subjectivity as to what to value and how much to value it, and this approach does not remove that element from the process. What this method does is organize the analysts’ judgment, and make the bases for their judgment more explicit and more uniform. Accordingly, the study team does not present their assessments as indisputable facts, but rather as the considered judgments of the professional team based on the explicit factors and considerations as described here.

Impacts determined to be “below significant” or “insignificant” are not dismissed as unimportant or nonexistent. Rather, these impacts, while adverse (or beneficial, as the case may be) are not considered to have crossed the threshold of significance.

Definitions

Discussions of environmental consequences in the following sections utilize a general vocabulary consisting of some of the terms and definitions below:

Types of Impact

Beneficial – A positive change in the condition or appearance of the resource, or a change that moves the resource toward a desired condition.

Adverse – A change that moves the resource away from a desired condition or detracts from its appearance or condition.

Direct – An effect that is caused by an action and occurs in the same time and place.

Indirect – An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.

Duration of Impact

Permanent – Impact would last indefinitely.

Long term – Impact would likely last more than 2 years, or over the lifetime of the project and possibly longer, exceeding the project lifetime.

Medium term – Impact would extend past the transition phase, or construction phase for future developments, but would not last more than 5 years, at most.

Intermittent – Impact would not be constant or continuous but may last indefinitely.

Short term – Impact would occur during a transition phase only, or in the case of potential future developments, during the site preparation and construction phases only. Once these phases have ended, resource conditions are likely to return to pre-transition/construction conditions.

Extent of Impact

Large – Impacts would affect the resource on a regional level, extending well past the immediate project site.

Medium or Localized – Impacts would affect the resource only on the project site or its immediate surroundings, and would not extend into the region.

Small or Limited – Impacts would affect the resource over a fraction of the project site.

Magnitude of Impact

Major – Substantial impact or change in a resource area that is easily defined, noticeable, and measurable, or exceeds a standard.

Moderate – Noticeable change in a resource occurs, but the integrity of the resource remains intact.

Minor – Change in a resource area occurs, but no substantial resource impact results.

Negligible – The impact is at the lowest levels of detection—barely measurable and with no perceptible consequences.

Likelihood of Impact

Probable – More likely to occur than not, i.e., approximately 50 percent likelihood or higher.

Possible – Some chance of occurring, but probably below 50 percent.

Unlikely – A non-zero but very small likelihood of occurrence.

3.2 Past, Present, and Reasonably Foreseeable Future Projects

This section describes projects, actions, and trends considered in the analysis of cumulative impacts. Cumulative impacts are defined by the CEQ regulations in 40 Code of Federal Regulations (CFR) 1508.7 as "the impact on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time."

Cumulative impacts include the direct and indirect impacts of a project together with the reasonably foreseeable future actions of other projects. According to CEQ's cumulative impacts guidance, the cumulative impact analysis should be narrowed to focus on important issues at a national, regional, or local level. The analysis should look at other actions that could have similar effects and whether a particular resource has been historically affected by cumulative actions.

3.2.1 General Growth and Development Since the Founding of KSC

At least until the recession that began in 2008, both Volusia and Brevard counties have witnessed rapid population growth and economic development, since NASA's Launch Operations Center and the portions of CCAFS that were used by NASA were renamed the John F. Kennedy Space Center in 1963. Brevard County's population almost quadrupled in the 30 years from 1960 to 1990, while Volusia County's nearly tripled in that same time period (Table 3.2-1). Each county grew by more than 100,000 residents from 1990 to 2010. Growth has slowed in both counties since the onset of the "Great Recession" toward the end of the first decade in the new century, which hit Florida especially hard.

Table 3.2-1. Population growth in Brevard and Volusia counties, 1960-2013

Year	Brevard County	% growth in previous period	Volusia County	% growth in previous period
1960	111,435	371%	125,319	69%
1970	230,006	106%	169,487	35%
1980	272,959	19%	258,762	53%
1990	398,978	46%	370,712	43%
2000	476,320	19%	443,343	20%
2010	543,376	14%	494,593	12%
2013	550,823	1%	500,800	1%

Sources: USCB, 1995; USCB, 2001; USCB, 2015

Greater populations in the two counties into which KSC extends tend to signify greater effects on the local environment. Higher populations and associated development, especially within the watersheds discharging into the Mosquito Lagoon and Indian River, would increase the number of source and non-point sources of water pollution into these important waterbodies, including nutrients like phosphorus and nitrogen, urban runoff, sediments, and a variety of contaminants. Higher population would also mean higher mobile and non-mobile sources of criteria pollutant emissions to the local airshed. Higher populations and rapid population growth are also associated with greater levels of economic activity, traffic, noise, and use of recreational sites, including Merritt Island National Wildlife Refuge, Canaveral National Seashore, Mosquito Lagoon and Indian River.

While fewer jobs at KSC since the termination of the Shuttle Program have also resulted in slower population growth in the surrounding communities, given overall background demographic trends in Florida, both counties are expected to continuing growing substantially in the future, albeit at a somewhat slower rate than in the latter half of the 20th century. By 2040, Brevard County is projected to have 668,020 residents (an increase of more than 100,000 from the population at present), and Volusia County 591,980, an increase of nearly 100,000 (EDR, 2015).

These projected population increases will likely be associated with increases in paved and impervious surfaces, greater peak storm runoff, more non-point sources and higher pollutant loadings, more traffic, and greater higher visitation to and use of recreational facilities and natural areas in and around KSC.

3.2.2 Proposed Shiloh Launch Complex

Space Florida is an Independent Special District of the State of Florida. It was created by Chapter 331, Part II, Florida Statutes, for the purposes of promoting the growth and development of a sustainable and world-leading space industry in Florida (Space Florida, 2015). Space Florida is proposing to develop a non-Federal launch site at the northern edge of KSC that is both State-controlled and State-managed. Its goal is to provide launch site options other than Federal installations/ranges. Under a Proposed Action that is now the subject of an EIS being prepared by the Federal Aviation Administration (FAA), and for which NASA is a cooperating agency, Space Florida would construct and operate a commercial space launch site – known as the Shiloh Launch Complex – consisting of two vertical launch facilities and two off-site operations support areas (FAA, 2014).

The proposed Shiloh Launch Complex would provide up to 24 launches per year (12 launches per vertical launch facility), in addition to up to 24 static fire engine tests or wet dress rehearsals per year (12 static fire engine tests or wet dress rehearsals per vertical launch facility). Launches would include liquid fueled, medium- to heavy-lift class orbital and suborbital vertical launch vehicles. All launches would be conducted to the east over the Atlantic Ocean. The first stage of the launch vehicle could return to and land at the proposed Shiloh Launch Complex or it could land in the Atlantic Ocean (FAA, 2015).

The FAA is the lead Federal agency in the preparation of an EIS on the proposed Shiloh Launch Complex to comply with NEPA. The U.S. Army Corps of Engineers, NASA, USFWS, NPS, and the Florida Department of State, Division of Historical Resources, State Historic Preservation Office are all serving as cooperating agencies (FAA, 2015).

3.2.3 Proposed Port Canaveral Rail Extension

The Canaveral Port Authority intends to file a request with the Surface Transportation Board (STB) for the authority to construct and operate approximately 11 miles of new rail line to Port Canaveral in Brevard County. The proposed Port Canaveral Rail Extension would also utilize approximately 17 miles of existing rail line at KSC connect with a main line of the Florida East Coast Railway. The proposed rail line would begin near the Port's North Cargo Area, extend west over the Banana River, enter KSC on Merritt Island south of Kars Park, and then turn north through KSC grounds where it would connect with KSC's existing rail line. Once the rail extension was operational, approximately three to four trains per week would use the new tracks, with the trains moving at approximately 10 miles per hour (STB, 2014).

The Surface Transportation Board determined that construction and operation of the proposed rail extension has the potential to result in significant environmental impacts; therefore, the Board's Office of Environmental Analysis (OEA) determined that preparation of an EIS was appropriate, pursuant to NEPA; scoping began in October 2014.

3.3 Soils and Geology

3.3.1 Affected Environment

3.3.1.1 Soils

Soil is a collective term for the inorganic and organic substrate covering bedrock in which vegetation grows and a multitude of organisms reside. Soil resources provide a foundation for both plant and animal communities by establishing a substrate for plant growth and vegetative cover for animal habitat and feeding. These resources are equally important in both terrestrial and aquatic environments. Soils are surveyed nationwide by county.

Although the soil mantle varies widely from place to place, all soils share common traits. They are all composed of minerals, organic matter, living organisms, water, and air in varying proportions, depending on the type of soil. Soils form as the result of processes at work on materials deposited or accumulated by geological processes. Soil properties at any given site are determined by five factors: (1) physical and mineralogical composition of the parent material, (2) climate under which the soil material accumulated and has existed since accumulation, (3) plant and animal life atop and within the soil, (4) topography, or the "lay of the land," and (5) length of time that the forces of soil formation have acted on the parent material (NRCS, no date).

The system of soil classification in use today has six categories. Beginning with the broadest, these are: order, suborder, great group, subgroup, family and series. A series consists of soils that formed in a particular kind of material and have horizons (horizontal layers) that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement within the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition. A soils complex is a mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication. A soil association is a group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit (SCS, 1980).

The soils at KSC were mapped by the Soil Conservation Service (now the Natural Resources Conservation Service or NRCS) and its Florida partners in the soil surveys for Brevard County (SCS, 1974) and Volusia County (SCS, 1980). Fifty-eight soil series and land types occur at KSC, even though Merritt Island is a relatively young landscape and one formed from coastal plain deposits (NASA, 2010a, 2015). Some differences in soil parent material do occur. In particular, soils that formed in deposits over limestone, coquina, or other alkaline material differ greatly in properties from those formed in sand. Textural differences in parent material such as that between loam or clay material and sand also influence soil properties.

Coquina

Coquina (Spanish for 'cockle') is a sedimentary rock, that is, one formed from sediments deposited in the ocean. It is composed entirely or almost entirely of transported, abraded, sorted and cemented shell fragments. The shells are made of the mineral calcite, that is, calcium carbonate ($CaCO_3$), and the shell makers are mollusks, trilobites (a now-extinct class of marine arthropods), brachiopods, or other invertebrates.

The primary source of parent material for KSC soils is sands of mixed terrestrial and biogenic (biological) origin. The terrestrial material originated from rivers carrying sediments eroded from highly weathered Coastal Plain and Piedmont soils; these sediments consist of quartzose (a very hard mineral composed of silica) with a low content of feldspar (another common mineral). These sediments moved south along the Atlantic coast through long-shore transport and may have been reworked repeatedly. The biogenic carbonate fraction of the sand is primarily of mollusk or barnacle origin with smaller concentrations of coralline algae; some may be reworked from offshore deposits of coquina and oolitic limestone (NASA, 2010a, 2015).

Soils of the Cape Canaveral-Merritt Island complex are not all of the same age. Soils on Cape Canaveral, False Cape, and the barrier island section on the east side of 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, Canaveral) in these areas still retain shell fragments in the upper layers, while those inland on Merritt Island (e.g., Paola, Pomello) do not. The presence of shell fragments affects soil nutrient levels, particularly calcium and magnesium, as well as pH (acidity). The eastern section of Merritt Island inland to about State Route 3 has a marked ridge-swale topography presumably retained from its initial formation as a barrier island; west of State Route 3, the island is flatter, without obvious ridges and swales, probably due to the greater age of this topography (NASA, 2010a, 2015).

Differences in age and parent material account for some soil differences, but on landscapes of Merritt Island with similar age, topography has a dramatic effect on soil formation. Relatively small changes in elevation cause marked differences in the position of the water table. This, in turn, influences leaching, accumulation of organic matter, and formation of soil horizons. In addition, proximity to the lagoons affects soil salinity.

Five general soil associations have been identified in the Brevard County section of KSC. These are:

- <u>Paola-Pomello-Astatula association</u> – nearly level to strongly sloping, excessively to moderately drained soils that are sandy throughout the profile. In the KSC area, these soils are located on long, narrow ridges between the Indian River and the Banana River and along the Kennedy Parkway.

- <u>Canaveral-Palm Beach-Welaka association</u> – includes soils that are nearly level to gently sloping, moderately well drained to excessively drained, and sandy throughout that occur primarily on the outer barrier island and Cape Canaveral.

- <u>Myakka-Eau Gallie-Immokalee association</u> – consists of nearly level, poorly drained soils, sandy throughout to a depth of 40 in (102 cm) and loamy below; these soils are associated with flatwoods vegetation.

- <u>Copeland-Wabasso association</u> – includes soils that are nearly level, very poorly drained to poorly drained, sandy to depth of 40 in (102 cm) and loamy below; these soils are associated with hammock vegetation.

- <u>Salt Water Marsh-Salt Water Swamp association</u> – consists of nearly level, very poorly drained, saline to brackish soils of variable textures; these soils are associated with salt marsh and mangrove vegetation.

Similar but differently-named soil associations have been mapped in the Volusia County section of KSC (NASA, 2010a, 2015).

The above soil associations are too generic for many purposes, but there are too many soil series and land types to address each individually. As part of a baseline characterization of soil, groundwater, surface water and sediment at KSC, 10 soil classes were developed based on similarities (NASA, 2010a, 2015). First, soils were divided into four groups: Upland, Wetland, Agricultural, and Disturbed (Table 3.3-1).

Table 3.3-1. Soil classification for the Kennedy Space Center

Division	Subdivision	Description	Class
Upland	Well-drained	Recent, coastal, alkaline soils – vegetation is coastal dunes, coastal strand, or coastal scrub	Coastal
		Old, inland, acid soils – vegetation is scrub or scrubby flatwoods	Acid Scrub
		Inland, circumneutral* soils over coquina – vegetation is scrub or xeric hammock	Coquina Scrub
	Poorly-drained	Acid, sandy soils – vegetation is flatwoods	Flatwoods
		Circumneutral to alkaline soils over coquina or limestone – vegetation is hammock	Hammocks
Wetland	Freshwater	Inland, freshwater soils – vegetation is freshwater marshes or hardwood swamps	Freshwater Wetland
	Saline	Coastal, brackish to saline soils – vegetation is saltmarsh or mangroves	Saltwater Wetland
Agricultural	Scrub soil	Active or abandoned citrus on acid or coquina scrub soils	Citrus Scrub
	Hammock soil	Active or abandoned citrus on hammock soils	Citrus Hammock
Disturbed		Soils modified by construction or filling	Disturbed

Source: NASA, 2010a, 2015
* “Circumneutral” soils are neither acidic or alkaline, having a pH between 6.5 and 7.5.

Upland soils are not flooded for substantial periods, while Wetland soils have standing water for substantial periods. Flooding affects organic matter accumulation, oxidation-reduction conditions, and other chemical properties of soils. Upland soils were then subdivided into well-drained and poorly drained categories. Well-drained, upland soils were divided into three classes: 1) geologically recent, alkaline, sandy soils of coastal dunes where the vegetation is coastal dunes, coastal strand, or coastal scrub; 2) old, inland, leached, acid, sandy soils where the vegetation is oak-saw palmetto scrub or scrubby flatwoods; and 3) inland, circumneutral soils formed over coquina where the vegetation is oak-saw palmetto scrub or xeric hammock. Poorly-drained, upland soils were divided into two classes: 1) acid, sandy soils with flatwoods vegetation; and 2) circumneutral to alkaline soils formed over coquina or limestone where the vegetation is mesic hammock (NASA, 2010a, 2015). Poorly drained soils accumulate more organic matter, which forms the cation exchange capacity in these soils retaining nutrients and metals.

The primary division of wetland soils was between: 1) inland, freshwater wetlands where the vegetation was freshwater marshes or hardwood swamps; and 2) coastal, brackish to saline wetlands where the vegetation was salt marshes or mangroves.

Agricultural soils are of two types: 1) active or abandoned citrus groves on scrub soils; and 2) active or abandoned citrus on hammock soils. Disturbed soils included various types modified by construction. This group could be heterogeneous, but there was no apparent division into homogeneous subgroups.

The acreage of KSC soil classes listed in the right-most column of Table 3.3-1 is shown in Table 3.3-2. Figure 3.3-1 depicts the distribution of these soil classes at KSC.

Table 3.3-2. Area of identified soil classes at the Kennedy Space Center

Class	Area – acres (hectares)	Percent of soil area
Coastal	2,714.0 (1,098.3)	3.30
Acid Scrub	3,847.2 (1,556.9)	4.76
Coquina Scrub	668.2 (270.4)	0.81
Flatwoods	25,779.5 (10,432.6)	31.32
Hammocks	4,917.6 (1,990.1)	5.97
Freshwater Wetland	15,207.6 (6,154.3)	18.48
Saltwater Wetland	23,786.8 (9,626.2)	28.90
Citrus Scrub	863.1 (349.3)	1.05
Citrus Hammock	1,581.5 (640.0)	1.92
Disturbed	2,946.5 (1,192.4)	3.58

3.3.1.2 Geology

Florida has a complex geologic history with repeated periods of deposition when the Florida Plateau was submerged under the ocean and erosion when the seas recessed. The oldest formations known to occur beneath Brevard County and the KSC were deposited in the early Eocene Epoch (56 to 43 million years ago) in an open ocean. The sea then receded and a period of erosion ensued. In the late Eocene, the seas advanced again and limestones of the Ocala group were deposited. In the next cycle, the Hawthorn formation of calcareous clay, phosphatic limestone, phosphorite, and radiolarian clay was deposited in the late Miocene Epoch (23 to 5.3 million years ago). Overlying these strata are unconsolidated beds of fine sand, shells, clay, and calcareous clay of late Miocene or Pliocene age. Surface strata in Brevard County are primarily unconsolidated white to brown quartz sand containing beds of sandy coquina of Pleistocene and Holocene age (NASA, 2010a, 2015).

During the Pleistocene Epoch or Ice Age from 1.6 million to 13,000 years ago, repeated glaciation of the Northern Hemisphere produced dramatic fluctuations in the sea level. At the maximum of the Wisconsinian glaciation (ca. 18,000 years ago), sea levels were on the order of 100 m (over 300 feet) lower than at present, and substantial additional areas were exposed along the Atlantic and Gulf coasts, including Florida.

The alternating high and low sea stands of the Pleistocene and Holocene (since ca. 13,000 years ago) shaped the surface of Brevard County. The outer barrier island and Cape Canaveral formed after sea levels rose when the Wisconsinian glaciers retreated. Cape Canaveral is mapped by geologists as Holocene in age, beginning to form about 7,000 years ago. Cape Canaveral is part of a prograding barrier island complex (i.e., one that builds seaward), the result of southward

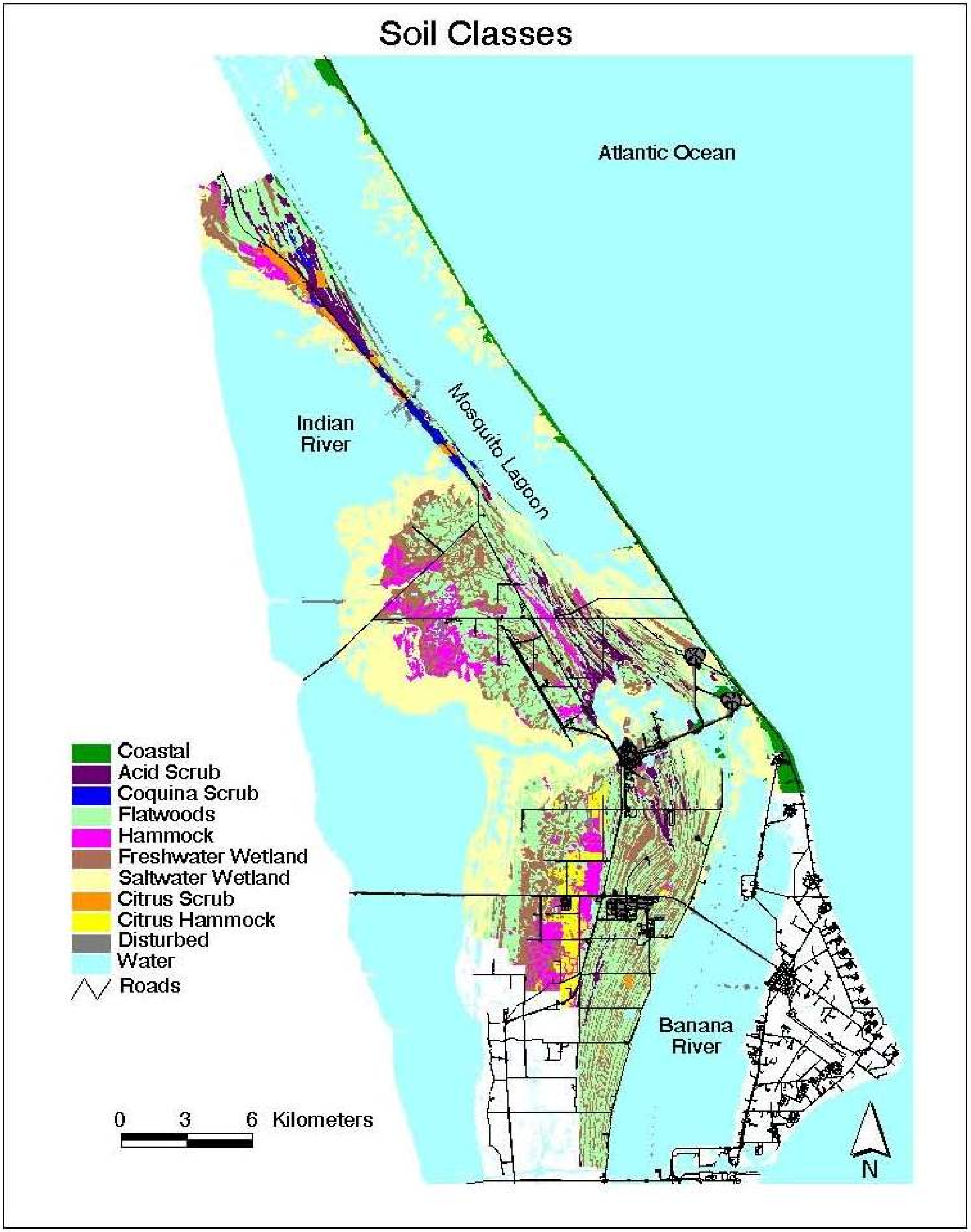

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Figure 3.3-1. Distribution of soil classes at Kennedy Space Center
Source: NASA, 2010a, 2015

growth of an original cape at the site of the present False Cape. Multiple dune ridges on Cape Canaveral suggest that alternating periods of deposition and erosion occurred. The barrier island separating Mosquito Lagoon from the Atlantic Ocean also originated about 7,000 years ago. However, its history has been marked by erosion, overwash, and landward migration rather than progradation; these processes are continuing even today. Some areas of the barrier island south of Cape Canaveral have a history of overwash, while others have been more stable (NASA, 2010a, 2015).

Merritt Island also formed as a prograding barrier island complex; the eastern edge of Merritt Island at its contact with the Mosquito Lagoon and the Banana River forms a relict cape aligned with False Cape. Multiple dune ridges apparently represent successive stages in this growth. The western portion of Merritt Island is substantially older than the east. Erosion has reduced the western side to a nearly level plain.

Lithology, stratigraphy and geologic structure are important determinants of groundwater quality, the distribution of aquifers and confining beds, and the availability of groundwater. Four distinct geologic units are characteristic of the coastal area of East-Central Florida and lie beneath KSC (Table 3.3-3). In descending order these are: Pleistocene and Recent age sands with interbedded shell layers, Upper Miocene and Pliocene silty or clayey sands, Central and Lower Miocene compacted silts and clays, and Eocene limestones (NASA, 2010a, 2015).

Lithology and Stratigraphy

Lithology refers to the general physical properties of rocks in a given area.

Stratigraphy refers to the order and relative positions of rock strata, as well as their relationship to the geologic time scale.

3.3.1.2.1 Pleistocene and Holocene (Recent) Deposits

The Pleistocene period was characterized by a wide range of sea level fluctuations. These deposits are, therefore, characterized by 35 to 45 stratigraphic feet (10.7-13.7 m) of fine-medium sands with varying amounts of shell and interbedded layers of shell deposited by long shore currents and wave action (high energy environments) and subjected to varying degrees of oxidation. The upper limits of Pleistocene deposits range from 5 to 8 ft. (1.5-2.4 m) above mean sea level (MSL) or the elevation of the Silver Bluff terrace, the youngest terrace formed as the result of the Pleistocene age sea level fluctuation. The characteristics of these Pleistocene deposits have been altered by cementation and compaction; in the upper horizons discontinuous layers of limerock hardpan, dark brown humic sandstone hardpan, silt, and clay can be found (NASA, 2010a, 2015).

3.3.1.2.2 Undifferentiated Upper Miocene and Pliocene Silts, Sands and Clays

Visually, there is little difference between the upper Hawthorn and Upper Miocene deposits. They generally occur between a top elevation of -30 ft. (9.1 m) MSL and a base elevation of -115 feet (35.0 m) MSL, and consist primarily of sands, silts, and clays with minor occurrences of limestone and shelly sands. They were deposited in shallow marine and lagoonal environments subjected to numerous sea level fluctuations, resulting in numerous interbedded, discontinuous strata of local area extent. The upper limits of these undifferentiated deposits are equivalent to the Caloosahatchee Marl Formation and in the northern edge of Merritt Island, the top of the Pliocene Tamiami Formation is at approximately -87 ft. (26.5 m) MSL.

Table 3.3-3. Generalized stratigraphy at the Kennedy Space Center

Geologic Age	Formation Name	Aquifer	Physical and Water-bearing Characteristics
Holocene (Recent)			Highly variable and undifferentiated deposits.
Pleistocene	Anastasia Formation	Surficial Aquifer System	Sand, shell, clay, coquina, and mixtures. Yields moderate amounts of water, depending on permeability of deposits.
Pliocene	Tamiami Formation	Surficial Aquifer System	Interbedded limestone, coquina, sand and clay (eastern). Shell, sand, clay and cemented zones (western).
Miocene	Hawthorn Formation	Intermediate Confining Unit	Sand clay, green and brown clays, and some limestones. Generally impermeable; poor water yield except for some thin shell and limestone beds.
Oligocene	Suwanee Limestone	Floridan Aquifer System	Gray to cream colored, clayey, granular limestone. Poor water yields.
Eocene	Ocala Limestone	Floridan Aquifer System	Gray to cream colored, porous massive limestone, generally yields good quantity of water.
Eocene	Avon Park Limestone	Floridan Aquifer System	Cream colored to tan, porous, chalky, and hard crystalline limestone and dense dolomite.
Eocene	Lake City Limestone	Floridan Aquifer System	Cream colored to tan, porous, chalky, and hard crystalline limestone and dense dolomite.
Eocene	Oldsmar Limestone	Floridan Aquifer System	Not commonly tapped by wells.

Source: NASA, 2010a, 2015

A narrow band of shelly conglomerate or medium hard limestone lies within the Tamiami Formation. The contact between the undifferentiated sediments and the overlying surficial sands is conformable and gradational over approximately three stratigraphic feet (0.9 m), but is nonetheless distinct (NASA, 2010a, 2015).

3.3.1.2.3 Lower and Middle Miocene Silts and Clays

The Ocala limestone was submerged during the Miocene Epoch, at which time the Hawthorn Formation was uniformly deposited on the karst Ocala limestone surface. The top of the Hawthorn Formation is located approximately -115 ft. (35.0 m) MSL and extends down to the Ocala limestone. It consists of calcareous clays and silts, sandy phosphatic limestone, and phosphatic clays. These massive beds of marine clays and silts are identified by varying amounts of phosphatic material (formed from residue of shallow marine life) and a dramatically high natural gamma ray signature on geophysical well logs.

Associated with this formation are at least two thin (approximately 2-3 ft. [0.6-0.9 m]), discontinuous conglomerate limestone/ sandstone beds. The upper bed, although not always present, is located near the -120 ft. (36.6m) MSL mark and the location of the lower bed ranges between approximately -130 ft. (39.6 m) MSL and -140 ft. (42.7 m) MSL depending on the presence or absence of faulting. Its thickness depends on the extent to which the Ocala limestone surface has been eroded. The top of the Hawthorn Formation gradually changes to Upper Miocene silts and clays. The exact upper limits of the formation have not been described; however, it is assumed to be the change from firm compact sediments to looser, less consolidated materials. Numerous geophysical logs (natural gamma) indicate the diagnostic signatures of the Hawthorn Formation beginning at approximately -110 ft. (33.5 m) MSL to -120 ft. (36.6 m) MSL (NASA, 2010a, 2015).

3.3.1.2.4 Eocene Limestones

At least four limestone formations from the Eocene Epoch make up the Floridan aquifer system in the KSC area (Table 3.3-3). The upper limestones, the Ocala group, are the best defined as they have been test drilled numerous times for the design of facilities for the Manned Lunar Landing Program and have been utilized for an artesian water source. The Ocala limestone is of late Eocene age and was formed in a shallow sea environment. This limestone was later exposed to subaerial processes above sea level where it developed karst topography complete with sinks, cavities, and solution channels (NASA, 2010a, 2015).

3.3.2 Environmental Consequences Including Cumulative Impacts

Soils and geology can be altered through three processes: (1) physical degradation, such as wind and water erosion, and compaction; (2) chemical degradation such as toxification, salinization, and acidification; and (3) biological degradation, which includes declines in organic matter, carbon, and the activity and diversity of soil fauna. While there are few applicable regulations regarding soils, proper conservation principles can reduce erosion, decrease turbidity, and generally improve water quality.

3.3.2.1 Proposed Action

3.3.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

Impacts of the Land Use Plan, Future Development Plan, and Functional Area Plans on upland and wetland soils and geology are considered in this section. Actions from these plans that could affect upland and wetland soils and geology include ground-disturbing construction of:

- Vertical launch pads and landing areas
- Horizontal launch and landing areas
- Launch operations and support areas
- Assembly, testing, and processing areas
- Utility systems areas and corridors
- Administration facilities
- Central Campus facilities

- Support Services facilities
- Public Outreach facilities
- Research and Development facilities
- Renewable energy areas

The acreage of some land use areas would increase, while others would decrease (see Table 2.1-1). Overall, the effort to reduce NASA's footprint and consolidate operations into specific functional areas would result in an increase of 75.73 additional acres of land in use as part of the KSC complex. However, 5,850 acres that are currently part of the operational buffer, both public use and conservation components, and open space would be allocated for other land uses where soils and geology would be disturbed during development (Table 2.1-1). Concentrations of functions and uses would occur in functional areas as listed in Section 2.1.5, which would minimize impacts to soils and geology over the long-term.

Actions under the Land Use Plan, Future Development Plan, and Functional Area Plans would result in impacts on upland and wetland soils and geology from clearing, grubbing, grading, excavating, filling, etc. Ground-disturbing construction activities would occur in some areas where soils have previously been disturbed, but activities would also occur in undisturbed areas. In previously disturbed areas, adverse impacts on soils would be considered minimal as soil structure and function have already been destroyed or altered. Additionally, some areas where project activities would occur are likely to consist of fill or road base material placed during previous construction, thus there would not be any natural soils present. Where disturbance of intact natural soils may occur as a result of project activities, the impacts would be greater. These types of impacts are described below.

The use of heavy equipment would be short-term during project activities, and the degree of soil impacts would depend on the types of soils occurring onsite (disturbed vs. natural), site topography, and the size of the project area. Proposed actions may expose previously undisturbed earthen materials. If any natural soil horizons exist, they would likely be disturbed during the earthwork. Heavy equipment may compact or loosen and destroy the structure and function of the organic soil horizon and mineral soils and reduce soil moisture, potentially resulting in increased runoff and erosion. Severe soil compaction could inhibit revegetation in denuded areas.

Soil erosion from use of heavy equipment could occur as a result of ground disturbance leading to detachment of soils and transport of freshly disturbed surfaces in wind and storm flow runoff. The tires and tracks of heavy equipment may potentially erode soils and carry sediment from construction sites to paved areas, which would drain into ditches and catch basins during rain events, or cause dust in dry periods. Disturbing soils could create habitat for colonization by invasive species. Spills and leaks of hazardous materials during construction can lead to soil contamination and toxicity. Proper control of hazardous materials during construction and prompt response to spills or releases would, however, reduce this impact. Best Management Practices (BMPs) would be implemented during project activities to prevent or reduce soil erosion into water surfaces and minimize adverse soil impacts.

Activities that do not involve heavy equipment could expose and compact soils to varying degrees in the short-term. As with use of heavy equipment, any new areas that would be repeatedly compacted by vehicles during project activities would have adverse impacts on soils. Off-road vehicular traffic can decrease soil porosity, decreasing the transfer of air and water through the soil and causing decreased vegetative productivity due to root restriction. If any natural soil horizons exist, they would likely be lost. Exposed soils would be subject to erosion until stabilized or revegetated. Rutting could occur if proper drainage is not implemented. Soil compaction could also result from foot traffic during construction activities; however, these impacts would likely be minimal and limited to the area immediately surrounding the project site.

During construction and preparation activities, topsoil should be removed and stockpiled wherever possible and reused in the area where it was salvaged. After construction is complete, the establishment of a native vegetative cover in disturbed areas would aid in reestablishing biological activity in the soil. Other than areas where impervious surfaces are placed, it is likely that adverse impacts on soils would not occur over the long-term as mitigation actions such as topsoil replacement and re-establishment of native vegetation would help reduce erosion by facilitating site recovery.

Exposure and disturbance of soils could increase the potential for accelerated soil erosion from sites affected by construction. Disturbance of soils would impede soil development, including soil structure and profile development. Excavation, transportation, and placement of topsoil also could promote the breakdown of soil aggregates into loose soil particles, increasing the potential for wind and water erosion of stockpiled soils. Blading and/or excavation of remaining subsoil materials to achieve desired grades and soil conditions for the facilities could result in steeper slopes on exposed soils, mixing of soil materials, and the additional breakdown of subsoil aggregates. Soil biological activity (especially with mycorrhizea-root association) and nutrient cycling would be substantially reduced or eliminated during stockpiling as a result of anaerobic conditions created in deeper portions of the stockpiles.

Although stripping, stockpiling, and redistribution adversely affect soil characteristics, including alterations of soil profiles and soil structures, the benefits of using soil for revegetation outweigh the adverse effects of soil handling. Revegetation efforts would return some areas of soil disturbance to a productive state following construction, thereby reducing the duration and magnitude of impact. Loss of soil or discontinuation of natural soil development, decreased infiltration and percolation rates, decreased available water-holding capacities, breakdown of soil structures, and loss of organic material as a result of the proposed action would be lessened by natural soil development over the long-term.

Potential indirect effects of soil destabilization and erosion would be dust generation and off-site deposition. Wind erosion of disturbed soils could result in deposition of soil particles off-site. Off-site stream sedimentation would be minimized by the use of erosion control practices such as sediment catchment basins placed around the base of soil stockpile and dump slopes. Dust generated by vehicular traffic would be reduced by using dust abatement techniques such as the application of wetting and binding agents on roads.

The appropriate foundation type to support the proposed new structures as part of this alternative depends on many factors, including subsurface conditions, types of loads that the structure would support, environmental concerns, surface constraints, etc. Digging to install facility foundations would, in some cases, disturb and damage subsurface geological materials. However, such impacts would be localized and would not affect the overall geology of the area.

Impacts of proposed project activities on soils and geology would be short-term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, types of soils occurring onsite, and whether impervious surfaces would be placed over soils and geological materials. Impacts on soils and geology would be less than significant.

3.3.2.1.2 Launch, Landing, Operations and Support

Impacts of Launch, Landing, Operations and Support on soils and geology are considered in this section. Actions from the proposed action that could affect soils and geology include:

- Vertical launches and landings
- Horizontal launches and landings

Other activities associated with launches and landings, such as preparation for launch, safing operations, and payload operations would not affect soils and geology as they would occur on already developed and hardened surfaces, so there would be no ground disturbance.

Vertical and horizontal launches may result in local adverse impacts on soils and geology. Impacts would result from the deposition of rocket engine emissions (e.g., acids, various metals, and other substances based on the propellant type and characteristics). Solid rocket propellant typically consists of aluminum powder fuel, ammonium perchlorate (AP) oxidizer and a binder. The main combustion products of these fuels are solid aluminum oxide (Al_2O_3) particulate, hydrogen chloride (HCl) gas, water vapor (H_2O), nitrogen (N_2) and carbon dioxide (CO_2). Based on findings from past studies, elevated metal concentrations and changes in soil pH would be expected from such deposition within a small radius of the launch pad. Far-field deposition may be sufficiently dispersed and variable from launch-to-launch that successive launches would seldom affect the same areas.

Past studies indicate that the pH of leachate from soils exposed to near-field deposition decreased immediately post-launch; however, leachate pH recovered to pre-launch values within seven days (NASA, 2010a, 2015). Over the course of the study, a cumulative decline of 0.35 pH units in the background soil pH was noted in the highly exposed soils. With each loading of hydrochloric acid by the launch exhaust cloud, metal concentrations (e.g., aluminum, copper, iron, and zinc) increased in soil leachates due to increased metal solubility at lower pH. Between launches, as leachate pH recovered to near background levels, metal concentrations in the leachate declined, probably due to the formation of less soluble metal oxides and hydroxides, at circumneutral pH. Cation concentrations, particularly calcium and magnesium, were elevated immediately post-launch and between launches probably due in part to dissolution of shell fragments prevalent in these coastal soils. Other contaminants found in soils post-launch were benzo(a)pyrene, arsenic, and nickel.

Studies also found that in non-saline soils, there were increases in conductivity, calcium, potassium, sodium, and zinc and decreases in phosphorus, nitrogen from nitrates (NO_3), and nitrogen from ammonium (NH_4) post-launch (NASA, 2010a, 2015). In saline soils, there were increases in calcium, potassium, sodium, zinc, and phosphorus but not conductivity and decreases in ammonium nitrogen but not nitrate nitrogen. Increases in conductivity, calcium, potassium, and sodium (Na) may be due to leaching of soil material including shell fragments; increases in zinc could be from soil leaching or from deposition of material derived from paint or plating on pad structures. Soils in the impact area remained well buffered; even after many launches and soil pH was still alkaline. Since pH was still high, the aluminum deposited by the exhaust cloud was not exchangeable.

RP-1, Jet-A and LCH4 (liquid methane) can all be classified as liquid hydrocarbon propellants. These fuels commonly use Liquid Oxygen (LOX) as the oxidizer. Jet-A propellant typically contains sulfur. As carbon is a main ingredient in the fuel, hydrocarbon propellants produce a large amount of carbon dioxide and water vapor as products of combustion, which would not adversely affect soils. Other minor constituents include CO and sulfur dioxide SO_2, which could be deposited on soils and cause local impacts.

Cryogenic engines (liquid hydrogen (LH2)/ liquid oxygen (LOX)) are in a category by themselves. Water vapor is the only product of combustion, thus there would be no impacts on soils and geology.

Propellants categorized as using liquid hydrazine fuels typically use dinitrogen tetroxide as the oxidizer. These fuels are hypergolic with the listed oxidizers and are very hazardous; however, when burned as fuel, the products of combustion are mostly non-hazardous. Combustion of these propellants produces mostly water vapor and nitrogen, as well as smaller quantities of carbon dioxide, carbon monoxide and nitrous oxides. The nitrogen deposited on soils could cause local impacts.

Mitigation measures could include sediment blocks in areas with outfalls outside the launch perimeter fence to prevent off-site migration of soils containing elevated metal concentrations.

The deposition of launch vehicle (LV) stages (i.e., booster rockets) or the landing of a reentry vehicle (RV) would result in an adverse impact on soils and geology in the event they are deposited on land rather than water. Soils and substrates may be compacted or otherwise disturbed by the impact of LV stages or RVs.

Overall, the effects of vertical and horizontal launches and landings on soils and geology are expected to be short-term to medium-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of soils to the launch or landing site. Impacts on soils and geology would be less than significant.

3.3.2.1.3 Future Transportation Plan

Impacts of the Future Transportation Plan on soils and geology are considered in this section. Actions from this plan that could affect soils and geology include:

- Road improvements, repair, and resurfacing
- Bridge replacement
- Parking lot repurposing or demolition
- Expansion of the Horizontal Launch and Landing capability with a new runway, facilities, infrastructure, and other airfield systems

Other actions in this Plan that would impact soils and geology would need separate NEPA analysis and would not be covered under this Programmatic EIS. These actions include development of railroads and seaports.

Activities that require construction, renovation, or replacement of facilities would have similar impacts on soils and geology as described for ground-disturbing construction in Section 3.1.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans. It is likely that actions such as road improvements or bridge replacement would impact road shoulders and other areas that have been previously disturbed, thus effects on soils and geology would be minimal. If construction occurs in larger areas that are undisturbed, such as building new runways, impacts would be much greater. Parking lot demolition would have beneficial effects if the site is then revegetated and soils allowed to recover.

Impacts of proposed project activities on soils and geology would be short-term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, types of soils occurring onsite, and whether impervious surfaces would be installed. Overall impacts on soils and geology would be less than significant.

3.3.2.1.4 Cumulative Impacts

Cumulative impacts on soils and geology at KSC would be expected from past, present, and foreseeable future activities such as road repair and construction; infrastructure development; wetland conversion; vegetation clearing; USFWS (MINWR) management activities (e.g., prescribed fire management, water level management, invasive species management, and visitor services); and NPS (CNS) management activities. Adverse impacts would include soil compaction, channelization of runoff from impervious surfaces, erosion of soils and mass movement, loss of ecological function where soils are under impervious surfaces, and land subsidence. The cumulative effect of sediment transport from neighboring projects could affect sediment deposits into streams. Adverse soils impacts associated with proposed actions would be small as compared to cumulative past, present, and foreseeable future effects. Cumulative impacts from the Proposed Action would vary with the nature and extent of projects, and impacts would be expected to be minor and adverse.

3.3.2.2 Alternative 1

Impacts from Alternative 1 on soils and geology would be almost the same as those described for the Proposed Action, but on a somewhat smaller scale and covering a slightly smaller area. Under this alternative, the two proposed new seaports under the Proposed Action would be not be constructed, and thus the impacts on soils associated with these actions would not occur. Also under Alternative 1, construction of the Proposed Action’s Horizontal Launch and Landing functional area north of Beach Road may not happen. If it were not to occur, impacts to soils in this undeveloped area would thus be avoided.

Cumulative impacts from Alternative 1 would be essentially the same as the Proposed Action's.

3.3.2.3 No Action Alternative

Under the No Action Alternative, soils and geology would not be affected by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws and permits and within the footprint of existing developed areas. Existing uses would continue at current levels. Effects on soils and geology from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. Thus the No Action Alternative would not have any additional impacts on soils and geology.

3.4 Water Resources

3.4.1 Affected Environment

This chapter describes the water resources in and around the NASA KSC that could be affected by the Proposed Action and alternatives. Much of the information here is derived from the most recent Environmental Resources Document (NASA, 2010a, 2015), a report which contains comprehensive data on the natural resources, environmental features, and programs at KSC.

3.4.1.1 Surface Waters

The KSC is surrounded by the Atlantic Ocean and a portion of the Indian River Lagoon (IRL) system consisting of the Indian River to the west, the Banana River to the southeast, and the Mosquito Lagoon to the north (see Figure 3.4-1). This system was formed by changing sea levels and its prominent features are the southern barrier islands, the Cape Canaveral foreland formation, the western mainland ridges, and the valleys and sloughs between the ridges. These basins are shallow lagoons with depths averaging five feet (1.5 m) and maximum depths of 30 feet (9 m) generally restricted to dredged basins and channels.

The Indian River Lagoon (Figure 3.4-2) is a diverse, shallow-water estuary that extends along fully 40 percent of Florida's east coast. Running for 156 miles from Ponce de Leon Inlet in Volusia County to the southern boundary of Martin County, the lagoon is a crucial commercial and recreational fishery and economic resource. Its estimated annual economic value is $3.7 billion and it supports 15,000 full and part-time jobs, while providing recreational opportunities for 11 million people per year (SJRWMD, 2013).

The lagoon runs along the entire western boundary of KSC (Figure 3.4-1). The western boundary of KSC is undeveloped and is part of the Merritt Island National Wildlife Refuge (MINWR). Most of the shoreline on KSC/MINWR is impounded with no direct runoff into the lagoon. The eastern shore of the IRL is highly developed in the area from Titusville south with many areas of point and non-point runoff (NASA, 2010a, 2015).

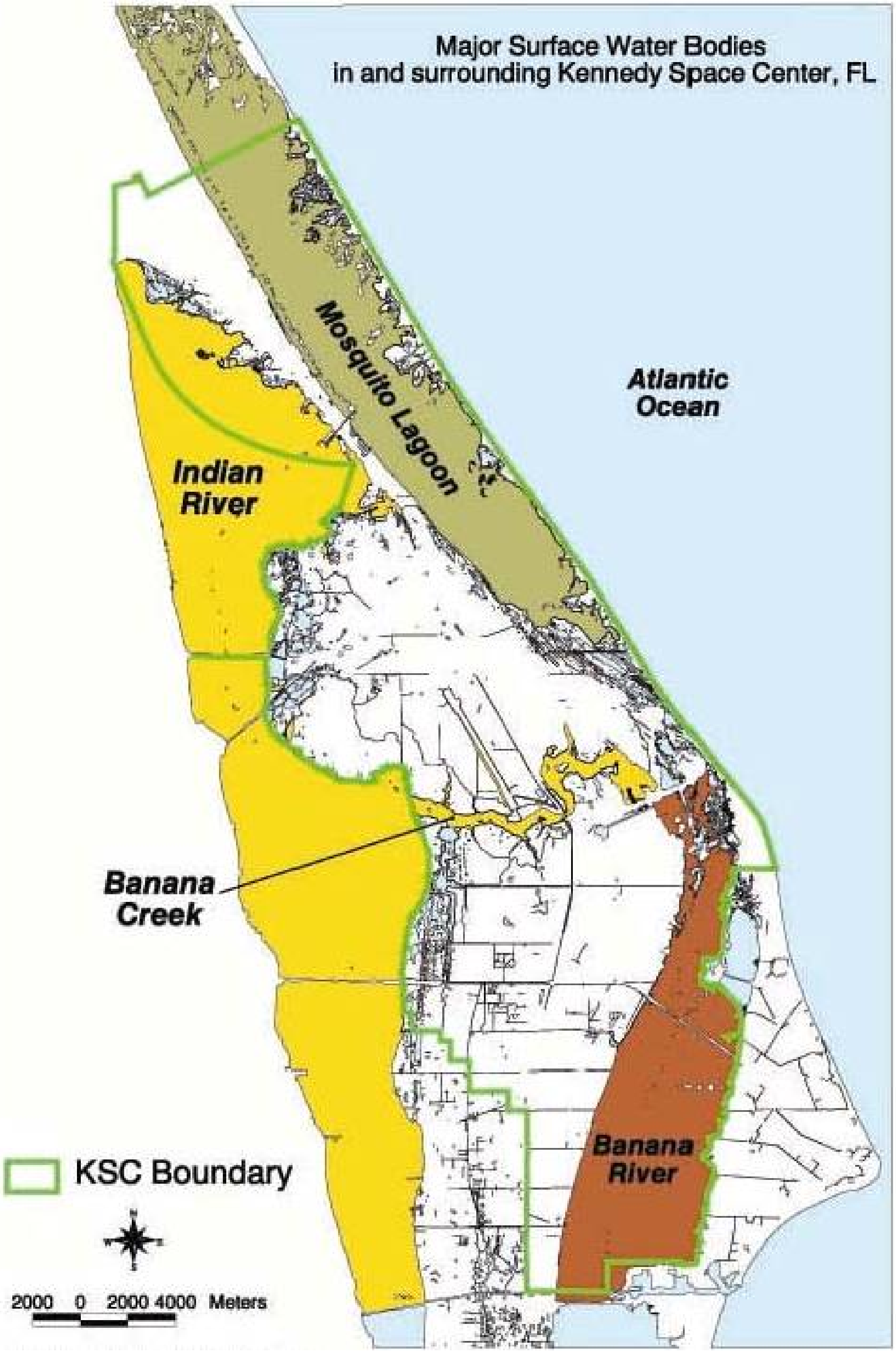


Figure 3.4-1. Major surface water bodies surrounding KSC

Figure 3.4-2. Aerial view of Indian River Lagoon

Mosquito Lagoon and the Indian River are connected by Haulover Canal and the Intracoastal Waterway. Water flow between these two systems is primarily driven by wind. Because of the various man-made modifications related to the space program and mosquito control, circulation between Mosquito Lagoon and the Banana River was blocked in the early 1960s.

The Indian and Banana Rivers mix in the southern region near Eau Gallie and through a man-made canal located just south of KSC. This navigation canal accesses the Atlantic Ocean through the Port Canaveral Locks, whose oceanic waters influence surface water quality in the northern Banana River. The northernmost Banana River reaches inside KSC property and is closed to motorized boat traffic. It is part of the Merritt Island National Wildlife Refuge and its water quality is one of the best in the Indian River Lagoon System. The region of the Banana River north of the NASA Causeway includes Pintail Creek and Max Hoeck Back Creek. Very little tidal fluctuation occurs here, and water movement in this area is influenced primarily by wind and evaporation (NASA, 2010a, 2015).

Banana Creek drains the area adjacent to the Space Shuttle launch pads via a canal located northwest of the VAB to the Indian River. Salinity usually increases in a westward direction, but depending on wind direction, the Indian River system can have a greater or lesser effect on Banana Creek water quality. Freshwater inputs to the estuarine system surrounding KSC include direct precipitation, stormwater runoff, discharges from impoundments, and groundwater seepage (NASA, 2010a, 2015).

The aquatic environment in this area is very biologically diverse, including the temperate Carolinian and the subtropical Caribbean zoogeographic provinces. Lagoonal waters surrounding KSC are shallow flats that support dense growths of submerged aquatic vegetation including manatee grass (*Syringodium filiformis*) (Figure 3.4-3), shoal grass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*), gulf halophila (*Halophila engelmanii*) and various macroalgae such as Gracilaria, Caulerpa, Sargassum, Laurencia, Penicillus, Acetabularia and Acanthophora. Cool winter temperatures preclude the growth of turtle grass (*Thalassia testudinum*) in the KSC area.

Figure 3.4-3. As its name suggests, manatee grass is a key food source for manatees

Shorelines of the system near KSC are dominated by white mangrove (*Laguncularia racemosa*) and black mangrove (*Avicennia germinans*) with red mangrove (*Rhizophora mangle*) occurring in small patches; however, this region represents the northern limit of their range and winter freezes in recent decades significantly affected their populations. Fauna in the lagoon system near KSC represents both the Carolinian and subtropical provinces. Among the most common finfish and shellfish species are mullet (*Mugil cephalus*), spotted sea trout (*Cynoscion nebulosus*), red fish (*Sciaenops ocellatus*), sea catfish (*Arius felis*), and blue crab (*Callinectes sapidus*).

Subtropical species of flora and fauna are present but become more prevalent to the south of KSC. Its unique environmental setting makes KSC one of the most ecologically diverse areas in the United States (NASA, 2010a, 2015).

Sea-based transportation capability and surrounding area water accessibility are essential at KSC. Ponce de Leon Inlet is an oceanic connection to Mosquito Lagoon, located approximately 31 miles north of KSC. Port Canaveral provides an oceanic connection to the Banana River, approximately 7.5 miles south of KSC. Navigation locks within Port Canaveral virtually eliminate any significant oceanic influence on the Banana River. Sebastian Inlet, located 50 miles south of KSC, is the next southerly oceanic connection to the Indian River. The remoteness of the estuarine waters from oceanic influence and the restrictions imposed by constructed causeways, minimize water circulation within the lagoon basins. Surface water movement and flushing are primarily a function of wind-driven forces, and salinity regimes are mostly controlled by precipitation, upland runoff, evaporation, and groundwater seepage. Navigable channels including the Intracoastal and the Turning Basin access channel are excavated waterways. The Intracoastal Waterway follows the Indian River through Haulover Canal and proceeds north through Mosquito Lagoon. Dredged material from the construction of the Intracoastal Waterway and the Turning Basin access channel was typically deposited along the waterways as small islands. The Intracoastal Waterway has a variable width and a design depth of 12 ft.

The Turning Basin access channel extends from Port Canaveral north through the Banana River to the VAB area. A channel spur to Hangar AF provides navigable access for two vessels used in the retrieval of solid rocket boosters (SRBs). Public navigational access is prohibited north of the NASA Parkway East.

The Banana River, south to KARS Park, has been closed to powered vessels with the designation of the area as a manatee sanctuary (NASA, 2010a, 2015).

3.4.1.1.1 Surface Water Standards, Regulations and Permits

Surface waters at KSC include “Waters of the United States,” “Navigable Waters,” and “Waters of the State,” in which construction, discharge, or other activities are subject to a number of Federal, state and regional regulations. The Environmental Protection Agency (EPA) regulates the discharge of pollutants into navigable waters of the United States under the Federal Clean Water Act of 1977 (CWA), as amended by the Water Quality Act of 1987. EPA has adopted many regulations to implement the CWA found in Title 40 CFR. The U.S. Army Corps of Engineers (USACE) administers dredge and fill activities in navigable waters through the authority of the Rivers and Harbors Act of 1899 (RHA), and in Waters of the United States (including isolated wetlands) through Section 404 of the CWA.

3.4.1.1.1.1 Water Quality Standards

The CWA requires each state to adopt water quality standards. These standards are based on the use and values of waters for public water supplies, propagation of fish and wildlife, recreation, agriculture, industry and navigation (NASA, 2010a, 2015).

The EPA was designated under the CWA as the federal agency with regulatory jurisdiction over the discharge of pollutants into waters of the United States. EPA’s regulatory authority is vested in the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES permits are operating permits, which ensure compliance with state and federal water quality standards.

State compliance with the CWA has been delegated to the Florida Department of Environmental Protection (FDEP). Today, surface waters in Florida are designated according to five classifications based on their potential use and value:

- Class I – Potable Water Supplies
- Class II – Shellfish Propagation and Harvesting
- Class III – Recreation and Fish and Wildlife Propagation
- Class IV – Agricultural Water Supplies
- Class V – Navigation and Utility and Industrial Use

Minimum water quality standards for surface and ground waters have been established by FDEP. A complementary water quality classification is provided by the designation of Outstanding Florida Waters (OFW). The regulatory standard for activities in OFW is no reduction of the existing ambient water quality. Additionally, numeric criteria for nutrients in the form of Total Maximum Daily Loadings (TMDLs) have been established for segments of the Indian River and Banana River Lagoons adjoining KSC. The site-specific nature of the OFW water quality standard and TMDL is designed to preclude surface water degradation (NASA, 2010a, 2015).

A Basin Management Action Plan is a blueprint for restoring impaired waters by reducing pollutant loadings to meet the allowable loadings established in a TMDL. It represents a comprehensive set of strategies (e.g., permit limits on wastewater facilities, urban and agricultural best management practices, conservation programs, financial assistance and revenue generating activities, etc.) designed to implement the pollutant reductions established by the TMDL. These broad-based plans are developed with local stakeholders; they rely on local input and local commitment and are adopted by Secretarial Order to be enforceable. KSC is a stakeholder to this process and borders two of the three sub-basins (North Indian River Lagoon and Banana River Lagoon) of the Indian River Lagoon Basin Management Action Plans.

3.4.1.1.1.2 Classification of Surface Waters at KSC

The State of Florida has classified all surface waters at and surrounding the KSC (Figure 3.4-4) as either Class II or Class III.

Class II
The entire Mosquito Lagoon within KSC boundaries and the northern-most segment of the Indian River extending from the NASA Railway spur crossing are designated as Class II - Shellfish Propagation or Harvesting (see Figure 3.4-4). Class II waters establish more stringent limitations on bacteriological and fluoride pollution; the discharge of treated wastewater effluent is also prohibited. Dredge and fill projects in Class II waters require a Plan of Procedure to adequately protect the project area from significant damage.

Class III
The remainder of surface waters surrounding KSC is designated as Class III (Recreation-Propagation and Management of Fire and Wildlife). Class III water standards are intended to maintain water quality suitable for body contact sports and recreation and the production of diverse fish and wildlife communities (NASA, 2010a, 2015).

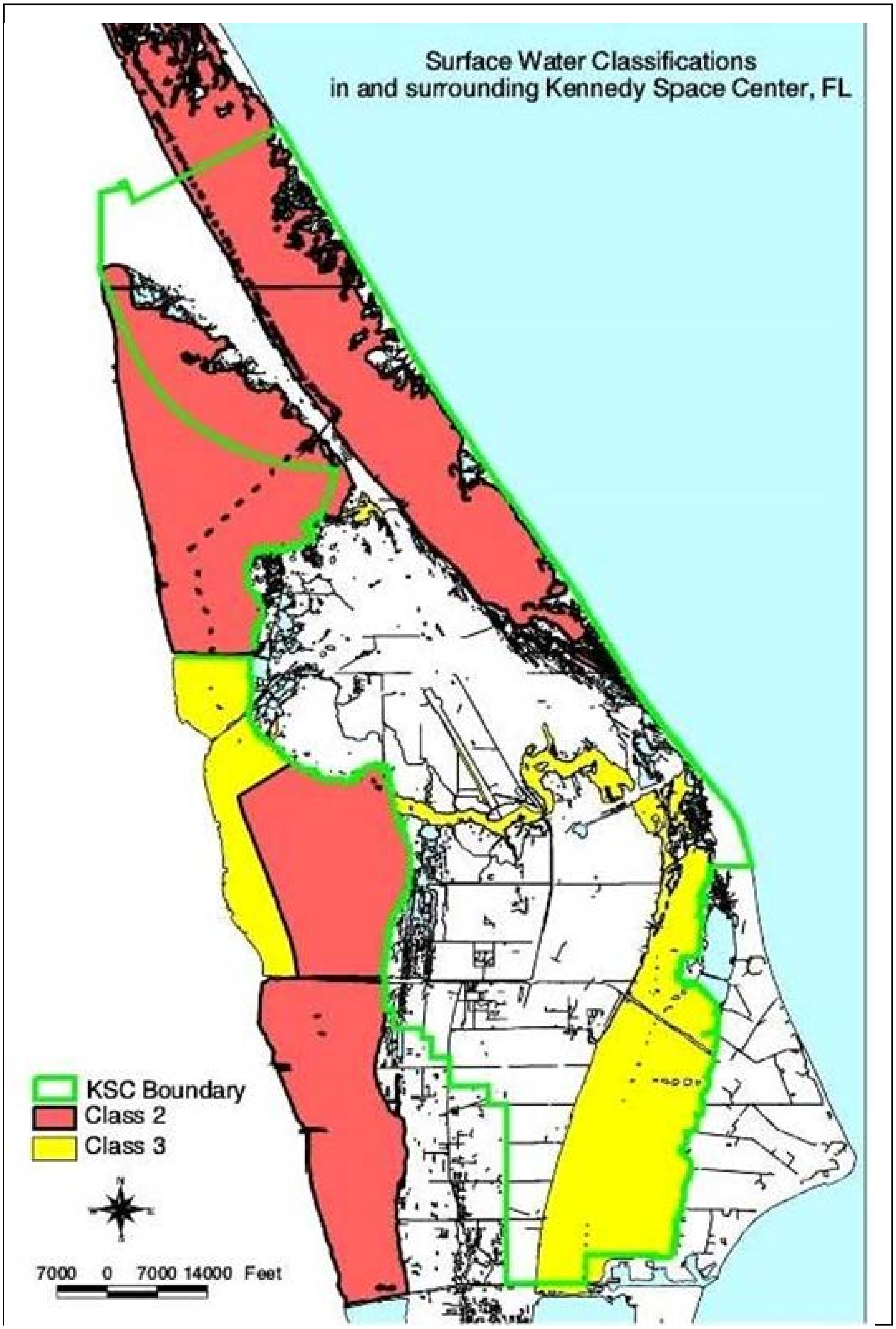


Figure 3.4-4. Surface water classifications at and around KSC

Outstanding Florida Waters
A special classification has been established for certain water bodies which possess demonstrated exceptional recreational or ecological significance. Outstanding Florida Waters (OFW) include waters within national and state parks, wildlife refuges, aquatic preserves, and other State and Federal areas. Areas designated as OFW are afforded the highest protection of any surface waters in the State of Florida. Water quality standards for OFW are established to prevent compromising existing water quality. The Florida Department of Environmental Protection (FDEP) is the principal State agency responsible for the administration of OFW (NASA, 2010a, 2015).

The surface waters within the Merritt Island NWR have been designated as OFW. The OFW designation supersedes other surface water classifications, and water quality standards are based on ambient conditions. These waters cannot be degraded below their existing water quality.

Aquatic Preserves
The Florida Aquatic Preserve Act of 1975 (Chapter 258 F.S.) set aside certain state-owned submerged lands and associated coastal waters in areas which have exceptional biological, aesthetic, and scientific values. The aquatic preserve designation substantially restricts or prohibits activities requiring dredge and fill permits, drilling or gas or oil wells, and the discharge of wastes or effluents. The FDEP is the state agency responsible for the administration of the Aquatic Preserve Program. In this capacity, the FDEP is required to develop and implement management plans for the preservation, protection, and enhancement of the natural resources of each aquatic preserve.

The entire Mosquito Lagoon has been designated by the Board of Trustees of the Internal Improvement Trust Fund as an Aquatic Preserve. The Mosquito Lagoon aquatic preserve management plan has been published, but it has no jurisdiction in Federal waters based on agreements with the State that turn their management over to the Federal agencies.

The Banana River Aquatic Preserve begins at SR 528 (Bennett Causeway) and extends south to Mathers Bridge and includes that entire section of the Banana River and portions of Sykes Creek and Newfound Harbor. A management plan has been developed for this aquatic preserve. The Banana River Aquatic Preserve does not extend to KSC, and NASA operations are not affected by the implementation of the management plan (NASA, 2010a, 2015)**.**

3.4.1.1.1.3 Water Use Permitting

The State of Florida has granted the St. Johns River Water Management District (SJRWMD) the authority to issue permits for the withdrawal and consumption of waters of the state. In so doing, the State is attempting to conserve and promote the proper utilization of Florida's surface and ground waters. KSC is located in the District's Upper St. Johns River Administrative Basin. A Consumptive Use Permit (CUP) is required by the SJRWMD in accordance with the rule criteria set forth in Chapter 40C-2, F.A.C. as amended on August 12, 2008. This rule requires a CUP for the consumptive use of ground or surface water for any of the following:

- Average annual daily withdrawal exceeding one hundred thousand (100,000) gallons average per day; or

- Withdrawal equipment or facilities which have a capacity of more than one million (1,000,000) gallons per day (GPD); or
- Withdrawals from a combination of wells or facilities having a combined capacity of more than one million (1,000,000) GPD; or
- Withdrawals from a well in which the outside diameter of the largest permanent water bearing casing is six inches or greater.

All permits are to include certain limiting conditions set forth in Rule 40C-2.381. The SJRWMD prohibits significant adverse impacts on offsite land uses and legal uses of water existing at the time of permit application.

KSC recently surrendered its facility-wide Consumptive Use Permit for general water consumption. The SJRWMD determined that it has no authority to require Federal Facilities to get CUPs for certain projects/activities. However, KSC is still required to obtain CUPs for certain activities, such as construction dewatering.

3.4.1.1.1.4 Dredge and Fill Permitting in Waters and Wetlands

Discharge of effluent and pollutants to surface waters is regulated by the waters and wetland resource regulatory authority granted to Federal and State agencies. The permitting of dredge and fill activities in Florida is subject to independent review and action by State and Federal regulatory agencies. Despite differing jurisdictional parameters between these agencies, a common joint form permit application has been developed. The joint form application notifies all regulatory authorities of a proposed action. Federal authority over dredge and fill operations is established by the CWA of 1977, the Rivers and Harbors Act of 1899, the NEPA, the U.S. Fish and Wildlife Coordination Act, the Safe Drinking Water Act, and the Endangered Species Act of 1973.

The USACE administers the Federal dredge and fill permitting program (referred to as wetlands resource permitting by FDEP) under Section 404 of the Clean Water Act with assistance and review from other Federal agencies including the USFWS, the National Marine Fisheries Service (NMFS), and the EPA.

In exercising its authority to permit the discharge of dredge and fill to Waters of the United States, including wetlands, the USACE exerts jurisdiction over all coastal and inland waters, lakes, tributaries to navigable waters, and adjacent wetlands to the above. In addition, as a result of a ruling by the EPA regarding interpretation of the "interstate commerce connection," the USACE has been authorized regulatory jurisdiction over all isolated wetlands and surface waters.

Thus, virtually any activity within wetlands or surface waters is subject to the USACE permitting authority. The USACE 1987 Wetland Delineation Manual, used to identify waters and wetlands over which the USACE has jurisdiction (referred to as “jurisdictional wetlands”) was updated in December 2008. Wetlands are generally characterized by the presence of hydric soils, wetland hydrology, and hydrophytic (water-dependent) plants. The landward extent of wetlands as determined by the State and Federal agencies is generally the same or very similar.

FDEP is the principal agency for administering the State wetland resource permit process (Chapter 62-312 F.A.C.). Under the provisions of The Warren S. Henderson Wetlands Protection Act of 1984, the FDEP authority to regulate dredge and fill activities was largely consolidated under Chapter 403, F.S. FDEP jurisdiction extends over the "Waters of the State," which are defined to include, but are not limited to, rivers, lakes, streams, springs, impoundments, and all other waters or bodies of water including fresh, brackish, saline, tidal, surface or underground. The Henderson Act clarified FDEP jurisdiction over wetlands by establishing indicator wetland species and soil types. In addition, the Act establishes provisions for the special consideration of OFW in the permit application review process.

FDEP wetland resource permitting authority is supported by the Florida Fish and Wildlife Conservation Commission (FFWCC), which is responsible for the management, protection, and conservation of wild animal life and aquatic freshwater life, and the Florida Department of Environmental Protection-State Lands (formerly Florida Department of Natural Resources), which processes requests for the use of State-owned lands including submerged bottoms.

SJRWMD received delegation for wetland resource permitting in 1988. The operating agreement between SJRWMD and FDEP was subsequently amended on July 1, 2007. SJRWMD reviews all wetland resource permit applications when an activity also requires a stormwater discharge permit, with the following exceptions:

- All wetland resource permits for solid, industrial, domestic and hazardous waste treatment facilities will be reviewed by FDEP;
- SJRWMD projects will be permitted by FDEP;
- Power plant siting will be processed by FDEP;
- USACE water resources projects will be permitted by FDEP;
- Marinas (ten or more boat slips);
- Other activities listed in the delegation agreement;

KSC obtains its potable water under contract from the City of Cocoa, which draws its supplies from the Floridan Aquifer. The water distribution system at KSC is sized to accommodate the short-term, high-volume flows required for launches. In average, the facility utilizes 4.9 million liters (1.3 million gallons) of water per day (NASA, 2008).

3.4.1.1.1.5 Surface Water Quality

Surface water quality at KSC has been characterized as generally good. The waters tend to be alkaline and have good buffering capacity. The areas of highest water quality are adjacent to undeveloped parts of the lagoon, such as the north Banana River, Mosquito Lagoon, and the northernmost portion of the Indian River.

In order to document the surface water quality in the vicinity several different monitoring programs are used. NASA, SJRWMD and Brevard County all maintain water quality monitoring stations in and around KSC. The SJRWMD lagoon-wide network maintains two surface water quality monitoring stations within KSC (Figure 3.4-5). Surface water quality data are collected by KSC and are submitted to the SJRWMD for incorporation into a region-wide database. The surface water quality data from this program are used for long-term trend analysis and play a supportive role in land use planning for the entire Indian River Lagoon.

Since 1984, eleven sites within the boundary of KSC have been monitored quarterly until 2000 and bi annually to present (Figure 3.4-5). The purpose of this monitoring program is to maintain a baseline ecological database of basic surface water quality parameters. Most of the monitoring sites are located away from major facilities and operational areas as background stations to characterize ambient conditions which can be compared to several sites that are located near launch complexes to monitor any short-term or long-term impacts. 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.

In 1998 a comprehensive study to document background chemical composition of soils, groundwater, surface water, and sediments of the KSC was conducted. In addition to the ongoing, long-term surface water quality monitoring sites, forty additional locations were examined. Location of the surface water sampling stations was determined based on the watershed basins. Forty stations were selected to incorporate samples from open lagoonal water, rivers, creeks, ditches, borrow pits, and impoundments. Samples were collected using standard sampling protocols. Basins included Banana Creek, Banana River, Indian River Lagoon, Mosquito Lagoon, saline ditches, and freshwater ditches (Figure 3.4-5).

Surface water samples from inland bodies have been analyzed for a number of parameters and contaminants, including organochlorine pesticides, aroclors (PCBs), chlorinated herbicides, polycyclic aromatic hydrocarbons (PAHs), and metals. Field parameters such as pH, temperature, turbidity, dissolved oxygen (DO), and conductivity were also measured at each sampling location. All of the aroclors (6) and chlorinated herbicides (18) were below detection limits. One of 25 organochlorine pesticides (Dieldrin) was above detection, as were five of 17 PAHs. The occurrence of Dieldrin, a persistent synthetic insecticide, is probably due to past agricultural use on these lands. Concentrations of PAHs were low and may result from natural sources or regional deposition.

Sixteen of 24 metals were above detection limits; eight of them were always below detection (barium (Ba), cadmium (Cd), chromium (Cr), cobalt (Co), mercury (Hg), nickel (Ni), vanadium (Vn), and zinc (Zn)). Nine metals were above detection in too few samples to test for differences among watershed basins (antimony (Sb), arsenic (As), beryllium (Be), copper (Cu), lead (Pb), manganese (Mn), selenium (Se), silver (Ag), and thallium (Tl)). Seven metals commonly above detection limits differed among basins (aluminum (Al), calcium (Ca), chlorine (Cl), magnesium (Mg), iron (Fe), potassium (K), and sodium (Na)). Patterns of differences varied among metals. For Al, Banana Creek was higher than the other basins. Fe was higher in Banana Creek, saline ditches, and freshwater ditches compared to Banana River, Indian River Lagoon, and Mosquito Lagoon. Values of Ca, Cl^- , and Mg occurred in three classes with Banana Creek, Mosquito Lagoon, and Indian River Lagoon the highest, Banana River and saline ditches intermediate, and freshwater ditches low. K was highest in Mosquito Lagoon, intermediate in Banana Creek,

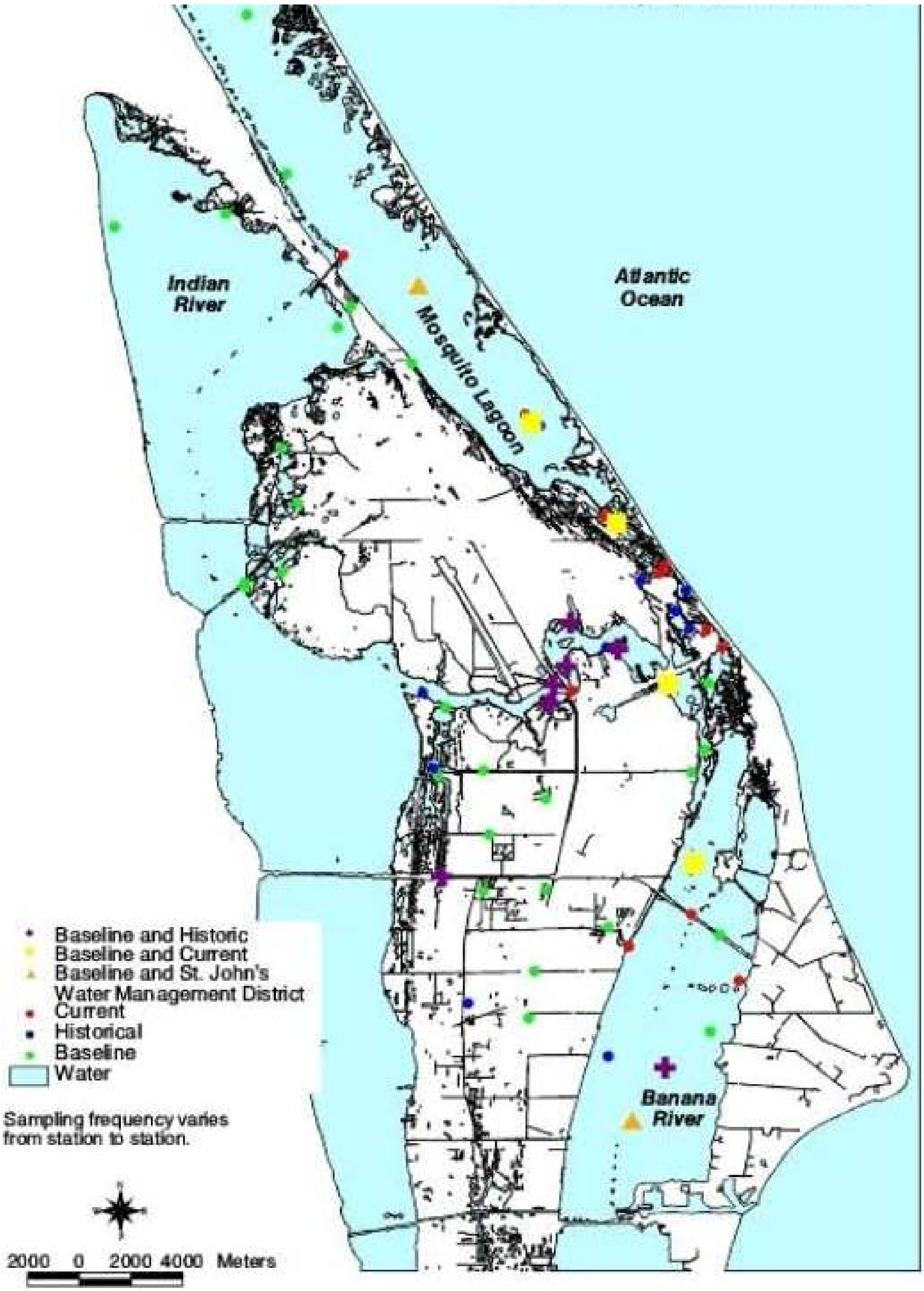


Figure 3.4-5. Surface water quality sampling stations at KSC

Indian River Lagoon, Banana River, and saline ditches, and lowest in freshwater ditches. Na was highest in Mosquito Lagoon and the Indian River Lagoon, intermediate in Banana Creek, Banana River, and saline ditches, and lowest in freshwater ditches (NASA, 2010a, 2015).

The SJRWMD reports that population growth around the lagoon, much of it attributable to the very attractiveness of its features – including its diverse and abundant marine life, plants and animals; its temperate climates; its accessibility and direct links to the Atlantic Ocean – have changed those characteristics over the last century and especially within the past half-century. Fish kills, algal blooms and changes in water quality have always occurred naturally, and the lagoon has had a natural ability to absorb pollutants up to a point. However, when overloaded, the lagoon is stressed and suffers (SJRWMD, 2013).

After years of decreasing water quality as population and development boomed in the surrounding counties that comprise the lagoon's watershed (Table 3.2-1), its condition improved steadily beginning in the early 1990s in response to a number of restoration and water quality improvement projects and programs. The estuary's seagrass coverage, used as an indicator of relative water quality, improved steadily from 1993 through 2011 (Figure 3.4-6).

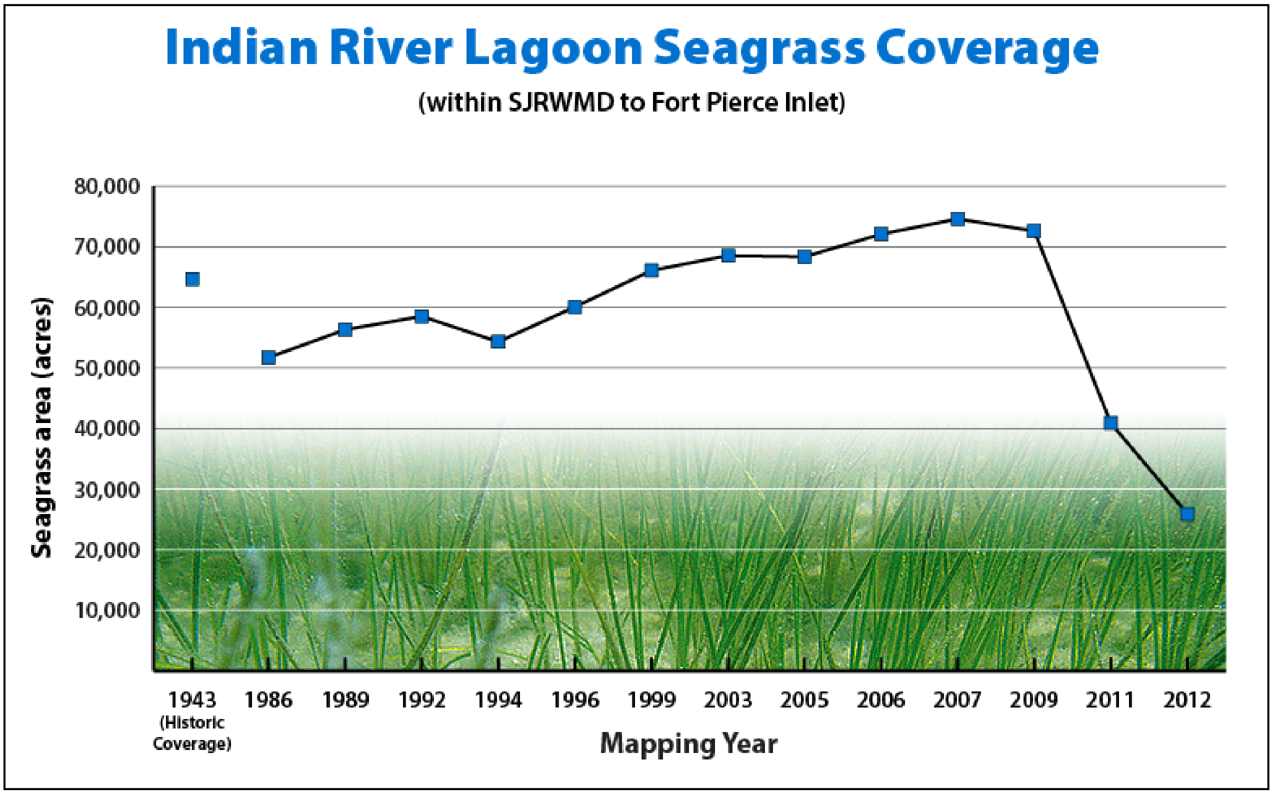


Figure 3.4-6. Seagrass coverage in the Indian River Lagoon
Source: St. Johns River Water Management District (2013)

After these years of progress, an algal "superbloom" appeared in the portion of the lagoon system known as Banana River Lagoon in the spring of 2011. It ultimately spread into the northern Indian River Lagoon and farther north into the Mosquito Lagoon (Figure 3.4-7). Simultaneously, a smaller bloom extended from just north of Melbourne south to the Vero

Beach-Fort Pierce area. Approximately 47,000 acres of seagrasses died during these events, a loss of about 60 percent of the lagoon's total seagrass coverage (SJRWMD, 2013).

In August 2012, a brown tide bloom began in the Mosquito Lagoon and moved into the northern Indian River Lagoon near Titusville; it reappeared in 2013. Adding to concerns were mortality of manatees and pelicans since July 2012 and bottlenose dolphins since January 2013. The cause(s) of these deaths are still under investigation.

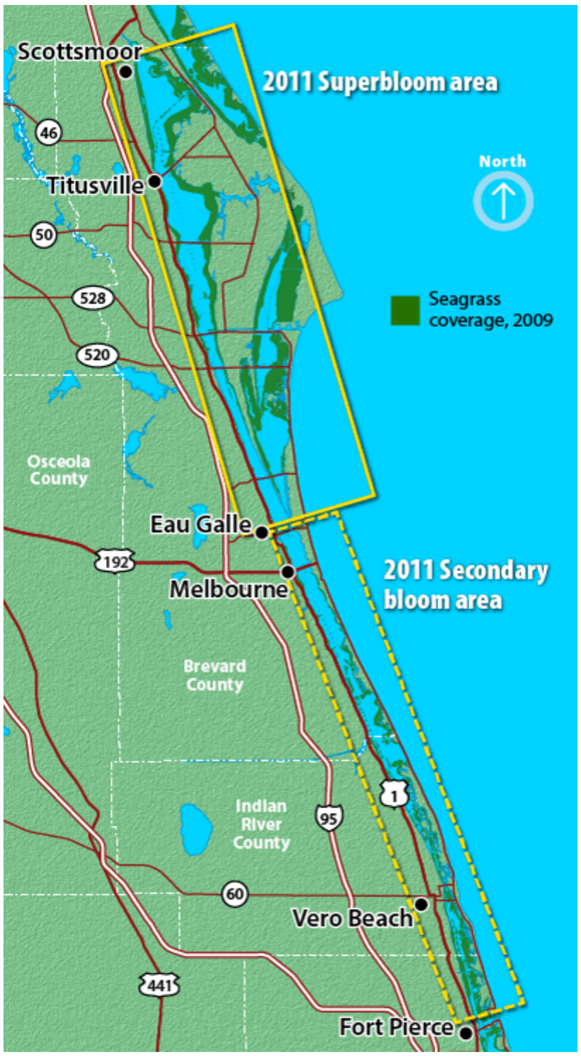


Figure 3.4-7. Algal superbloom in 2011
Source: SJRWMD, 2013

The cause or causes of the superbloom itself continue to be investigated as well. The SJRWMD emphasizes that there may have been several contributing factors. Before the blooms, long-term droughts had increased lagoon salinity; at the same time, extremely low water temperatures occurred during the winters of 2010 and 2011. These extreme climatic events – in conjunction with chronic, decades-long nutrient enrichment – may have created conditions favoring certain algal species that had never previously reached bloom proportions (SJRWMD, 2013).

The Indian River Lagoon 2011 Consortium is studying the possible causes of the algal blooms and developing strategies to reduce their magnitude, duration and frequency. The SJRWMD's Indian River Lagoon Protection Initiative focuses on better understanding the sources, cycling and transport of lagoon nutrients and the long-term impacts from the disappearance of the lagoon's seagrasses, as well as potential strategies aimed at restoring the Indian River Lagoon to a seagrass-dominated ecosystem.

3.4.1.1.1.6 Stormwater Runoff

Stormwater runoff is controlled by more than 100 onsite surface water management systems and a National Pollutant Discharge Elimination System (NPDES) stormwater permit for industrial activities.

As recognition of the implications of stormwater runoff for water quality and quantity has grown in recent years, stormwater runoff control and management programs have become increasingly important; they will continue to grow in importance to KSC. The Water Quality Control Act of 1987 required EPA to permit industrial and municipal stormwater discharges. In 1990, EPA issued the final rule for the NPDES permit application regulations for stormwater discharges.

Applications for stormwater discharges associated with industrial activity were required by March 1991, for a permit through a group application or by November 1991 for an individual permit. In addition, NPDES stormwater permits are required for all construction projects that impact an area one acre or more in size. Construction sites are covered under the Generic Permit for Stormwater Discharge from Large and Small Construction Activities.

FDEP has stormwater permit authority for discharges to surface water and groundwater. The stormwater rule is designed to minimize permit requirements for stormwater designs which utilize BMPs. FDEP has been authorized to delegate stormwater permitting authority to the State Water Management Districts or Local Governments. Several districts have assumed this regulatory function, including the SJRWMD (NASA, 2010a, 2015).

3.4.1.1.1.7 Surface Water Management

The Florida Water Resource Act, enacted in 1972, created six Water Management Districts in the state. These districts were assigned to Florida's major watersheds and were provided with the authority to manage and regulate surface waters. Regulated activities include any construction, alteration, maintenance, or operation of any dam, impoundment, reservoir or works including ditches, canals, conduits, channels, culverts, pipes and other construction that connects to, draws water from, drains water into, or is placed in or across open waters or wetlands. Each water management district has established thresholds, which trigger permit application requirements. KSC is located within the watershed area administered by the SJRWMD. The SJRWMD has a comprehensive surface water management permitting program in place (NASA, 2010a, 2015).

3.4.1.1.1.8 Wastewater Management

KSC transports its raw domestic wastewater to the CCAFS Regional Treatment Plant located on CCAFS. It also maintains operating permits for two industrial wastewater treatment facilities. Launch Complex (LC)-39 Pads A and B utilize holding tanks to treat industrial wastewater streams generated by fire and sound suppression water, Solid Rocket Booster (SRB) exhaust, and post-launch wash down (NASA, 2008).

3.4.1.2 Groundwater

KSC is underlain by three aquifers, including the surficial aquifer, the secondary semi-confined aquifer and the Floridan Aquifer (see Figure 3.4-8, and Table 3.4-1). The surficial aquifer is largely recharged by rainfall percolation and surface runoff and is used by the areas near KSC for nonpotable uses; however, some locations northwest and south of KSC use this aquifer for public water supply. Surface recharge of the secondary, semi-confined aquifer is minor and depends on leakage through surrounding lower-permeability soils. The Floridan Aquifer is the primary source of potable water in central Florida (NASA, 2008). Of the approximate 55 inches (140 cm) of annual precipitation, approximately 75% is claimed by evapotranspiration and returned to the atmosphere before it can become either surface or groundwater. The 25% remainder becomes runoff, base flow, and recharges the surficial aquifer.

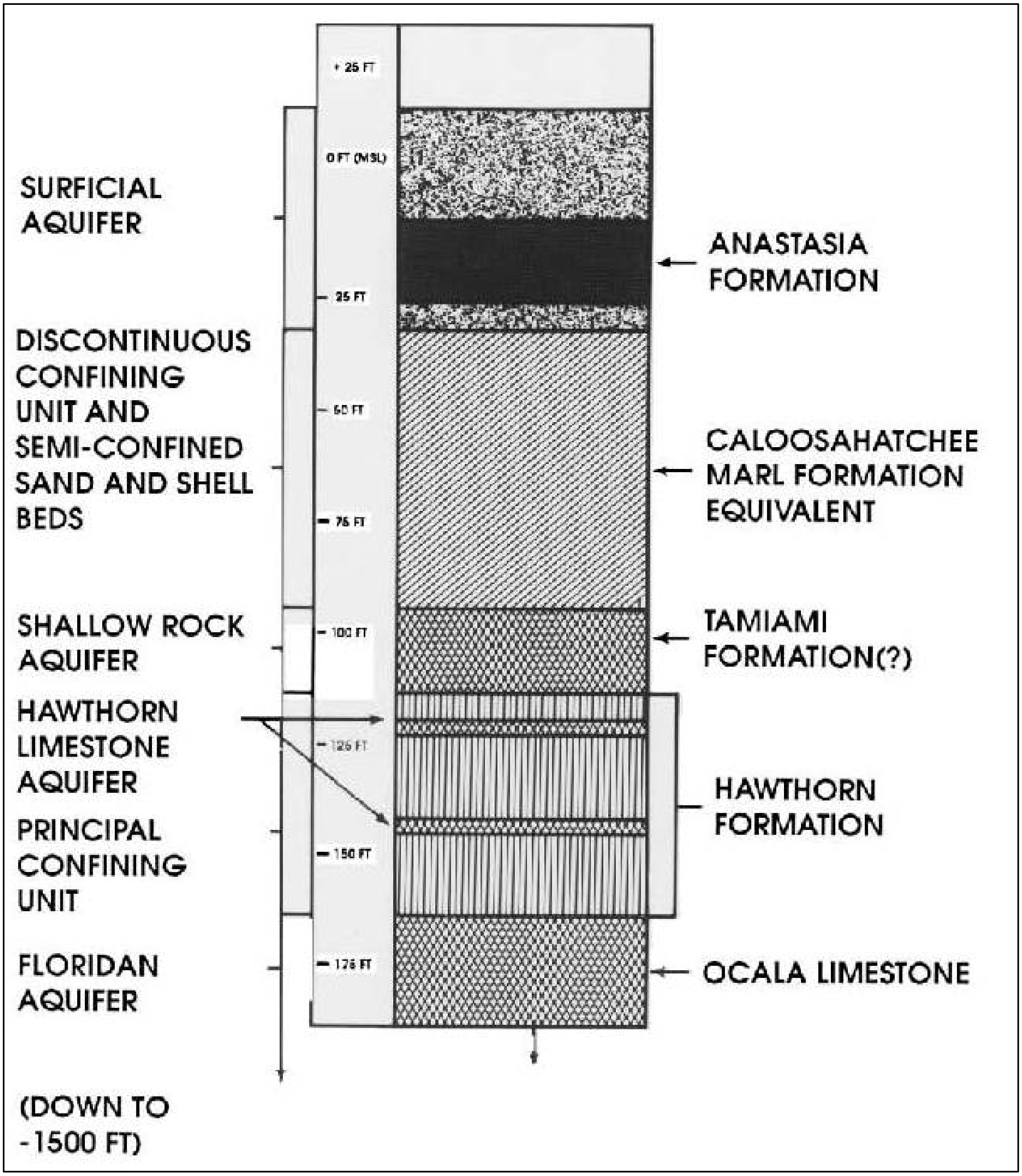


Figure 3.4-8. Profile of geohydrological units and aquifers at KSC

Table 3.4-1. General characteristics of aquifers at KSC

Aquifer	Geologic Strata	Recharge Area	Discharge Area	Water Quality
Unconfined Water Table Aquifer				
Surficial Aquifer	Pleistocene and Recent deposits – sand, shell, coquina, silt, and marl	Rainfall and direct infiltration, particularly that on central sand ridges of island	Drainage canals and ditches; evapotranspiration including losses from swales; seepage to impoundments, lagoons, and ocean	Fresh in center of island, becomes mineralized toward lagoons and ocean
Secondary Artesian Aquifers				
Semi-artesian Shell and Sand Beds	Little freshwater recharge, may act as conduits for seawater intrusion		(?)	Moderately brackish, generally poorer than Florida aquifer
Shallow Rock Aquifer	Leakage upward from Floridan aquifer	Tamiami Formation – shelly, partially consolidated quart sand and some limestone	(?)	Brackish
Hawthorn Limestone Aquifer	Leakage upward from Floridan aquifer	Thin beds of weathered lime-stone, sandstone, and sand within the Hawthorn Formation	(?)	Moderately brackish
Principal Artesian Aquifer				
Floridan Aquifer	Eocene limestones, Ocala Group, Avon Park Formation	Central Florida-West Osceola, South Orange, and Polk counties; Mims-Titusville ridge	Atlantic Ocean via offshore submarine springs, upward leakage where Hawthorn Formation thins	Highly mineralized, primarily chlorides

In the immediate vicinity of KSC, groundwater from the Floridan Aquifer is highly mineralized. Water quality in the secondary semi-confined aquifer varies from moderately brackish to brackish. Groundwater quality in the surficial aquifer system at KSC is generally good due to immediate recharge, active flushing, and a lack of development. Groundwater from the surficial aquifer meets Florida's criteria for potable water and national drinking water criteria for all parameters other than iron and total dissolved solids (NASA, 2008). These two main aquifers are separated by nearly impermeable confining units that contain three shallow aquifers referred to as the Intermediate aquifer system.

The Surficial aquifer can be divided into several subsystems (Figure 3.4-9). The Dune (Barrier Island) subsystem has a lens of freshwater less than 10 feet (3 m) thick on top of intruded saline water. The primary dune acts as the prime recharge area (Figure 3.4-10). Shallow groundwater flows east of the ridge to the Atlantic Ocean and west to Banana River, Mosquito Lagoon, or swales; at depth (> 20 ft or 6.1 m) flow is to the Atlantic Ocean. The Dune-Swale subsystem includes high ridges with permeable sand that favor recharge. This is the only area where the freshwater recharge of the deeper layers of the Surficial aquifer occurs.

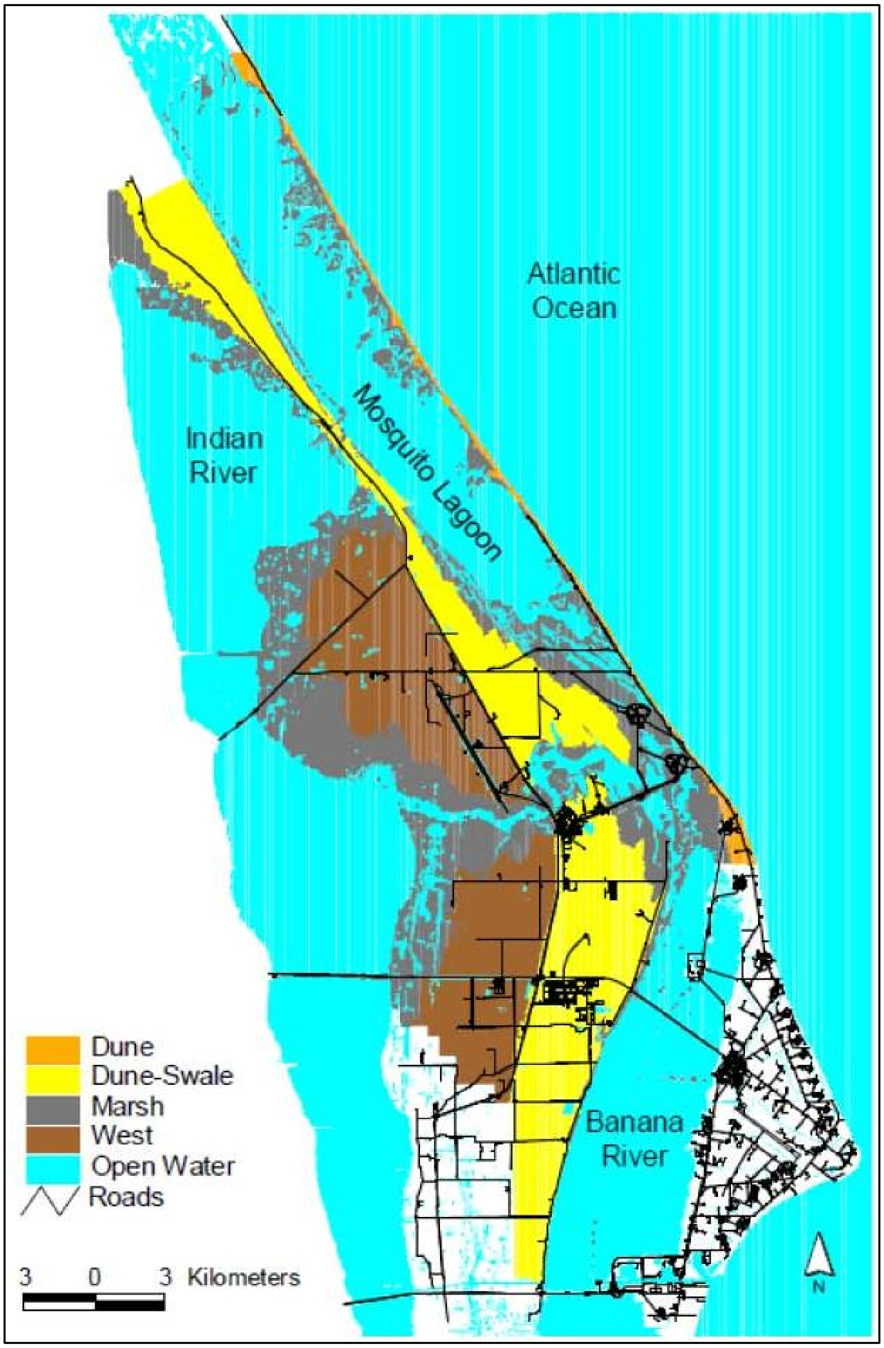


Figure 3.4-9. Subaquifers of the Surficial aquifer at KSC

During most of the year, shallow groundwater discharges to the swales. At the beginning of the rainy season after the spring drought, swales collect water and remain flooded; lateral and downward seepage from the swales helps to recharge the groundwater. In areas of pine flatwoods and swales, topography is lower and most soils have well-developed hardpans that restrict infiltration. During heavy rains, water perches above the hardpan and infiltrates slowly into the Surficial aquifer. This increases evapotranspiration and reduces recharge relative to the prime groundwater recharge areas. In the West Plain and Marsh (Lowland) subsystems, the water table is typically within about 3 ft. (0.9 m) of the land surface, evapotranspiration losses are high, and the dispersed saline water interface renders water quality variable. In the West Plain south of Banana Creek, a limerock "hardpan" replaces the humic hardpan of the Dune-Swale flatwoods. Along the coastlines, the Surficial aquifer contacts the saline water of the Atlantic Ocean and the brackish lagoons. Seawater intrusion occurs as a wedge at the base of the Surficial aquifer since seawater is denser than fresh water. The position of the fresh-saline water interface fluctuates; when water levels are low, saline water moves inland, and when water levels are high, saline water is forced out, producing a dynamic system (NASA, 2010a, 2015).

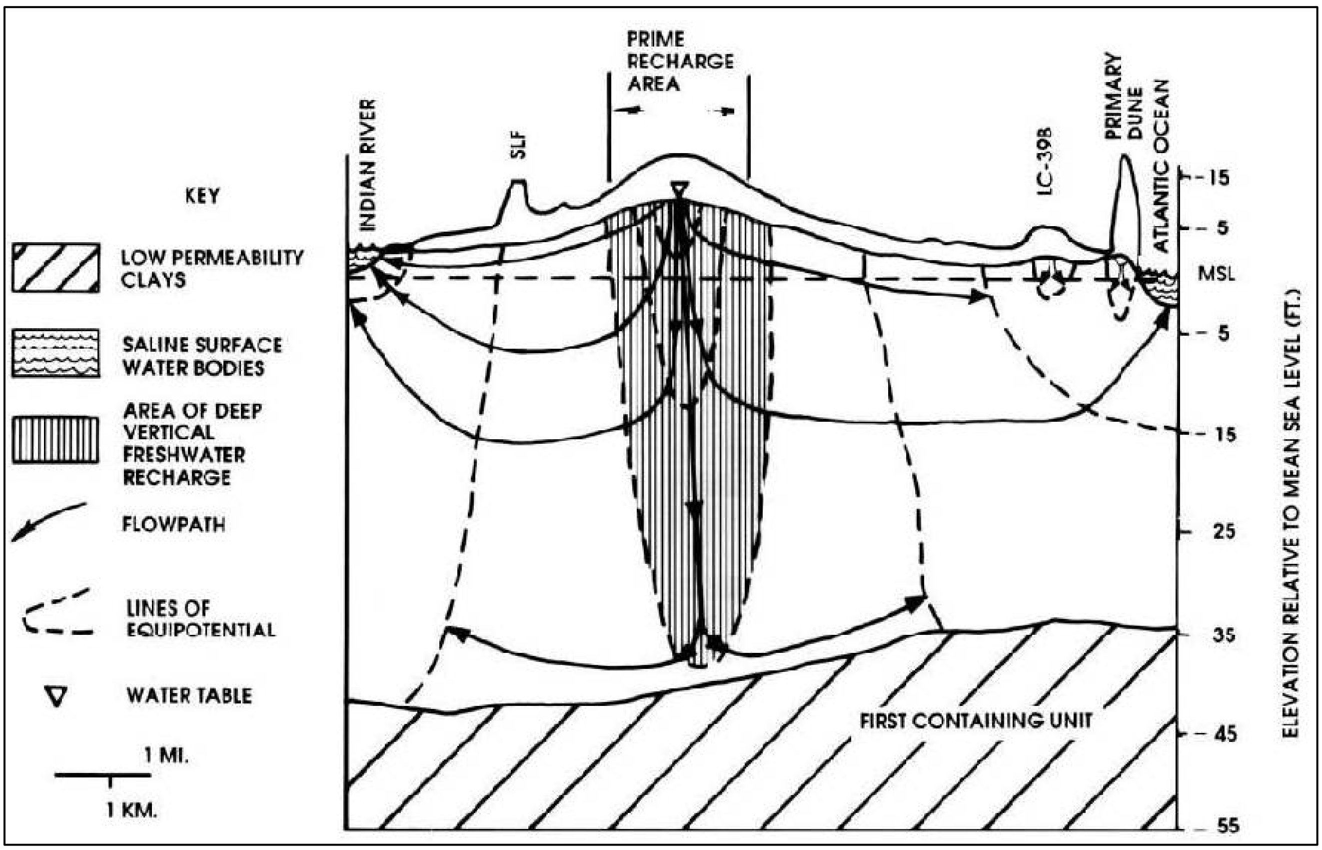


Figure 3.4-10. Profile of groundwater circulation patterns in the Surficial aquifer at KSC

3.4.1.2.1 Groundwater Flow Patterns

The primary recharge to the Surficial aquifer system primarily is from direct infiltration of precipitation. Recharge potential varies across the KSC, with the greatest recharge potential in the ridges of eastern Merritt Island and north of Haulover Canal. Groundwater mounds at the prime recharge areas. Groundwater flows from these recharge areas east toward the Banana

River, Mosquito Lagoon, and the Atlantic Ocean and west toward the Indian River. In general, water in the Surficial aquifer system near the groundwater divide of the island has potential gradients which tend to carry some of the water vertically downward to the deepest part of the Surficial aquifer system and potentially to the upper units of the Intermediate aquifer system.

Major discharge points for the Surficial aquifer system are the estuary lagoons, shallow seepage occurring to troughs and swales, and evapotranspiration.

Internal fresh surface waters are derived mostly from surficial groundwater; shallow groundwater supports freshwater wetlands; groundwater discharge to surrounding saltwater bodies contributes to the maintenance of lagoon salinity. Groundwater underflow is also a major factor in establishing the equilibrium of the fresh-saltwater interface in the Surficial aquifer system (NASA, 2010a, 2015).

Because they are under pressure, the Floridan and Intermediate aquifer systems have upward flow potentials; that is, they are artesian or semi-artesian. The great elevation differential between the Floridan aquifer system recharge areas (e.g., Polk and Orange counties) and discharge areas along the Atlantic coast provides the potential for the flowing artesian pressure experienced at KSC. Upward flow is limited by the thickness and the relatively impermeable nature of the confining units. Some upward flow may occur in the northwestern areas of KSC where the Hawthorn Formation thins. In addition, there are cases of free-flowing and abandoned artesian wells that have allowed the deeper saline groundwaters to impact the fresh Surficial aquifer system. The general horizontal direction of flow in the Floridan aquifer system is northerly and northwesterly. Recharge to the Intermediate aquifer system is dependent on leakage through the surrounding beds of lower permeability (NASA, 2010a, 2015).

3.4.1.2.2 Groundwater Quality

The quality of water in any given aquifer is dependent upon its lithology (rock composition), its proximity to highly mineralized waters, the presence or absence of residual saline waters, and the presence/absence of chemical constituents in the aquifer and overlying soils.

3.4.1.2.2.1 Surficial Aquifer System

Unconsolidated surficial aquifers are subject to contamination from both point sources (e.g., effluent emerging from pipes and outfalls) and non-point sources (general land use). Contaminants may include trace elements, pesticides, herbicides, and other synthetic organic substances. Urban and agricultural land uses have affected some Florida aquifers. Point source contamination to the KSC Surficial aquifer has occurred at certain facilities.

Groundwater surveys were conducted in 2000 to ascertain baseline conditions of the Surficial aquifer. Six sample sites were located in each subsystem of the Surficial Aquifer for a total of 24 sites. A total of 51 wells were installed at varying depths. Groundwater samples were collected using standard protocols. Groundwater samples were analyzed for organochlorine insecticides, aroclors, chlorinated herbicides, PAH, total metals, DO, turbidity, pH, specific conductivity, temperature, total dissolved solids (TDS), and total organic carbon (TOC).

The baseline data indicate that widespread contamination of the Surficial aquifer on KSC has not occurred. No organochlorine pesticides, aroclors, or chlorinated herbicides occurred 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 occurred in the shallow wells. PAHs occur in a variety of KSC soils at relatively low concentrations. Some occurrence of PAHs in shallow wells is unsurprising since PAHs have both natural and anthropogenic sources (NASA, 2010a, 2015).

Most trace metals occurring in KSC groundwater above detection limits were at low concentrations. This is 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. Aluminum, iron, and manganese occurred above detection limits more frequently than other trace metals. Al and Fe are abundant elements in the earth's crust and as such are present in KSC soils. Intense leaching, particularly in acid scrub and flatwoods soils, mobilizes Al and Fe. Iron is a typical constituent of groundwater in the Surficial aquifer in Florida. Mn is one of the most abundant trace elements and is present in KSC soils at relatively low concentrations. 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 Ca, Cl-, Mg, K, and Na, as well as conductivity and TDS that are related to these cations (positive charged ions) and anions (negatively charged ions). 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 fresh water 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 Indian River Lagoon system, respectively (NASA, 2010a, 2015).

3.4.1.2.2.2 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 that exist for the relatively thin Hawthorn Limestone Aquifer indicate that it too is moderately brackish.

3.4.1.2.2.3 Floridan Aquifer System

The Floridan aquifer system at KSC contains highly mineralized water with high concentrations of chlorides due to connate (innate) seawater in the aquifer, and to a lesser degree induced lateral saltwater intrusion (due to inland pumping), as well as a lack of flushing due to distant freshwater recharge areas.

3.4.2 Environmental Consequences Including Cumulative Impacts

3.4.2.1 Proposed Action

3.4.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

Impacts to water resources can result from several types of activities under the Land Use Plan, Future Development Plan, and Functional Area Plans. Erosion caused by site runoff and contamination by chemical spills can impact surface water quality. Additionally, non-point sources can potentially impact surface and ground water quality, such as oil and grease from paved street and road surfaces that wash into a water body or are absorbed into the water table. There would be no substantial impact to water quality from disposal of demolition debris generated during construction activities.

Surface drainage during storms over the long-term would still occur, but new construction or repurposing of existing facilities can lead to potential changes in the surface drainage pattern system. Some project sites have been previously disturbed and natural drainage patterns no longer exist. Other sites have been minimally disturbed previously, and adverse impacts to natural drainages are anticipated. Under the Proposed Action, impervious or semi-impervious surfaces would likely contribute to more surface drainage than at present.

The use of heavy equipment for construction would occur during project activities. Some projects could result in substantial ground disturbance and movement of earth with relatively large areas of exposed soils, increasing the likelihood of soil erosion and sediment delivery to nearby surface waters and wetlands, resulting in localized turbidity increases and mobilization of fine sediments. Repeated disturbance of vegetation and soils (i.e., due to vehicle passes) during project activities would also cause surface erosion. Siltation and runoff can degrade water quality. Increased turbidity could cause an increase in water temperature as turbid water heats more readily when exposed to sunlight. Elevated levels of turbidity could also lead to decreases in primary production and dissolved oxygen levels. There could also be increased short-term fine sediment and loss of benthic food resources. The effects to local water quality and hydrology during construction would be adverse and short- term; the degree of effect would depend on the extent of the disturbance and proximity to water.

Fuel products (petroleum, oils, and lubricants) would be needed to operate the equipment used for construction; therefore, there is some risk of an accidental fuel or chemical spill, which could adversely affect water quality if the spill were to enter ground or surface water. To prevent accidental fuel or chemical spills, no refueling would occur near surface water. The fueling operation would be closely monitored, and an emergency spill kit containing absorption pads, absorbent material, a shovel or rake, and other cleanup items should be readily available on-site in the event of an accidental spill.

Riverine wetland or floodplain loss or alteration could occur if wetlands or floodplains are disturbed by construction or if impervious surfaces are constructed on top of them. Vegetation clearing within and adjacent to wetland, floodplain, and riparian areas may also occur to accommodate construction. BMPs limiting the amount of disturbance to just the project footprint would be implemented to reduce adverse impact to wetlands, floodplains, and riparian areas, but there could still be some adverse effects that would be inevitable.

Repurposing existing facilities and/or constructing new infrastructure would have an impact on the management of sanitary and industrial wastewaters and storm waters. Current facilities treatment and discharge are permitted by the applicable state and/or local regulatory agencies. New infrastructure would have to comply with these regulations after evaluating the minimal impact from the following: integrate to the already existing wastewater treatment facilities (based on up-to-date capacity), discharge to local municipality, or a combination of both. The repurposing of existing facilities would not require substantial modifications to current permits and discharge volumes; therefore, no adverse impacts are expected to water resources from wastewaters.

BMPs to control erosion, sediment release, and stormwater surface runoff would be utilized during all project activities to minimize adverse impacts on water resources. All disturbed areas should be planted with native vegetation once a project is complete, thus stabilizing soils, reducing long-term effects such as erosion, sedimentation, and runoff, and improving water quality in nearby receiving waters. Identifying and staking the limits of clearing and earth work, installing silt fences, establishing a controlled area for construction material and equipment, and preparing a sediment and erosion control plan would minimize the potential for adverse impacts to water quality, hydrology, floodplains and wetlands. Vigorous application of appropriate BMPs would minimize erosion and sediment runoff to surface waters and wetlands at the project site and in the surrounding vicinity. The small amount of sediment that cannot be effectively removed using BMPs should be negligible to minor in magnitude and of a short duration while a project is in progress.

Sedimentation is a leading cause of water impairment in the U.S., and it can cause disturbances in aquatic ecosystems such as the degradation of fish spawning grounds. The NPDES under the Clean Water Act prohibits the discharge of any pollutant, including sediments, to waters of the United States; thus a NPDES Storm Water Construction Permit would be required by FDEP. A permit for stormwater discharge from construction activities would likely be required, as well as permits under Sections 401 and 404 of the CWA. Impacts from erosion, and specific measures to control both wind and water erosion of soils during and after construction, would be taken care of by developing a Stormwater Erosion and Pollution Prevention Plan (SWPPP). An Environmental Resource Permit would also be required by SJRWMD for any activity that meets the requirements listed in Rule 40C, F.A.C.

Impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, site topography, and proximity to surface water. Impacts on water resources would be less than significant with implementation of BMPs and adherence to permit conditions.

3.4.2.1.2 Launch, Landing, Operations and Support

Vertical and horizontal launches may result in local adverse impacts on freshwater and marine systems. Such impacts would result from the deposition associated with rocket engine emissions on water bodies or associated watersheds, the deposition of spent launch vehicle (LV) equipment (e.g., booster rockets), or landing of a reentry vehicle (RV) or its associated equipment. Launches and reentries would be performed from and to existing or future water-permitted facilities that have been or would be designed and operated to protect sensitive surface and ground water resources (e.g., well head protection areas).

Each space shuttle launch, classified as a SHCLV, can generate over 860,000 gallons of deluge and washdown wastewater (NASA, 2010a, 2015) which could have adverse impacts on surface and ground water if not fully contained. Upon ignition of the main engines and SRBs, deluge waters are discharged to the flame trench for sound attenuation. As the launch proceeds, more water is discharged to the fixed service structure and moveable launch platform to dissipate launch heat energy. Within 10 minutes of a launch, pad facilities are washed down with up to 326,000 gallons of water. The high concentrations of hydrogen chloride (HCl) gas produced by ignition of the SRBs significantly lower the pH of the collected wash water. Average pH levels in the tanks immediately following launch range between 1.6 and 2.2 (NASA, 2010a, 2015). Operational procedures require that the contained launch waters be neutralized with 50 percent sodium hydroxide (NaOH) to a pH of 8.5 +/- 0.5 within 72 hours following launch. Previously, after neutralization, these waters were landspread over the adjacent pad area. Current practices follow the industrial wastewater permit.

Total quantities of washdown waste water and pollutants produced are dependent on Launch Vehicle Class and total number of annual launches. The largest class, SHCLV, produces the largest quantities of pollutants. By way of general comparison with smaller vehicle classes, roughly twelve times more launches of the SCLV or three times more launches of the MCLV of the same propellant type would be needed to produce the same quantity of pollutants as that of the SHCLV.

Deluge and washdown water would be supplied by the existing water distribution system and would have a negligible impact on system capacity or surface and groundwater resources. Wastewater would be processed through the existing wastewater handling and treatment systems. Local and regional water resources would not be affected since there would be no substantial increase in use of surface or groundwater supplies.

Most of the deluge and washdown water would be collected in concrete basins; however, small amounts could drain directly to grade. There is the potential to cause inadvertent discharge of deluge water into jurisdictional waters of the United States in the event of an overflow of the deluge water system deluge basin; however, it is highly unlikely that the maximum amount of deluge wastewater contained in the basin would be discharged. If the wastewater in the collection basins meets the criteria set forth in the industrial wastewater permit, the wastewater would be discharged directly to grade at the launch site. If the wastewater fails to meet the criteria, it would be treated on-site and disposed to grade or collected and disposed of by a certified contractor. Minimal adverse impacts to water resources from contaminated water are expected to result from launch operations.

3.4.2.1.2.1 Surface Water

The emission of hydrochloric acid (HCl) and aluminum oxide particulates by solid rocket propellant during launches would be the primary concern associated with the impact of normal launches on water quality. Short-term acidification of surface water could result from contact with the exhaust cloud and through HCl fallout from the cloud. Wet deposition of HCl may occur during rainfall. Impacts on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A short-term decrease in pH could occur in small streams and canals near the launch pad. Since there would only be a temporary decrease in pH, aluminum oxide deposition should not contribute to increased aluminum solubility in area surface waters. A normal launch would have no substantial impacts on the local water quality.

Background pH in the estuarine system at KSC generally ranges between 7.8 and 8.6. At launch, the surface layer of adjacent water bodies could receive up to 1700 kg of HCl from deposition (NASA, 2010a, 2015). This acid mixes downward into the water column through advection and diffusion, eventually impacting approximately the upper 1.5 m of water. The rate of mixing is driven primarily by wind speed and direction. Levels of impact are highly variable spatially and temporally depending on meteorological conditions at the time of launch. Maximum pH reductions (about 6 to 7 units) may be found at the surface and in area adjacent to stormwater drainage ditches in line with the flame trench at each pad. In these areas, pH depression may be acute and lethal to organisms utilizing gills for respiration. Minimal effects are observed around the edges of the near-field ground cloud footprint and at depth where buffering and dilution minimize chemical impacts.

Surface and ground waters in the region around the launch pads are highly buffered as a result of local soils and geological conditions, with total alkalinity values typically ranging between 120 and 200 mg/l as $CaCO_3$. This aquatic buffering system reacts readily with the exhausted HCl to produce $CaCl_2$, CO_2, and H_2O (NASA, 2010a, 2015). Advective and diffusive mixing during the 48 to 72 hours post-launch have been found to return pH readings and alkalinity measurements to pre-launch levels.

RP-1, Jet-A and LCH4 (liquid methane) can all be classified as liquid hydrocarbon propellants. These fuels commonly use Liquid Oxygen (LOX) as the oxidizer. Jet-A propellant typically contains sulfur. As carbon is a main ingredient in the fuel, hydrocarbon propellants produce a large amount of carbon dioxide and water vapor as products of combustion, which would not adversely affect surface water. Other minor constituents include CO and sulfur dioxide SO_2, which could be deposited in surface water and cause localized impacts.

Cryogenic engines (liquid hydrogen (LH2)/ liquid oxygen (LOX)) are in a category by themselves. Water vapor is the only product of combustion, thus there would be no impacts on surface water.

Propellants categorized as using liquid hydrazine fuels typically use dinitrogen tetroxide as the oxidizer. These fuels are hypergolic with the listed oxidizers and are very hazardous; however, when burned as fuel, the products of combustion are mostly non-hazardous. Combustion of these propellants produces mostly water vapor and nitrogen, as well as smaller quantities of carbon dioxide, carbon monoxide and nitrous oxides. The nitrogen deposited in surface water could cause localized impacts.

Under normal flight conditions, vehicle stages that do not reach orbit have trajectories that result in ocean impact. Stages that reach initial orbit would eventually reenter the atmosphere as a result of orbital decay. Corrosion of stage hardware would contribute various metal ions to the water column. Due to the slow rate of corrosion in the deep-ocean environment and the large quantity of water available for dilution, toxic concentrations of metals are not likely to occur. Since the liquid stages and fuel would be burned to depletion in-flight, there would be only relatively small amounts of propellant left in the stages that impact the ocean (NASA, 2011). The release of solid propellants into the water column would be slow, with potentially toxic concentrations occurring only in the immediate vicinity of the propellant. Insoluble fractions of RP-1 propellant would float to the surface and spread rapidly to form a localized surface film that would evaporate. Hydrazine fuels are soluble and would also disperse rapidly. Minimal adverse impacts are expected from the reentry of spent stages.

On-pad accidental or emergency releases of small quantities of propellants are unlikely to occur. However, in the event of a release, spilled propellants would be collected and disposed of by a certified disposal contractor. Potential contamination of groundwater or surface water resulting from accidental or emergency spills of propellants during propellant loading would be minimized through adherence to safety procedures. Potential leakage or spills from propellant storage tanks would be contained in holding basins that surround the tanks. Any accidental or emergency release of propellants after loading would be channeled to an impermeable concrete catch basin. Contaminants collected in the catch basin would be disposed of in accordance with appropriate state and federal regulations.

Launch accidents could result in impacts on local water bodies due to contamination from rocket propellant. In the unlikely occurrence of a launch accident, spilled propellant could enter water bodies close to the launch pad. Potential contamination would primarily occur from hydrazine, menomethyl hydrazine, nitrogen tetroxide, and solid rocket motor (SRM) propellant. Powdered aluminum from the SRM propellant would rapidly oxidize to aluminum oxide, which is non-toxic at the pH that prevails in surface waters surrounding all proposed launch sites (NASA, 2011).

3.4.2.1.2.2 Groundwater

Groundwater data do not show any clear evidence of accumulation of metals in the surficial aquifer, nor do they show a cause and effect relationship between launches and detectable concentrations of metals in the groundwater (NASA, 2010a, 2015).

That said, pentachlorophenol (PCP) was identified at LC39A above FDEP Surface Water Cleanup Target Levels (SWCTL) in groundwater samples collected from monitoring wells, and trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC) were identified above their respective FDEP Groundwater Cleanup Target Levels (GCTL) in groundwater samples collected from monitoring wells (NASA, 2010a, 2015). Quarterly groundwater monitoring of the remaining dissolved phase TCE, cDCE, and VC is being implemented to obtain additional information to assist in recommending a path forward.

In subsequent investigations at LC39B, TCE, cDCE, VC, aluminum and iron were identified above their respective FDEP SWCTL in site groundwater. Aluminum and iron were detected in groundwater samples collected from monitoring wells where groundwater has been designated as non-potable. TCE, cDCE, and VC have also been detected in groundwater samples collected from monitoring wells and in groundwater samples located downgradient of the site. The cleanup strategy selected in the Corrective Measures Study was enhanced bioremediation and monitored natural attenuation for the impacted groundwater. Enhanced bioremediation has reduced TCE, cDCE, and VC concentrations. Similar cleanup strategies would be used for activities under the Proposed Action.

Overall, impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of water to the launch or landing sites. Impacts on water resources would be less than significant.

3.4.2.1.3 Future Transportation Plan

Impacts of the Future Transportation Plan that could affect water resources include road improvements, repair, and resurfacing; bridge replacement; parking lot repurposing or demolition; and expansion of the horizontal launch and landing capability with a new runway, facilities, infrastructure, and other airfield systems. Other actions in this plan that would impact water resources would need separate NEPA analysis and would not be covered under this Programmatic EIS. These actions include development of railroads, expansion of access via waterways, and seaports.

Activities that require construction, renovation, or replacement of facilities would have similar impacts on water resources as described for construction in Section 3.4.2.2.1 Land Use Plan, Future Development Plan, and Functional Area Plans.

The Master Plan has identified the potential need, if the marketplace demands such a capability, of expanding current access via waterways. The expansion of waterways would require some degree of dredging and/or other construction that would result in soil and sediments disturbance, plus potential turbidity. All of these activities would be temporary and of limited scope and would have minimal or no impact of any navigable waters in the United States. All three proposed waterway access would require multiple permits and authorizations. Each of them would need to incorporate floodplain management and wetland protection plans according to NASA’s regulations and in consultation with other federal and state agencies.

For instance, according to section 404 of the Clean Water Act, which regulates the discharge of dredged or fill material into waters of the United States including wetlands, an evaluation to minimize impacts to water bodies and wetlands and provide appropriate and practicable mitigation, such as restoring or creating wetlands, for any remaining, unavoidable impacts, would be need to be performed. A Section 10 permit would also be required from the Army Corps of Engineers. This might require the preparation of an EIS, or at a minimum an EA tiered to this PEIS, for each specific waterway proposed. The total amount of impacted wetlands and surface waters would depend on the decision to expand the water transportation capability based on the demand for it by one or more of the waterways proposed in the Master Plan. It is expected that surface water quality would experience minimal or no long-term impact with the expansion of these water access areas.

Impacts of proposed project activities on water resources would be short- term and long-term, direct, adverse, and minor to moderate depending on the extent of the project, proximity to water bodies, and whether impervious surfaces would be installed. Impacts on water resources would be less than significant.

3.4.2.1.4 Cumulative Impacts

Water resources at KSC have been impacted by past and present activities including facility development and impervious surfaces, wetland conversion, vegetation clearing, launch operations, and visitor use of water bodies. Adverse impacts from these activities include altered water levels, flow rates, and downstream water discharge; increased erosion and sediment loading into receiving waters; degraded water quality (i.e., turbidity, temperature, dissolved oxygen, and nutrient levels); draining, filling, or sedimentation of wetlands resulting in wetland losses and/or changes to functions and values (i.e., floodwater attenuation and contaminant filtration); deposition of chemical contaminants from launch clouds; recreational use pressure from activities such as boating and fishing contributing to water quality degradation from boat engine fuel leaks; introduction of bacteria from human use; and introduction of invasive species.

As described above, the ecologically, recreationally, and commercially important Indian River Lagoon adjacent to KSC has been impaired by the cumulative impacts of all point and non-point sources of pollutant loadings that have grown enormously in magnitude over the last half-century.

Adverse impacts on water resources associated with proposed actions at KSC would be small as compared to cumulative past, present, and foreseeable future effects. Cumulative impacts from the Proposed Action would vary with the nature and frequency of projects, and impacts would be expected to be minor and adverse.

Direct cumulative impacts from the reasonably foreseeable actions described in Section 3.2 are also likely to be minor and adverse. However, to the extent that all of these projects contribute to long-term economic and population growth and development of the Space Coast region, in combination they may contribute indirectly to continuing cumulative impairment of the Indian River Lagoon complex as a result of an increase in the area of impervious surfaces (pavement and roofs) and non-point source loadings of sediments, nutrients, and contaminants.

3.4.2.2 Alternative 1

With one important exception, impacts from Alternative 1 on water resources would be similar to those described for the Proposed Action, but on a somewhat smaller scale and covering a slightly smaller area. As described in Chapter 2, under this alternative, the two proposed new seaports under the Proposed Action would be not be constructed, and thus the impacts on water resources – and wetlands in particular – associated with these actions would not occur. This is a substantial difference between Alternative 1 and the Proposed Action.

Most of the discussion under Cumulative Impacts for the Proposed Action would also hold true for Alternative 1. However, by not constructing and operating the two new seaports, Alternative

1 would avoid contributing to further cumulative impacts on aquatic habitats and water quality in the Indian River Lagoon.

3.4.2.3 No Action Alternative

Under the No Action, water resources would not be affected by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Effects on water resources from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. Thus, the No Action alternative would not have any additional impacts on water resources. However, the long-term cumulative impacts on water quality in the IRL described under the Proposed Action could still well occur if other reasonably foreseeable projects were to take place and if population projections and associated development are realized in the decades ahead, fostering increases in non-point source pollution that have already damaged the lagoon.

3.5 Hazardous Materials and Waste

The following sections address the transport, handling, treatment, storage and disposal of hazardous materials and waste.

3.5.1 Affected Environment

Hazardous materials that are classified as waste fall under the Resource Conservation and Recovery Act (RCRA) Hazardous Waste Regulations. These materials require environmental permits to ensure that the public is not unduly exposed to risk from these materials during their storage, transportation, or treatment/disposal. These regulations are not applicable to storage of hazardous materials that are not a waste. However, because of the specific hazards associated with hypergolics, there are several regulations on this material even when it is not a waste. The primary concern regarding the presence of hazardous materials is an accidental release or spill of these materials into the environment due to improper storage/handling or unplanned incident (i.e., vehicle collision).

The hazardous materials at Kennedy Space Center primarily can be categorized into five types of materials:

1. Solvents used in cleaning
2. Surface coatings
3. Motor vehicle fuels: gasoline, diesel, and ethanol
4. Solid rocket propellants
5. Liquid propellants

Hypergolic rocket propellants

Hypergolics are rocket propellant combinations used in rocket engines; when the two components are brought into contact with each other, one the propellants will ignite spontaneously. The two propellant components typically include an oxidizer and a fuel. Although hypergolics tend to be difficult to handle due to their high corrosiveness and/or toxicity, they can often be stored as liquids at room temperature. Moreover, hypergolic engines can be ignited repeatedly and reliably.

3.5.1.1 Solvents

Solvents are commonly used at KSC for cleaning and painting operations. Procedures are well established for handling, storage and disposal. The most common solvent used at KSC is isopropyl alcohol (IPA). Similar to other solvents, IPA presents a minor health risk if ingested. Additionally, threshold limit values for inhalation hazards are set at 370 ppm. Solvents also present a fire hazard (MSDS, 2013).

3.5.1.1.1 Handling

The fire hazard of solvents is the greatest risk. A fire hazard exists when airborne concentrations exceed 2-12%. Use of these materials should always be conducted in a well ventilated area. Well-established hot work permit procedures shall be used to regulate the potential presence of ignition sources, such as welding equipment or cutting torches.

Personnel should use personnel protection equipment (PPE) to protect against splash and vapors, such as googles. Vapor respirators are required if sufficient ventilation does not exist.

3.5.1.1.2 Storage

Solvents should be stored in segregated and approved areas. Containers should be stored in cool, well ventilated areas. Containers should be sealed until ready for use.

3.5.1.1.3 Transport

IPA is a DOT Hazard Class 3, Flammable Liquid. Similar solvents will have the same hazard class.

3.5.1.1.4 Disposal

Waste solvents should be collected in approved containers for recycling or hazardous waste disposal. KSC currently operates three storage tanks used for waste IPA.

3.5.1.2 Surface Coatings

Surface coating operations are common at KSC. These operations produce waste paint, solvents and chromating chemicals such as Alodine. The chemicals used for chromate coatings are highly acidic and contain high quantities of chromium. As chromium is a known carcinogen, these chemicals are a health hazard (MSDS, 2001).

3.5.1.2.1 Handling

Contact with these materials should be avoided. Recommended PPE includes chemical goggles and/or full face shield, chemical gloves, such as butyl rubber, impervious apron and boots. These dusts should not be inhaled; respiratory equipment should be used if insufficient ventilation exists. Painting operations shall be equipped with appropriate fume collection equipment.

3.5.1.2.2 Storage

Containers should be tightly closed and stored in a cool, well ventilated place away from incompatible materials. Oxidizing agent may cause spontaneous ignition of combustible materials. Contact should be avoided.

3.5.1.2.3 Transport

Alodine is DOT Hazard Class 9, Miscellaneous Dangerous Goods. Hazard classes 5.1, oxidizers, 6.1 toxic substances, and 8, corrosives also apply to this substance.

3.5.1.2.4 Disposal

Chromium, a key component in Alodine, is a hazardous waste. Disposal must be done in accordance with local, state and federal regulations. KSC currently operates two large fiberglass storage containers for collection of waste Alodine.

3.5.1.3 Motor Vehicle Fuels

KSC currently stores large amounts of fuel for motor vehicles such as gasoline, diesel and ethanol. Liquid hydrocarbon fuels are not considered a major health hazard, but are considered hazardous for the fire hazard present with these materials.

3.5.1.3.1 Handling

These materials should be handled as flammable liquids. Fuels should be kept away from heat, sparks and open flame. Electrical equipment should be approved for classified area. Precautions can be taken to reduce risk of electrostatic initiation, such as proper grounding. Vapors present additional risk if concentrations are between 1-7% for gasoline/diesel and 3-19% for ethanol (MSDS, 2015, 2012a, 2012b).

These materials can be a minor irritant on the skin and in the eyes. Appropriate PPE can be used when splash hazards exist. Additionally, respirators with organic vapor cartridges can be used for excess vapor concentrations, such as a spill in an unventilated area.

3.5.1.3.2 Storage

Storage containers should be kept away from flame, sparks, excessive heat and open flame. Containers should be kept closed but vented and clearly labeled.

Because of the size and proximity of KSC fuel storage tanks to waterways, KSC is subjected to the Spill Prevention Control and Countermeasure (SPCC) regulations of 40 CFR 112. KSC currently maintains plans for spill prevention, response and reporting.

3.5.1.3.3 Transport

Fuels are classified as DOT Hazard Class 3, Flammable Liquids.

3.5.1.3.4 Disposal

Typically, hazardous wastes are not generated with fuels. This material is consumed. In the event of spill or contamination, waste fuel can be disposed in the same manner as organic solvents.

3.5.1.4 Solid Rocket Propellants

Solid rocket propellants are unique to facilities such as Kennedy Space Center that store or launch rocket motors.

Based on the formulation, solid rocket propellant can be classified as either a 1.1 or 1.3 division material. A 1.1 material has a mass explosion/detonation hazard, where 1.3 materials have a deflagration/fire hazard. The main ingredient in most solid rocket propellants is ammonium perchlorate (AP). The other main components of solid propellant are typically aluminum powder and binder such as HTPB.

AP has hazardous characteristics (MSDS, 2009) and it is a significant problem whenever it enters ground or surface water. There are many studies and considerable documentation regarding AP plumes in soil and groundwater. In the solid rocket propellant the binder holds AP in place and the propellant itself does not exhibit the same hazards as AP. However, because AP is soluble in water, if the propellant is allowed to contact water, AP can dissolve out of the propellant and enter the water that it has come in contact with. Therefore it is always required that rocket motors are stored and handled in such a manner that the propellant does not come in contact with water.

3.5.1.4.1 Handling

The main hazard from handling solid propellant is the fire hazard. There are specific safety rules applied to handling rocket motors to assure they are properly grounded to avoid static electricity. All ignition sources, such as sparks, open flame, excessive heat, and static, should be restricted in the vicinity of solid propellant.

3.5.1.4.2 Storage

Storage and use facilities for solid propellants are subject to quantity distance siting requirements. Launch sites and storage locations are required to have sufficient separation distances based on the propellant quantity and hazard division. Sufficient separation distance to public traffic routes and all other facilities must be maintained.

3.5.1.4.3 Transport

Solid rocket propellant is classified as either 1.1 or 1.3 DOT Hazard Class.

3.5.1.4.4 Disposal

Under normal operations, KSC does not generate waste solid propellant. Solid propellant is fully consumed with the vehicle launch.

3.5.1.5 Liquid Propellants

The KSC Spacecraft Fueling Service provides storage and handling services of liquid rocket propellants. The Spacecraft Fueling Service follows detailed operating procedures to ensure safety for handling spacecraft fueling materials. New operations will have a similar fueling service that utilizes the same detailed operating procedures that ensure safety for handling these materials.

There are various types of liquid propellants. The most common is hydrazine, which is one of the hypergolic fuels mentioned above. This material can be very hazardous. Hydrazine is a known carcinogen (MSDS, 2015) and can be very hazardous in the case of skin contact and ingestion. However, when it is mixed and burned as fuel, the combustion products are non-hazardous. Therefore there is little or no concern from the emissions of rocket motors regarding the use of liquid propellants; there are always precautions required when storing and handling these materials.

Other common liquid propellants include liquid oxygen (LOX), liquid hydrogen (LH2), kerosene (RP-1), MMH, Aerozine-50 (A-50), and LCH4. Combustion products of these propellants are also non-hazardous.

Figure 3.5-1. Hydrazine being loaded onto NASA's Messenger space probe

Because of the hazardous nature of these materials, there is a considerable body of federal regulations contained in the Code of Federal Regulations (CFR) governing all aspects of these fuels and propellants. There is also a culture of knowledge and procedures for safe handling of these materials at KSC. Therefore, although these materials are hazardous, the procedures in place assure that the chance of the public being exposed to these materials is extremely remote.

CFRs applicable to liquid propellant facilities, sites, storage for commercial launch site operators and commercial launch providers include:

- **14 CFR AERONAUTICS and SPACE (with appendixes)**
  - **414 Technical Criteria for [Launch] LICENSING--**This regulation identifies other criteria, including those defined by license applicant, for performance, design, quality assurance, acceptance tests, continued operation and public disclosure of support systems.
  - **417 LICENSING and SAFETY REQUIREMENTS for LAUNCH--**This regulation identifies toxic release hazard analysis, far-field blast effects, flight/ground safety

support systems, clear zones, hazard areas, and specific requirements for various propellant types.

- **420 LICENSE TO OPERATE A LAUNCH SITE, SEPARATION DISTANCES--** This regulation establishes requirements for launch site boundaries, launch operations, site separation distances for fuel and equipment, lightning protection, and site plans.

- **27 CFR ALCOHOL, TOBACCO and FIREARMS**
  - **555 EXPLOSIVES--**These regulations ensure that explosive compounds are properly shipped, stored, inventoried, and distributed. Reporting of lost or stolen explosives, inspection, licenses, changes in operations and magazines, identification and sampling, and storage facility requirements are defined.

- **29 CFR LABOR**
  - **1910 OCCUPATIONAL SAFETY and HEALTH, subpart H--**This part identifies hazardous materials (flammable liquids, oxidizers, explosives, etc.) and establishes requirements for working, exit route, emergency planning, man-lifts, platforms, ventilation, noise, nonionizing radiation, personnel protective equipment, confined spaces, lockout/tagout, first aid, fire protection, compressed gas, material storage, machines and electrical operations and equipment.
  - **1917 FUEL HANDLING AND STORAGE--**These regulations ensure that fuel handling facilities for marine terminals, railroad, and hazardous cargo operations protect personnel from hazards by establishing requirements for equipment, terminals, and personal protection.

- **40 CFR ENVIRONMENT**
  - **112 Pollution Prevention--**These regulations ensure that fuel storage, distribution and loading facilities, equipment and handlers satisfy planning, inspection, failure analysis, secondary containment and overfill prevention requirements.

3.5.1.5.1 Handling

These materials present both a health and fire hazard. To minimize the risk of fire hazard, these materials are kept away from initiation sources, such as sparks, open flame and excessive heat. As with solid propellants, there are specific safety rules applied to handling rocket motors to assure they are properly grounded to avoid static electricity. Electrical equipment used for handling liquid propellants should be rated as Class 1, for flammable vapors or gases.

In addition to mitigating the fire risks, the health risks can be reduced by use of proper PPE. Goggles, face shields, gloves and impervious clothing should be used to avoid skin and eye contact. Self-contained breathing apparatuses should be used for open exposure.

3.5.1.5.2 Storage

As with solid propellants, storage and use facilities for liquid propellants are subject to quantity distance siting requirements. Launch sites and storage locations are required to have sufficient separation distances based on the propellant quantity and hazard division. Sufficient separation distance to public traffic routes and all other facilities must be maintained.

3.5.1.5.3 Transport

Liquid rocket propellant is classified as 1.3 DOT Hazard Class. Additionally, hazard classes 2.1, 2.2, 3, 5.1, 6.1 and 8 apply to these fuels and oxidizers.

3.5.1.5.4 Disposal

Under normal operations, KSC does not generate waste liquid propellant. Liquid propellant is fully consumed with the vehicle launch.

3.5.2 Environmental Consequences Including Cumulative Impacts

3.5.2.1 Proposed Action

In the Proposed Action, KSC will transition to a multi-user spaceport. The impact on hazardous materials and waste is confined to an increase in quantity, rather than an influx of new materials. Those materials considered as part of the proposed action are materials that are currently used at KSC.

The Proposed Action will result in an increase of hazardous materials stored and handled at KSC compared to the No Action Alternative. The increase is solely in the quantity of hazardous materials, not an increase in material types. KSC currently handles solvents, surface coatings, propellants and fuels. Procedures for handling, transporting, storing or disposing of hazardous materials would be unaffected by the Proposed Action.

In the Proposed Action, the frequency at which hazardous materials are used, handled, transported, etc., would be increased. Because of the increase in exposure and the activities related to these materials, the risks associated with them are also slightly increased. The importance of adhering to proper safety procedures must be viewed as a top priority for future operations to minimize the risks of accidental release and personnel exposure. Due to the regulatory and safety requirements inherent in the industry and the nature of expected operations it is considered likely that sufficient engineering and administrative controls would mitigate the risks associated with the presence of these materials to the lowest possible level. The severity of an unplanned event is unlikely to increase. The probability of an accidental release would increase due to the increased activities and quantity of materials, but best practices would ensure this increase in risk is small, with the probability of a major spill kept at a minimum.

Overall, adverse impacts of the Proposed Action on hazardous materials and waste would be of slight precedence, negligible to minor magnitude, and long-term duration. Cumulative impacts are not expected, even with the construction and operation the proposed Shiloh Launch Complex. Shiloh would be required to follow all of the same safety regulations that KSC follows for hazardous materials handling, storage, transport and disposal, and would also need to implement comparable practices and procedures.

3.5.2.2 Alternative 1

Alternative 1would be essentially identical to the Proposed Action. There would be no difference in the amount of hazardous materials that would be handled, transported, stored or disposed at KSC under this alternative.

3.5.2.3 No Action Alternative

Under the No Action alternative, the status quo would be maintained at KSC. There would be no increase or decrease in the amount of hazardous materials that would be handled, transported, stored or disposed at KSC.

3.6 Air Quality

3.6.1 Affected Environment

Air quality as a resource incorporates air pollution within a region, as well as sources of, and regulations governing, air emissions. Below is a discussion of the National Ambient Air Quality Standards (NAAQS), local ambient air quality, and the State Implementation Plan (SIP) for the Clean Air Act (CAA), and conformity.

3.6.1.1 National Ambient Air Quality Standards and Attainment Status

EPA Region 4 and Florida Department of Environmental Protection (FDEP) regulate air quality in Florida. The CAA (42 U.S.C. 7401-7671q), as amended, assigns the EPA responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) that specify acceptable concentration levels of six criteria pollutants: particulate matter (measured as both particulate matter less than 10 microns in diameter [PM_{10}] and particulate matter less than 2.5 microns in diameter [$PM_{2.5}$]), sulfur dioxide (SO_2), carbon monoxide (CO), oxides of nitrogen (NO_X), ozone (O_3), and lead. Short-term NAAQS (1-, 8-, and 24-hour periods) have been established for pollutants contributing to acute health effects, while long-term NAAQS (annual averages) have been established for pollutants contributing to chronic health effects. While each state has the authority to adopt standards stricter than those established under the Federal program, the State of Florida accepts the Federal standards.

Federal regulations designate Air Quality Control Regions (AQCRs) in violation of the NAAQS as *nonattainment* areas. Federal regulations designate AQCRs with levels below the NAAQS as *attainment* areas. Brevard County (and therefore all areas associated with the proposed action) is within the Central Florida Intrastate AQCR (40 CFR 81.95). The EPA has designated Brevard County as in attainment for all criteria pollutants (EPA 2014a). The EPA monitors levels of criteria pollutants at representative sites in each region throughout Florida. For reference purposes, Table 3.6-1 shows the monitored concentrations of criteria pollutants at the monitoring location closest to KSC.

Table 3.6-1. Air quality standards and monitored data

Pollutant	Primary NAAQS	State of Florida Standard	Monitored Concentrations at KSC
CO			
1-hour[a] (ppm)	35	35	<no data>
8-hour[a] (ppm)	9	9	<no data>
NO_2			
1-hour (µg/m^3)	100	100	<no data>
O_3			
8-hour[b] (ppm)	0.075	0.075	0.063
SO_2			
1-hour[a] (ppb)	75		<no data>
3-hour[a] (ppm)	0.5	0.5	<no data>
$PM_{2.5}$			
24-hour[c] (µg/m^3)	35	35	21
Annual arithmetic mean[d] (µg/m^3)	15	15	5.8
PM_{10}			
24-hour[a] (µg/m^3)	150	150	54

Source: 40 CFR 50.1-50.12, EPA 2014b.

Note: ppm = parts per million, µg/m^3 = micrograms per cubic meter, NO_2 = Nitrogen dioxide

a - Not to be exceeded more than once per year

b - The 3-year average of the fourth highest daily maximum 8-hour average O_3 concentrations over each year must not exceed 0.075 ppm.

c - The 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor must not exceed 35 µg/m^3.

d- The 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from must not exceed 12.0 µg/m^3.

3.6.1.2 Permitting Overview

FDEP oversees programs for permitting the construction and operation of new or modified stationary source of air emissions in Florida. In Florida, air permitting is required for many industries and facilities that emit regulated pollutants. Based on the size of the emission units and type of pollutants, FDEP sets permit rules and standards for emissions sources.

The air permitting process begins with the application for a construction permit. Back-up generators, boilers, and other stationary sources of air emissions would require permits to construct in one form or another. There are two types of construction permits available through the FDEP for the construction and temporary operation of new emissions sources in attainment areas: Prevention of Significant Deterioration (PSD) permits; and Minor New Source Construction Permits (Minor New Source Review [NSR]).

3.6.1.2.1 Prevention of Significant Deterioration

The PSD program protects the air quality in attainment areas. PSD regulations impose limits on the amount of pollutants that major sources may emit. The PSD process would apply to all pollutants for which the region is in attainment (all but O_3 and $PM_{2.5}$). The PSD permitting process typically takes 18–24 months to complete. Sources subject to PSD are typically required to complete the following:

- BACT review for each criteria pollutant and greenhouse gases (GHG)
- Maximum Achievable Control Technology (MACT) review for HAPs
- Predictive air dispersion modeling
- Establishing procedures for measuring and recording emissions and/or process rates
- A public involvement process

The PSD regulations also set standards to protect Class I areas. CAA defines Class I areas as certain national parks, wilderness areas, national memorial parks, and international parks that were in existence as of August 1977. There are three Class I areas in Florida; the closest to KSC is Chassahowitzka Wilderness Area, approximately 115 miles west of KSC in Crystal River, Florida (EPA, 2014c).

3.6.1.2.2 Minor New Source Review

A Minor NSR permit would be required to construct minor new sources, minor modifications of existing sources, and major sources not subject to NNSR or PSD permit requirements. The Minor NSR permitting process typically takes 4–5 months to complete. Sources subject to Minor NSR could be required to complete the following:

- BACT review for each criteria pollutant
- MACT review for regulated HAPs
- Predictive air dispersion modeling upon request by FDEP
- Establish procedures for measuring and recording emissions and process rates

3.6.1.2.3 Operation Permits

A Title V permit is required for facilities whose potential to emit (PTE) is greater than 100 tpy of a criteria pollutant. KSC is considered a major facility for the purposes of air permitting, and holds a recently revised major operating permit (# 0090051-028-AV) (FDEP, 2015a). The permit requirements include annual periodic inventory of all significant stationary sources of air emissions for each of the criteria pollutants of concern; monitoring and recordkeeping requirements also are included in the permit. Primary stationary sources of air emissions include boilers, and generators. Table 3.6-2 lists KSC's facility-wide air emissions from all significant stationary sources.

Table 3.6-2. Annual emissions for significant stationary sources at KSC

Pollutant	Emissions (tons/year)
Carbon monoxide (CO)	7.2
Nitrogen oxides (NO_x)	25.0
Volatile organic compounds (VOCs)	4.4
Fine particulate matter ($PM_{2.5}$)	1.7
Fine particulate matter (PM_{10})	1.7
Sulfur dioxide (SO_2)	<0.1

Source: FDEP, 2015b.

In addition to the permitting requirements to construct and operate new or modified emissions sources, New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAPs) set emissions control standards for categories of new stationary emissions sources of both criteria pollutants and HAPs. The NSPS process requires EPA to list categories of stationary sources that cause or contribute to air pollution that might reasonably be anticipated to endanger public health or welfare. The NSPS program sets uniform emissions limitations for many industrial sources. The CAA Amendments of 1990, under revisions to Section 112, require EPA to promulgate NESHAPs to reduce the emissions of HAPs, such as formaldehyde, benzene, xylene, and toluene from categories of major and area sources (40 CFR Part 63). New stationary sources whose PTE exceeds either 10 tpy of a single HAP or 25 tpy of all regulated HAPs would be subject to MACT requirements.

3.6.1.2.4 Clean Air Act Conformity

The 1990 amendments to the CAA require Federal agencies to ensure that their actions conform to the SIP in a nonattainment area. EPA has developed two distinctive sets of conformity regulations: one for transportation projects and one for non-transportation projects. Non-transportation projects are governed by general conformity regulations (40 CFR 52.520(c)), and the State of Florida has adopted the Federal regulations by reference (§62-204 Florida Administrative Code). The KSC proposed action is a non-transportation project within an attainment area. Therefore, a general conformity analysis is not required.

3.6.2 Environmental Consequences Including Cumulative Impacts

An impact to air quality would be considered significant if it affects the achievement or maintenance of NAAQS in the region or if it leads to a violation of the Title V operating permit. The following sections discuss the potential for adverse impacts to air quality for the Proposed Action and No Action alternatives.

3.6.2.1 Proposed Action

The Proposed Action would have short- and long-term minor adverse effects. As KSC consolidates ongoing NASA functions and transitions into a multi-user spaceport, the Proposed Action could affect air quality in several ways: through airborne dust and other pollutants generated during construction; by the introduction of new stationary sources of pollutants, such as heating boilers and backup generators; and through increases in transportation-based emissions such as launches and automotive traffic. All components of the Proposed Action are completely within an attainment area and would not inherently lead to a violation of any Federal, state, or local air regulation. Therefore, a general conformity analysis would not be required and the level of effects would be less than significant under NEPA.

3.6.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

The implementation of the land use plan, future development plan, and functional area plans would have short- and long-term minor adverse effects on air quality. Short-term effects would be from airborne dust and other pollutants generated during demolition of aging or outdated facilities and construction of new facilities. Long-term effects would be from introduction of new stationary sources such as boilers and generators, as well as increases in transportation-based emissions such as launches and automotive traffic. This section outlines effects from planning activities, demolition and construction activities, and new stationary sources of air emissions.

Effect from proposed changes in launch, landing, operations, and support activities are addressed in Section 3.6.2.1.2. Effect from proposed changes in non-space-based transportation activities and infrastructure upgrades are addressed in Section 3.6.2.1.4.

3.6.2.1.1.1 Planning Activities

The planning activities associated with the updated land use plan, future development plan, and functional area plans in-and-of themselves would not generate any direct or indirect air emissions. Therefore, planning activities and updating the land use designations would have no effect on air quality.

3.6.2.1.1.2 Demolition and Construction Activities

Although the area is in attainment and the general conformity rules do not apply, the *de minimis* threshold values were used to determine the level of effects under NEPA. As a reasonable upper bound of effects, the total emissions of all criteria pollutants were estimated for a large (1,000,000-gross-square-foot [gsf]) demolition project and a large (1,000,000 gsf) construction project compressed into a 12-month period (Table 3.6-3). The total direct and indirect emissions resulting from projects of this magnitude or smaller would be below the *de minimis* threshold of 100 tons per year of each pollutant; therefore, the level of effects would be minor.

Table 3.6-3. Emissions from large demolition and construction projects

Activity	Emissions [tpy]						*De Minimis* Threshold [tpy]	Level of Effects?
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC		
Large Construction Project (1 million gsf/yr)	28.4	48.7	14.8	3.7	9.9	9.2	100	Less than significant
Large Demolition Project (1million gsf/yr)	37.7	71.7	15.4	4.6	9.0	9.3	100	Less than significant

Note: *de minimis* = of minimal importance, CO = carbon monoxide, NO_x = oxides of nitrogen, $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter, PM_{10} = particulate matter less than 10 microns in diameter, SO_x = sulfur dioxide, tpy = tons per year, VOC = volatile organic compound.

For purposes of analysis, it was assumed that all activities would be compressed into one 12-month period. Therefore, regardless of the ultimate implementation schedule, as long as the rate of construction was less than 1,000,000 gsf/yr, annual emissions would be less than those specified herein. The siting of the facilities, the ultimate design, and moderate changes in quantity and types of equipment used would not substantially change these emission estimates, and would not change the level of effects under NEPA. *Future or tiered NEPA would require air quality assessment for actions that include more than 1,000,000 gsf/yr of demolition or construction.*

All demolition and construction would be accomplished in full compliance with current and pending Florida regulatory requirements, through the use of compliant practices and/or products. Within the region, these regulatory requirements include:

- Air Pollution Control - General Provisions (62-204 FAC);
- Open Burning (62-256 FAC);
- Gasoline Vapor Control (62-252 FAC); and

- Asbestos Program (62-257 FAC).

During construction, reasonable precautions would be taken to prevent fugitive dust from becoming airborne, including, but not limited to:

- Use of water for control of dust in during construction, the grading of roads, or the clearing of land;
- Application of asphalt or water on dirt roads, material stockpiles, and other surfaces that can give rise to airborne dusts;
- Covering open-bodied trucks that are transporting materials likely to give rise to airborne dusts; and
- Removal of earth or other material from paved streets onto which earth or other material has been deposited.

Notably, any new construction would include climate change and sea-level rise hardening requirements where applicable.

3.6.2.1.1.3 Stationary Sources

Any new stationary sources of air emissions could be subject to Federal and state air permitting regulations, including PSD, minor new source review, and Title V permitting. Permitting scenarios can vary based on the types and sizes of new stationary sources, timing of the projects, and the types of controls ultimately selected. However, during the final design stage and the permitting process either, (1) the actual equipment, controls, or operating limitations would be selected to reduce the PTE below the major source threshold; or (2) the PSD permitting process would insure the NAAQS were not exceeded and the emissions from the projects would be included in the regional emissions inventory, ensuring that it would not interfere with the ability of the state to maintain the NAAQS. This cap-and-trade-type system is inherent to Federal and state air regulations, and leads to a forced preservation of clean air in attainment regions. Therefore, regardless of the ultimate permitting scenario, these effects would be less than significant. *Future or tiered NEPA would require air quality assessment for actions that included stationary sources that exceed the PSD major source threshold.*

In some cases, new facilities may require backup generators, and boilers for heating. The exact list of new equipment or stationary source of air emissions is not available at this time. Any new stationary sources of air emissions (e.g., back-up generators or other fuel burning equipment) would be inventoried and reviewed for addition to KSC’s operational air permit and to insure compliance with all applicable state and Federal air regulations. In addition, new sources would be subject to NSPS and NESHAP requirements. All other regulatory requirements and BMPs associated with both construction and new stationary sources would be similar to those outlined in the permitting overview in Section 3.6.1 Affected Environment. Future development activities that included additional stationary sources of air emissions would be added to the installation's Title V permit and meet all the requirements therein.

It is likely that non-NASA enterprises would be owned, operated, and maintained by private entities on Federal property. In general, these leased activities would not be considered under the direct control of KSC. Any leased activities would normally be considered “tenants” and KSC would need to perform an air quality regulatory analysis to determine if any Clean Air Act permitting would be required for the operation of any sources of air emissions. However, leased activities may be considered under common control when they also have a contract-for-service relationship to provide goods or services to KSC. Given the variety and complexity of leased and contract-for-service activities, case-by-case determinations would be necessary to determine if the existing sources of emissions would remain on, or new sources would be added to, KSC's operating permit.

3.6.2.1.2 Launch, Landing, Operations and Support

Launch, landing, operations and support would have short- and long-term minor adverse effects on air quality. Short-term effects would be from construction and modification of launch and support facilities. Long-term effects would be from introduction of new stationary sources such as launches and automotive traffic. This section outlines effects from:

- Site modifications and pre-launch preparations;
- Vertical launch activities; and
- Horizontal launch activities.

Effects from planning activities and associated demolition and construction activities, and new stationary sources of air emissions are addressed in Section 3.6.2.1.1. Effects from proposed changes in non-space-based transportation activities and infrastructure upgrades are addressed in Section 3.6.2.1.4.

3.6.2.1.2.1 Site Modifications and Pre-Launch Preparations

For most launch programs, site modifications would normally be minor and limited to launch pads and facilities directly related to individual launches and test programs. Modifications to existing facilities may include clearing, grading, and limited construction. Fugitive dust and criteria pollutant emissions would be expected. The total emissions of all criteria pollutants for a large demolition project and large construction project are outlined in Table 3.6-3.

Any construction or demolition activities associated with site modifications and prelaunch preparation would likely be substantially smaller than this; therefore, effects would be less than significant. As with the implementation of the land use planning outlined in Section 3.6.2.1.1 and for similar reasons, future or tiered NEPA would require air quality assessment if site modifications included more than 1,000,000 gsf/yr of demolition or construction.

The use of portable generators may be necessary to support some launches. Support equipment would meet all applicable Florida regulatory requirements. In addition, proper tuning and preventive maintenance of vehicles and other support equipment would minimize engine exhaust. These activities would have a limited amount of air emissions, and would not have significant impacts on local or regional air quality.

3.6.2.1.2.2 Vertical Launch and Landing

Under the Proposed Action, vertical launches and landings would be ongoing at KSC. In the hours before the launch, remote sensors and helicopters (when available) may be used to verify that the hazard areas would be clear of non-mission-essential aircraft, vessels, and personnel. Emissions of criteria pollutants for the helicopter exhaust from all vertical launches and landings would be minute. In addition to criteria pollutants, the products of combustion from solid rocket boosters would also include other common products of combustion including aluminum oxide, hydrogen chloride, hydrogen, nitrogen, carbon dioxide, and water. These components are predominately inert and would be emitted in limited amounts.

Under the proposed action, transitioning to a multi-user spaceport, increased launch frequency would be expected. Increased launch frequency, vehicle class (propellant quantity) and propellant type would be the determining factors on the impact on the air quality at KSC.

Table 3.6-4 summarizes the products of combustion based on propellant type.

Table 3.6-4. Summary of launch vehicle products of combustion

Propellant	Vehicle Class	Major Products of Combustion
Solid	Small, Medium, Super Heavy, Horizontal	H_2O, CO, CO_2, HCl, NOx, N_2, PM10 (Al_2O_3)
RP-1/Jet-A/ LCH4/LOX (Hydrocarbon Fuels)	Small, Medium, Super Heavy, Horizontal	H2O, CO, CO_2
Cryogenic (Liquid Oxygen/Hydrogen)	Medium, Super Heavy, Horizontal	H_2O
MMH/A-50/ N2H4/N2O4 (Liquid Hydrazine Fuels)	Small, Medium, Horizontal	H_2O, CO, CO_2, NOx, N_2

Note: See Appendix A for list of acronyms and abbreviations.

Solid rocket propellant typically consists of aluminum powder fuel, ammonium perchlorate (AP) oxidizer and a binder. The most common binder used is HTPB. Like other binders, HTPB is composed mostly of carbon and hydrogen. The main combustion products of these fuels are solid aluminum oxide (Al_2O_3) particulate, hydrogen chloride (HCl) gas, water vapor (H_2O), nitrogen (N_2) and carbon dioxide (CO_2). Other minor products include the criteria pollutants carbon monoxide (CO) and nitrous oxides (NOx). Combustion of AP-based propellants also has the potential to produce dioxins/furans in trace quantities (EDE, 2012a).

RP-1, Jet-A and LCH4 (liquid methane) can all be classified as liquid hydrocarbon propellants. These fuels commonly use Liquid Oxygen (LOX) as the oxidizer. Jet-A propellant typically contains sulfur. As carbon is a main ingredient in the fuel, hydrocarbon propellants produce a large amount of carbon dioxide and water vapor as products of combustion. Other minor constituents include CO and sulfur dioxide SO_2.

Cryogenic engines (liquid hydrogen (LH2)/ liquid oxygen (LOX)) are in a category by themselves. Water vapor is the only product of combustion.

The remaining propellants are categorized as those that use liquid hydrazine fuels. These fuels typically use dinitrogen tetroxide as the oxidizer. These fuels are hypergolic with the listed oxidizers and are very hazardous; however, when burned as fuel the products of combustion are mostly non-hazardous. Combustion of these propellants produces mostly water vapor and nitrogen, as well as smaller quantities of carbon dioxide, carbon monoxide and nitrous oxides.

Tridyne is also used with liquid fuels. Tridyne is nitrogen, helium and hydrogen and has no toxicity therefore it is not discussed further.

Criteria Pollutants

The Federal government (EPA) has found that emissions generated at or above 3,000 feet above ground level have no impact on surrounding air quality (40 CFR 93.153). Therefore, only the portion of emissions generated from Vehicle Launches below 3,000 feet are considered for contributions to the air quality and for *de minimis* calculations under the CAA. While *de minimis* calculations typically apply to stationary sources, they are applied in this EIS to assess the impact on air quality. The EPA uses *de minimis* to ascertain whether an emission source produces significant pollutants. Typically, sources that produce pollutants below *de minimis* levels are considered to have no impact on air quality. KSC is not located in an ozone transport region or in a nonattainment area.

Table 3.6-5 lists the criteria pollutants established as NAAQS under the CAA and its amendments. Criteria pollutant standards are set for VOC, NOx, CO, SO_2, PM and Pb. Vehicle Launches produce significant quantities of CO, NOx and PM; SO_2 and VOCs are also possible pollutants based on the fuel but typically would only be present in very low or trace quantities.

Total quantities of criteria pollutants produced are dependent on Launch Vehicle Classes and total number of annual launches. The largest class, SHCLV, produces the largest quantities of criteria pollutants. The *de minimis* levels for certain criteria pollutants could be exceeded by a large number of launches of this vehicle class. By way of general comparison with smaller vehicle classes, roughly twelve times more launches of the SCLV or three times more launches of the MCLV of the same propellant type would be needed to produce the same quantity of emissions as that of the SHCLV.

For example, the historic space shuttle would be classified as a SHCLV. A space shuttle launch produced PM-10 emissions in the lower atmosphere that exceed *de minimis* levels after roughly a dozen launches. CO emissions could also exceed those standards after 70 plus launches and NOx after 100-200 launches. As stated above for relative comparison, roughly twelve times the number of launches of SCLVs at KSC would have no increased or similar impact on the air quality as the space shuttle, assuming that the same propellant types are used.

Future launches at a re-tasked KSC could possibly result in an increase in the production of criteria pollutants over levels that have been emitted in under past KSC operations. However, vehicle launches alone would only exceed *de minimis* levels if a large number of SHCLV launches, coupled with numerous other classes of vehicle launches, were to be conducted during the calendar year. Table 3.6-6 summarizes *de minimis* calculation estimates for the no action and proposed action alternatives, including the two main categories for propellant type.

Thermal buoyant rocket plumes typically meet the listed standards, even for the largest of motors. However, vertical launches generate a ground cloud that does not exhibit typical thermal buoyant behavior. The lack of thermal buoyance is exacerbated by the large amounts of sound suppression water that is sprayed around the launch site. Water entrained into the launch cloud cools the hot gasses, reducing the elevation to which the cloud will climb, keeping the cloud near

Table 3.6-5. 40 CFR 93 § 153 *de minimis* levels

Pollutant	Area Type	Tons/Year
Ozone (VOC or NOx)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NOx)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
Carbon monoxide, SO_2 and NO_2	All nonattainment & maintenance	100
PM-10	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
PM2.5 Direct emissions, SO2, NOx (unless determined not to be a significant precursor), VOC or ammonia (if determined to be significant precursors)	All nonattainment & maintenance	100
Lead (Pb)	All nonattainment & maintenance	25

Table 3.6-6. Summary of *de minimis* calculation estimates

Criteria Pollutant	No Action Alternative	Proposed Action	
		Solid Propellant	Liquid Propellant
CO	<	<	<
NOx	<	<	<
VOC	<	<	<
SO_2	<	<	<
PM-10	<*	<*	<

< Less than *de minimis* levels, > Greater than *de minimis*
*Estimated to be below *de minimis*; future workload scenarios could exceed

ground level. Due to the reduced buoyancy, the high concentrations of combustion gases do not have as much time to diffuse in the ambient air before they return to the ground. Ground level concentrations could exceed the Ambient Air Quality Standards and Threshold Limit Values for Criteria Pollutants and Hazardous Air Pollutants (HAP) in the ground cloud near the launch pad. However, as the ground cloud moves away from the launch area, the cloud diffuses with atmospheric air and grows in size. Studies done as part of the Space Shuttle Environmental Impact Statement found constituent concentrations were typically predicted to be below Air Quality Standards and Threshold Limit Values in all areas outside of the launch area (NASA, 1978).

As the space shuttle was larger than all anticipated future launch vehicles, with the exception of the SLS, the ground cloud produced from future launches at KSC would be smaller than those generated by the space shuttle. Those clouds would travel, diffuse and disperse similar to those typically generated at KSC.

The SLS will generate a launch cloud larger than those from the space shuttle. The SLS will use solid propellant boosters similar to that of the space shuttle. The main SLS engine represents the largest increase in emissions, which uses a liquid hydrogen/oxygen engine. Therefore, ground clouds generated by the SLS are expected to have similar concentration of criteria pollutants as the space shuttle.

Propellants are typically designed to be under-oxidized to maximize the thrust to weight ratio. In the atmosphere, as the rocket plume exits the exhaust nozzle, ambient air is mixed into the high temperature flame region. Oxygen from the air is used to further oxidize nozzle exhaust gas species such as OH, CO, Al, and NO. The amount of partially oxidized constituents produced from a vehicle launch is a function of the mixing of the plume. In general, a larger rocket motor will produce more partially oxidized constituents, such as CO, than a smaller rocket motor per pound of propellant burned. The larger plume of the heavier vehicles not only requires more air to be mixed, but requires that the ambient air be mixed a longer distance into the flame region, compared to a smaller vehicle. Testing in the open air has found that smaller rocket motors have 20-30% more air available for combustion than for the SHCLVs, such as the space shuttle (EDE, 1996).

H_2O (Water)

All propellants expected to be employed at KSC produce water as a product of combustion. Solid propellants produce significantly less water than other fuel types. While a greenhouse gas, water vapor is typically considered to have no adverse effects on ambient air quality.

Carbon Monoxide

Carbon monoxide (CO) emissions are a criteria pollutant. CO is a colorless, odorless and poisonous gas that presents a health hazard when concentrations exceed the Threshold Limit Values (TLV).

Carbon is a main component in hydrocarbon fuels and the binder used in solid propellants. It is also present as a component in some hydrazine-based liquid propellants. The majority of the carbon in these fuels fully oxidizes to CO_2. However, propellants are frequently under-oxidized, meaning that additional oxygen is required for complete combustion of the carbon, resulting in some carbon monoxide being produced. CO production peaks at the moment of motor ignition before a stable motor plume is established. Also, the addition of sound suppression water into the rocket plume would result in a small increase in CO production due to quenching of some of the oxidation reaction which takes place with entrained ambient air. Because CO production is based on the amount of oxygen that is entrained into the plume, larger rocket motors typically produce more CO per unit mass versus smaller motors.

Ground clouds generated from vertical launch vehicles generate CO concentrations higher than the State and Federal Ambient Air Standards in the immediate vicinity of the launch pad. After the ground cloud reaches a stable altitude, disperses and moves away from the launch area, CO concentrations are diluted and reduce to levels below applicable standards (NASA, 1978).

Carbon Dioxide

The majority of carbon in propellants is converted to carbon dioxide (CO_2) during the combustion process. Carbon dioxide is an inert gas that is not a health hazard in low concentrations. For example, TLV for CO_2 is set at 5,000 ppm for 8 hour exposure.

In the past, there have been no regulations restricting CO_2 emissions. Because CO_2 is a greenhouse gas, recently there have been a number of rules adopted (with several more proposed) that put limitations on the amount of CO_2 that can be generated. While the majority of these new and proposed rules apply to power plant emissions and motor vehicles, CO_2 limitations could someday affect the amount of launches allowed at KSC.

Hydrogen Chloride (HCl)

Ammonium perchlorate based solid fuel generates hydrogen chloride (HCl) during combustion. HCl is a hazardous air pollutant. HCl readily dissolves in water vapor and droplets present in the exhaust gases and forms hydrochloric acid. Inhaled HCl gas forms hydrochloric acid on contact with water in the body. The corrosive acid can burn the skin and cause irritation in the nose, throat and lungs, with mild exposures. Severe exposures can lead to permanent damage to the eyes, respiratory and circulatory system and even death. The TLV for HCl is set at 5 ppm for any duration of human exposure.

The initial ground cloud can contain thousands of pounds of HCl, with concentrations far exceeding safe levels. HCl is readily absorbed into water droplets and onto the particulate matter. A large amount of water is sprayed during and after the launch to suppress sound and to cool and wash the launch structure. During the shuttle launches, this water captured 5-15% of the HCl generated in the ground cloud (Knott et al., 1983).

As the ground cloud moves away from the launch area, hydrochloric acid precipitates out of the cloud on water droplets and large particulate matter. The cloud diffuses and disperses greatly reducing the concentrations to acceptable levels a certain distance away from the launch area.

Nitrogen Oxides (NOx)

Nitrogen dioxide (NO_2) is a brownish gas with a strong odor. The gas is hazardous to human health if inhaled. NO_2 in the atmosphere combines with rain water to form nitric acid (acid rain). Additionally, NO_2 is a precursor for ozone (O_3), presenting a possible impact on the upper atmosphere.

Nitrogen oxides (NOx) are produced when nitrogen and oxygen are present at high temperatures. They are produced in the greatest quantities when nitrogen is present in the fuel and/or oxidizer. However, because atmospheric air mixes with the high temperature rocket plume, NOx is produced from all vehicle launches. However, the quantities of NOx produced from cryogenic engines (LOX/LH2) are considered negligible. The main nitrogen oxides are nitrous oxide (NO) and NO_2. In open air, NO will oxidize into NO_2.

In rocket motor combustion, NOx is produced in the smallest quantity of the major combustion products. In general, the amount of NOx produced by launches is negligible to that produced by other sources. It is unlikely that NOx would exceed *de minimis* values for practical anticipated launch scenario at KSC.

Particulate Matter (PM-10)
Solid rocket motors produce large amounts of particulate matter (PM), in the form of aluminum oxide (Al_2O_3). This solid particulate is inert and only considered health harming if the particle size is below 10 microns. PM-10 pertains to particles between 2.5 and 10 microns.

Testing of combustion of Al-AP propellant has shown that Al_2O_3 particles will coalesce increasing in size, leaving only 10-20% of the PM below 10 microns (EDE, 2012b). The larger particles settle out of the ground cloud orders of magnitude faster than the other constituents, leaving only the PM-10 dusts suspended in the air.

Sulfur Dioxide
Sulfur containing Jet-A fuel, used in horizontal launch vehicles, produces small amounts of sulfur dioxide (SO_2). SO_2 is a toxic by inhalation, causing problems in the respiratory system in high concentrations. SO_2 is soluble in water and can produce sulfuric acid when combined with moisture in the air. SO_2 is a primary source of acid rain.

Only a single fuel type evaluated contains significant quantities of sulfur. The amount of sulfur dioxide produced is expected to be 1-2 orders of magnitude below *de minimis* levels for any practical launch scenario at KSC.

Volatile Organic Compounds (VOCs)
Some fuel types are classified as volatile organic compounds (VOCs) before combustion. However, launch vehicle motors are designed to be very efficient combustion engines. Virtually no VOCs are emitted from vehicle launches.

As with carbon monoxide, additional oxygen must be mixed with the rocket plume to fully oxidize the hydrocarbon fuel. Poor mixing or premature quenching of rocket plume could release unburnt VOCs. VOCs are typically produced in much lower quantities than CO from launches as the temperature requirement for combustion of VOCs is significantly lower than that of CO.

Dioxins/Furans
Dioxins/furans can be produced when chlorine and carbon are present in combustion. These substances have been found to damage the immune system and are known carcinogens. Since

dioxins/furans will bioaccumulate in the human body, emission standards and tolerable intake levels are set extremely low.

AP solid propellant combustion can produce dioxins/furans. However, published open air testing of rocket motor exhaust has not indicated measured dioxins/furans above non-detect levels. Non-detection in open air can be due to the nature of methods for measurement, which do not apply well to an open air test; or simply due to the fact that the trace quantities are so low, they are easily diluted below detection levels.

The trace quantities of dioxins/furans that can be produced are not expected to exceed detection levels in the open air, and thus have negligible impact on the air quality.

Catastrophic Launch Vehicle Failure

In the event of catastrophic launch vehicle failure, there is the potential for the release of un-combusted fuels. Because of the Challenger accident, NASA performed a study based on large chunks of propellant falling to the ground and burning without a significant plume rise. In these instances, they believed that there was potential cause for concern. However, they reached these conclusions by stating that they did not have appropriate models available and used Cal Puff and REEDM which have questionable validity to this application. They suggested that risks could be mitigated by having people be indoors during launches. This is not deemed very practical as the public enjoys viewing launches. Moreover, there is no record of any spectator being harmed in the Challenger incident (NASA, 2004).

A catastrophic launch vehicle failure during launching, landing, testing or other activity can result in a greater impact on the air quality than a successful operation. Because launch vehicles are designed to be efficient combustion engines, catastrophic events can result in the release of un-combusted and partially oxidized fuels as the fuels are able to bypass the nozzle. The two criteria pollutant that would be released in greater quantities in a catastrophic failure are CO and VOCs as there is not sufficient mixing and temperature for complete oxidation.

Another consequence of catastrophic failures can be an increase in emissions generated at or below 3,000 feet AGL. During successful vehicle launches, only a fraction of the fuel is consumed below this elevation. If a catastrophic failure occurs below this elevation, a majority of the combustion products would be released in the lower atmosphere. This is opposed to a successful vehicle launch in which the majority of the combustion products are released in the upper atmosphere.

Each product of combustion behaves slightly different once it has dispersed in the open environment.

CO

Carbon monoxide in the atmosphere will naturally oxidize to CO_2. CO is not accumulated in the air between vehicle launches.

CO_2

A portion of atmospheric carbon dioxide is absorbed by plant life, absorbed by moisture in the air and bodies of water. The remaining carbon dioxide remains as a gas and disperses in the atmosphere. No measureable increase of CO_2 remains in the KSC area following a vehicle launch. CO_2 emissions therefore do not impact the air quality in the KSC area.

The CO_2 emitted from vehicle launches would result in a slight, incremental increase to the total amount of global CO_2 emissions if as part of the no action alternative, these launches did not take place. However, even if KSC would be unable to support these launches, these launches would still occur, only at a different facility. Therefore, there would be no incremental impact on global CO_2 emissions as part of this action.

NOx

A portion of nitrogen oxides in the atmosphere are absorbed by moisture and form nitric acid. Nitric acid is then deposited to the soil or ocean as slightly acidic rain. The alkaline soil of the KSC region quickly neutralizes the acid. Rain water with this acid that falls in the ocean is immediately diluted below detection levels.

NOx in the atmosphere also reacts with hydrocarbons in the presence of sunlight to form ozone. In the lower atmosphere, ozone is a key component in the creation of smog. As KSC is in an attainment zone, NOx and ozone do not accumulate to smog producing levels. Lower atmosphere ozone does not remain in the air; as part of the same reaction that produces smog, ozone is broken into hydroxyl and peroxyacetyl nitrates that are eventually deposited on the ground.

PM-10

All PM produced from a vehicle launch settles out of the air. Aluminum oxide particulate matter can typically be found in the near and far field launch impact areas. Previous and subsequent vehicle launches do not lead to any increase in PM-10 in the air. Aluminum oxide is inert, and once settled to the ground poses no health or environmental hazard.

HCl

Hydrogen chloride is readily soluble in water. HCl is absorbed into moisture in the air and any ground level water it comes in contact with. HCl is then naturally scrubbed out of the air in water droplet. HCl does not remain in the atmosphere following launches.

SO_2

SO_2 is not produced from vehicle launches in significant quantities. The majority of SO_2 that is generated is captured in rain water and scrubbed from the air.

The majority of the products of combustion from vehicle launches do not remain in air. Those few constituents that remain airborne, diffuse and disperse into the atmosphere. Wind currents further dilute and carry emissions away from the KSC area. Within hours of a launch, vehicle emissions are undetectable. There is no significant cumulative impact on the air quality from increased launch frequency at KSC.

Emissions generated from vehicle launches produce localized short-term impacts on air quality. The proposed action will increase the number of launches per year at KSC. However, it is not anticipated that this increase would result in multiple launches each day. The launches under the proposed action will likely be sequenced with time intervals from several days to weeks between launches. A localized short term impact will occur for each launch, however, the fate of the exhaust products in the environment do not indicate that cumulative impacts will occur to local air quality.

Individual launches would be short-term discrete events. Therefore, atmospheric concentrations would differ depending on local meteorological conditions at the time of launch, such as temperature profiles, atmospheric stability, wind speeds, and the presence or absence of inversions. Although rocket motor emissions would be released in the lower atmosphere, they would be rapidly diluted and dispersed by prevailing winds. During boost flight, additional rocket emissions would be rapidly dispersed over a large geographic area and by prevailing winds. No exceedance of air quality standards or health-based standards for any air pollutants would be expected. As a result, no significant impacts on local or regional air quality are expected. Although effects would likely be minor, there are a wide range of possible vertical launch and landing fuel types and operating scenarios. *Because of these uncertainties, future or tiered NEPA would require air quality assessment for increases in vertical launch and landing activities at KSC.*

In the hours and days following vertical launches, a general safety check and cleanup of the launch site would occur. There would be some small amount of air emissions from worker commuting, the removal of equipment from the launch site, and general refurbishment of the launch facilities. As with any construction or demolition, post-launch refurbishment activities would meet all applicable Florida regulatory requirements. No new air emission permits would be required for these activities. Effects from post-launch activities would be less than significant.

3.6.2.1.2.3 Horizontal Launch and Landing

Under the Proposed Action, horizontal launches and landings may occur regularly at KSC. Launch vehicles would likely consist of traditional commercial aircraft comparable to a 747 and designed to carry an additional launch vehicle which would be released in the upper atmosphere. Carrier vehicles would use traditional fossil fuels and have emissions comparable to existing commercial aircraft.

Table 3.6-7 provides FAA estimates for the total annual emissions for all horizontal launches and landings nationwide. Emissions have been broken down to areas below 3,000 feet above ground level (AGL) (troposphere) and above 3,000 feet AGL (tropopause and stratosphere). Three thousand feet AGL would be the nominal height of the atmosphere mixing layer below which emissions naturally sink and contribute to ground-level concentrations of air pollutants, and above which they do not. Emissions from launch vehicles above 3,000 feet AGL would naturally rise into to the upper atmosphere and would not contribute to ground-level concentrations. Ground level emissions of criteria pollutants from all horizontal launches and landings would be very small and below the *de minimis* thresholds. These effects would be less than significant.

Individual launches of additional launch vehicles in the upper atmosphere would be short-term discrete events with no ground level emissions. In addition to criteria pollutants, the products of combustion from solid rocket boosters would include products of combustion such as aluminum oxide, hydrogen chloride, hydrogen, nitrogen, carbon dioxide, and water. These components are

Table 3.6-7. Estimated annual emissions for all horizontal launches and landings nationwide

	Emissions [tpy]						*De Minimis* Threshold [tpy]	Level of Effects?
	CO	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**		
Below 3,000 Feet (Troposphere)	3.4	0.1	1.0	1.0	<0.1	0.5	100	Less than significant
Above 3,000 Feet (Stratosphere)	121.6	0.1	13.1	13.1	<0.1	<0.1	N/A	Negligible

Source: FAA, 2005.
Note: CO = carbon monoxide, *de minimis* = of minimal importance, NO_x = oxides of nitrogen, $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter, PM_{10} = particulate matter less than 10 microns in diameter, SO_x = sulfur dioxide, tpy = tons per year, VOC = volatile organic compound.

predominantly inert and would be in limited amounts. As with vertical launches, atmospheric concentrations would differ depending on meteorological conditions at the time of launch. Rocket motor exhaust would not be released in the lower atmosphere, and rocket emissions would be rapidly dispersed over a large geographic area and by prevailing winds. No exceedance of air quality standards or health-based standards for any air pollutants would be expected. As a result, no significant impacts on local or regional air quality are expected. Although effects would likely be minor, there are a wide range of possible horizontal launch and landing fuel types and operating scenarios. *Future or tiered NEPA would require air quality assessment for increases in horizontal launch and landing activities at KSC.*

3.6.2.1.3 Climate Change

Implementation of the climate change and sea-level rise requirements would have short- and long-term minor adverse effects on air quality. Short-term effects would be from airborne dust and other pollutants generated during demolition of aging or outdated facilities, construction of new facilities, and modification of existing facilities. Long-term effects would be from introduction of new stationary sources such as generators and combustion driven water pumps. Effects from the demolition of outdated facilities and construction of new facilities are addressed in Section 3.6.2.1.1. Any new construction stated under future planning efforts would naturally include climate change and sea-level rise requirements.

Modifications of existing facilities to meet climate change and sea-level rise requirements may include everything from minor hardening efforts to complete on-site demolition and reconstruction. The total emissions of all criteria pollutants for a large demolition project and a large construction project are outlined in Table 3.6-3. Any construction or demolition activities to meet climate change and sea-level rise requirements would likely be substantially smaller than this; therefore, effects would be less than significant. As with the implementation of the land use planning outlined in Section 3.6.2.1.1 and for similar reasons, future or tiered NEPA would require air quality assessment if site modifications included more than 1,000,000 gsf/yr of demolition or construction.

In some cases, facilities may require backup generators and onsite water pumps. Any new stationary sources of air emissions would be inventoried and reviewed for addition to KSC's operational air permit and to insure compliance with all applicable state and Federal air regulations including NSPS and NESHAP requirements. All other regulatory requirements and BMPs associated with both construction and new stationary sources would be similar to those outlined in the permitting overview in Section 3.6.1 Affected Environment.

3.6.2.1.4 Future Transportation Plan

Implementing the transportation plan would have short-term minor adverse effects from construction activities. Increases in emissions would be relatively small and would not contribute to a violation of any Federal, state, or local air regulation. Construction emissions would be temporary, and include emissions from heavy equipment, fugitive dust and emissions from construction vehicles traveling to and from the sites. Construction of transportation projects would be performed in full compliance with Florida air regulations. There would be no permanent sources of air emissions associated with the transportation projects.

3.6.2.1.4.1 Roads, Bridges, and Parking

Road, bridges and parking improvement and replacement projects would be specifically designed to relieve congestion and reduce the number of vehicle miles traveled by commuters and others using the roadways near KSC. Small changes in traffic patterns would have negligible long-term effects to air quality. There would be some construction emissions with these activities; however, these emissions would be very small and effects to air quality would be less than significant. Road and bridge divestiture would eliminate the vehicle traffic on and the maintenance of the divested infrastructure and any associated air emissions. Rerouted traffic may cause congestion in the centralized areas of KSC; however, these small changes in traffic patterns would have negligible long-term effects to air quality either regionally or locally.

The primary air pollutants from mobile sources are CO, NO_x, and VOCs. Lead emissions from mobile sources have declined in recent years through the use of unleaded gasoline, and potential SO_2 and particulate emissions from mobile sources are small compared to stationary sources, such as power plants and industrial facilities. Potential emission increases from additional vehicle miles traveled resulting from an action could affect regional O_3 and/or $PM_{2.5}$ levels. However, because these are problems of regional concern and subject to air transport phenomena under different weather conditions, regional effects are generally evaluated using regional airshed model(s). Regional analysis is generally not conducted on a project-specific basis and is not necessary for this EIS or future tiered NEPA. CO and $PM_{2.5}$ are site-specific pollutants with higher concentrations found adjacent to roadways and signalized intersections. Brevard County, and therefore KSC, is not a nonattainment or maintenance area for CO or $PM_{2.5}$ and changes in traffic from implementing the transportation plan would have only minute changes in CO concentrations at nearby intersections; therefore, "hot-spot" analysis is not necessary for this PEIS or future tiered NEPA.

3.6.2.1.4.2 Rail and Water

Construction and operation of new rail spurs and seaports would have some level of air emissions and impacts. Although effects would likely be minor, there is a wide range of possible seaport operating scenarios. *Future or tiered NEPA would require air quality assessment for the establishment of any new seaports at KSC.*

3.6.2.1.4.3 Air

Modifications to SLF facilities, infrastructure, the runway, and other airfield systems would have some level of air emissions. Construction emissions would be relatively small and their effects to air quality would be less than significant. Development of a new runway may constitute a relatively large effort with both temporary and ongoing sources of air emissions. *Future or tiered NEPA would require air quality assessment for the establishment of any new runways at KSC.*

3.6.2.1.5 Programmatic Determinations

A programmatic approach was performed for this EIS to assess the effect of the Proposed Action on air quality. In general, the overall effects of the action and its component activities would be less than significant or beneficial. Site-specific and project-level details are not available at this time; however, based on existing information no additional evaluation under future or tiered NEPA would be required for air quality unless the project entails:

- More than 1,000,000 gsf/yr of demolition or construction;
- Stationary sources of air emission that exceeded the PSD major source threshold;
- Increases in vertical launch and landing activities at KSC;
- Increases in horizontal launch and landing activities at KSC;
- Establishment of any new seaports at KSC, or
- Establishment of any new runways at KSC.

Without these components, future or tiered NEPA could include this programmatic analysis by reference and eliminate air quality as a resource area carried forward for detailed evaluation.

3.6.2.1.6 Cumulative Impacts

The Proposed Action would have short- and long-term minor adverse cumulative effects. By directly inventorying all emissions in a nonattainment region and monitoring concentrations of criteria pollutants in attainment regions, the State of Florida takes into account the effects of all past and present emissions in their state. This is done by putting a regulatory structure in place designed to prevent air quality deterioration for areas that are in attainment with the NAAQS and to reduce common or criteria pollutants emitted in nonattainment areas to levels that would achieve compliance with the NAAQS (EPA, 2013e). This structure of rules and regulations are contained in the SIP. SIPs are the State regulations and other materials for meeting clean air standards and associated CAA requirements. SIPs include:

- State regulations that EPA has approved;
- State-issued, EPA-approved orders requiring pollution control at individual companies; and

- Planning documents such as area-specific compilations of emissions estimates and computer modeling demonstrating that the regulatory limits assure that the air would meet air quality standards (EPA, 2013f).

The SIP process includes (either specifically or indirectly) all sources of air emissions and all activities in the region. No large-scale projects or proposals have been identified that when combined with the Proposed Action would interfere with the state's ability to maintain the NAAQS in this region or would lead to a violation of any Federal, state or local air regulation.

3.6.2.2 Alternative 1

Alternative 1's direct, indirect, and cumulative impacts on air quality would be almost the same as those of the Proposed Action, but somewhat less. Because the two new seaports would not be built, air emissions associated with its construction and operation would not occur. Overall impacts would be minor and long term.

3.6.2.3 No Action Alternative

Selecting the No Action Alternative would result in no additional effect on air quality. This alternative involves continuing existing activities and environmental programs at KSC. Because the number and type of activities would remain relatively constant under the No Action Alternative, similar levels of emissions of air pollutants would be expected. Ambient air quality would remain unchanged when compared to existing conditions.

3.7 Climate Change

3.7.1 Affected Environment

The climate of KSC is subtropical with short, mild winters and hot, humid summers, with no recognizable spring or fall seasons. Summer weather, usually beginning in April, prevails for about 9 months of the year. Typically, dawns are slightly cloudy or hazy, with little wind and temperatures near 70 degrees Fahrenheit (F). During the day the temperature rises into the 80s and 90s F. A typical day is mostly sunny, with scattered white clouds. Often dark clouds in the afternoon foreshadow a storm. Thundershowers frequently lower local temperatures and an ocean breeze usually appears. Occasional cool days occur in November, but winter weatherstarts in January and extends through February and March. These last two months are usually windy, and temperatures range from about 40^{o}F at night to 75^{o}F during the daytime (NASA, 2010a, 2015).

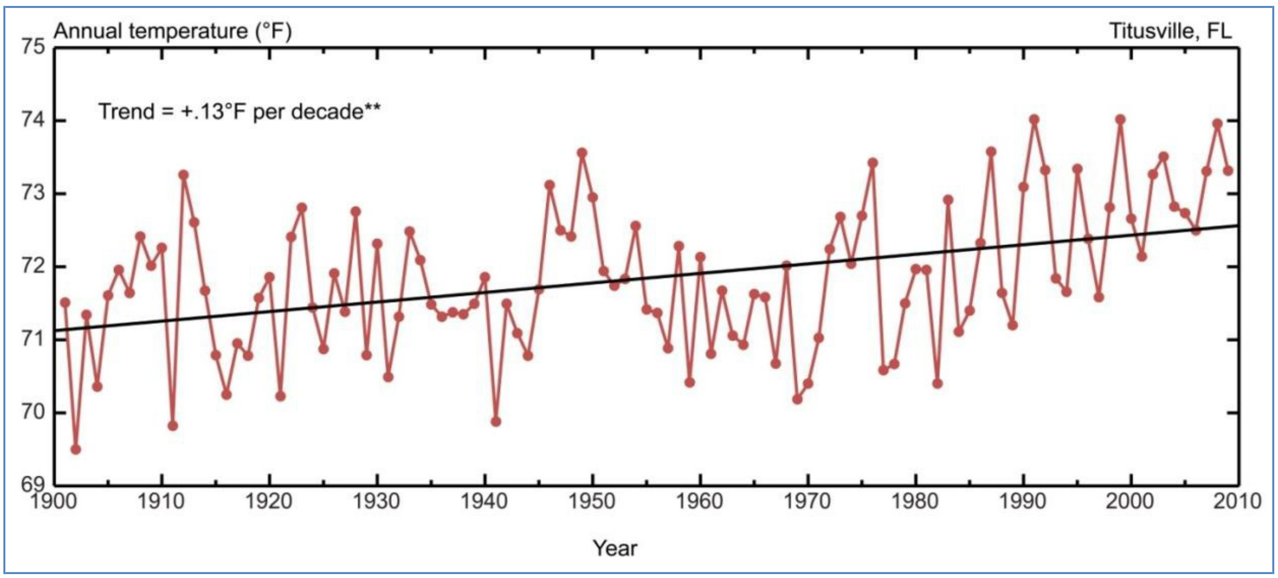
The dominant weather pattern (May to October) is characterized by southeast winds, which travelclockwise around the Bermuda High. The southeast wind brings moisture and warm air, whichhelp produce almost daily thundershowers creating a wet season. Approximately 70 percent of the average annual rainfall occurs during this period. Weather patterns in the dry season (November to April) are influenced by cold continental air masses. Rains occur when these masses move over the Florida peninsula and meet warmer air. In contrast to localized, heavy thundershowers in the wet season, rains are light and tend to be uniform in distribution in the dry season (NASA, 2010a, 2015).

The main factors influencing climate at KSC are latitude and proximity to the Atlantic Ocean and the Indian and Banana Rivers, which moderate temperature fluctuations. Results of the Cape Atmospheric Boundary Layer Experiment found that wind direction, especially the seabreeze front, is controlled by thermal differences between the Atlantic Ocean, Banana River, Indian River, and Cape Canaveral Land Mass. Heat is gained and lost more rapidly from land than water. During a 24-hour period, water may be warmer and again cooler than adjacent land. Cool air replaces rising warm air creating offshore (from land to ocean) breezes in the night and onshore (from ocean to land) breezes in the day. These sea breezes have been recorded at altitudes of 3,281 feet and higher, and reach further inland during the wet season. Seasonal wind directions are primarily influenced by continental temperature changes. In general, the fall winds occur predominantly from the east to northeast. Winter winds occur from the north to northwest shifting to the southeast in the spring and then to the south in the summer months.

3.7.1.1 Temperature

Figure 3.7-1 plots annual mean temperature from 1900-2010 at Titusville, Florida, displaying a warming of +.13°F per decade on an upward sloping trend.

Figure 3.7-1. Long-term temperature data from Titusville, Florida



Source: NASA. Adapting Now to a Changing Climate, NP-2010-11-687-HQ

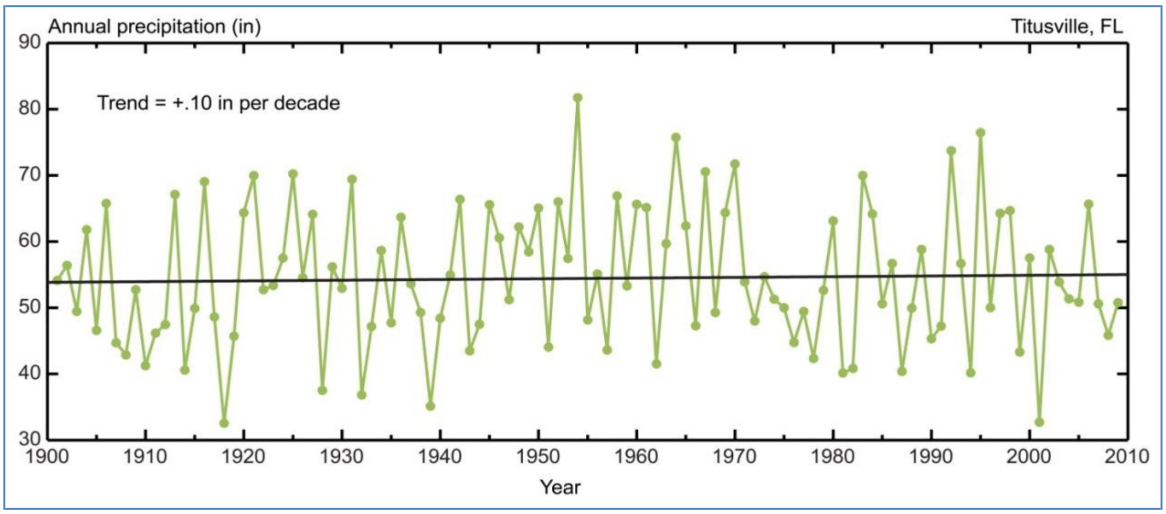
3.7.1.2 Rainfall

Rainfall data are gathered from several collecting stations in the KSC area. These stations provide both long-term records (Merritt Island and Titusville) and site-specific data of special interest to KSC. Mean annual rainfall for Merritt Island and Titusville are 51.6 in. and 53.8 in., respectively. Annual rainfall varies widely; values for Merritt Island range from 30.5 in. to 85.7

in, and for Titusville range from 33.4 in to 81.7 in. Distribution of rainfall is bimodal, with a wet season occurring from May to October, and the remainder of the year being relatively dry. There is noticeable variation in mean monthly rainfallamounts among the wet season months (June through October) with little variation during the dryseason.

On average, measurable precipitation occurs 148 days per year, with about 60 percent of these being in the wet season. Year to year variability in precipitation is high with droughtconditions (high temperatures and low groundwater table) being somewhat common. These occurrences are usually associated with La Niña conditions. As shown in Figure 3.7-2 for Titusville, the total annual precipitation for 2000 was only 32.60 inches, which is the lowest recorded in twenty-five years at the site. Rainfall has displayed a negligible trend in intensity or volume over the last 100 years (+.10 inches per decade, equivalent to 0.2%).

Figure 3.7-2. Long-term rainfall data for Titusville, Florida



Source: NASA. Adapting Now to a Changing Climate, NP-2010-11-687-HQ

3.7.1.3 Sea Level

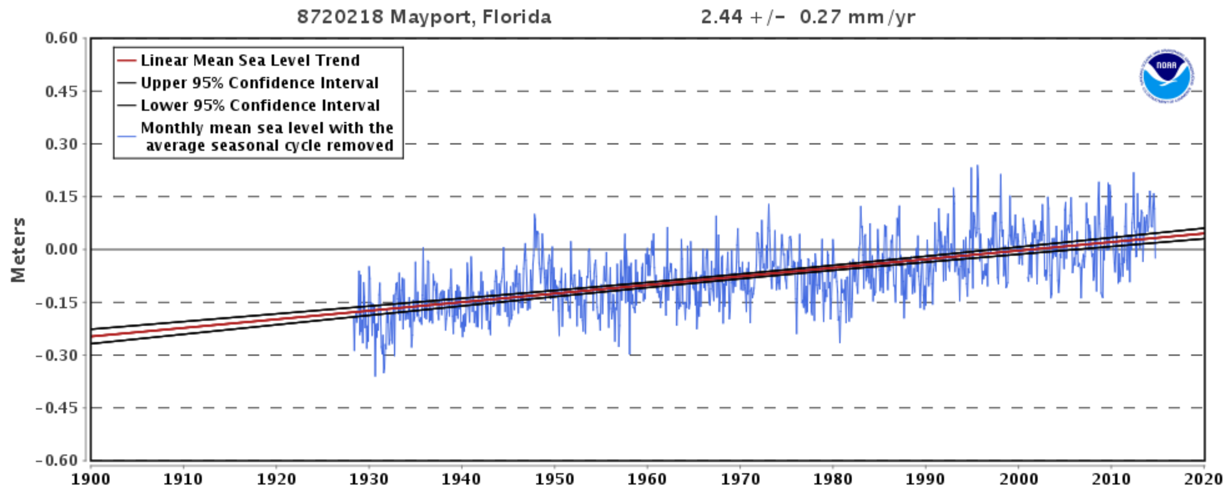
The Center for Operational Oceanographic Products and Services has been measuring sea level for over 150 years, with tide stations of the National Water Level Observation Network (Network) operating on all U.S. coasts. Changes in Mean Sea Level (MSL) have been computed at 128 long-term water level stations using a minimum span of 30 years of observations at each location. These measurements have been averaged by month to remove the effect of higher frequency phenomena in order to compute an accurate linear sea level trend (CO-OPS, 2014).

The nearest monitoring station to KSC that still provides MSL data is in Mayport, FL (a closer station at Daytona Beach Shores was closed in 1983). The Mayport, FL station is approximately 140 miles from KSC. The mean sea level trend (shown in Figure 3.7-3) is 2.44 millimeters/year with a 95% confidence interval of +/- 0.27 mm/yr. based on monthly mean sea level data from 1928 to 2013 which is equivalent to a change of 0.80 feet in 100 years. By way of comparison, before it was closed in 1983, the mean sea level trend in Daytona Beach Shores was 2.32 mm/yr from 1925 to 1983 (NOAA, 2014b).

3.7.1.4 Climate Projections

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 (NASA, 2010b). Members of the CASI team 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.

Figure 3.7-3. Sea level trend at Mayport, FL



Source: NOAA Mean Sea Level Trend 8720218, Mayport, FL.

Figure 3.7-4. Sea level is rising at KSC, threatening habitats and infrastructure

Results of the regional CASI GCM-based forecast for future climate conditions in the project area are summarized in Tables 3.7-1 to 3.7-3. 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 F 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 3.7-2. 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 3.7-3. 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 3.7-1. 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)	73-74°F (+1 to 2°F)	74.5-75.5°F (+2.5 to 3.5°F)	75-78°F (+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%.

Source: NASA. Adapting Now to a Changing Climate, NP-2010-11-687-HQ

Table 3.7-2. Estimated changes in the numbers of days of extreme hot or cold temperatures for KSC

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

Source: NASA. Adapting Now to a Changing Climate, NP-2010-11-687-HQ

Table 3.7-3. Projected likelihood of extreme events through the latter part of the 21st Century[1]

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%)

[1]based on global climate simulations, published literature, and expert judgment
Source: NASA. Adapting Now to a Changing Climate, NP-2010-11-687-HQ

In addition, scientists from NASA's Climate Adaptation Science Investigator (CASI) Workgroup at KSC, working with the St. Johns River Water Management District and the EPA-funded Indian River Lagoon National Estuaries Program, have developed sea level rise scenarios and conducted sea level affecting marshes modeling (SLAMM) for KSC and the surrounding Indian River Lagoon estuary. Results suggest that sea level rise on the order of 0.4m (1.3 ft.) will inundate approximately 25% of the current KSC land area, converting extensive wetlands into open water. Warming weather and less frequent and intense cold spells will also allow for the expansion of mangrove forest into the region, displacing current high marsh habitats that are home to numerous species of special concern.

3.7.1.5 Greenhouse Gas (GHG) Emissions

Some direct greenhouse gases (e.g., carbon dioxide, chlorofluorocarbons, and water) are emitted from mission activities at KSC, and other gases (e.g., NO_X and VOCs) emitted from these processes contribute indirectly by forming ozone and other reactive species that photochemically react with the greenhouse gases and control the radiation penetrating to the troposphere.

To measure and manage emissions, the U.S. Department of Energy classifies GHGs into three categories:

- Scope 1: Emissions from sources that are owned or controlled by a Federal agency
- Scope 2: Emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency. Primary sources for Scope 1 & 2 GHG emissions are the following:
    - Energy and Buildings: Buildings are the number one consumer of energy for NASA; therefore, facility energy intensity directly correlates to Scope 2 GHG emissions.
    - Fleet: Fleet vehicles owned by NASA contribute a large quantity of Scope 1 GHG emissions.
- Scope 3: Emissions are from sources not owned or directly controlled by a Federal agency, but related to agency activities. These include emissions associated with contracted waste disposal and transmission and distribution losses from purchased energy (NASA, 2012b).

As noted in Table 3.7-4, the biggest driver of GHG emissions at NASA is facilities energy use—specifically, purchased electricity, which accounted for over 73 percent of agency-wide emissions in FY 2013. From FY 2008-FY 2013, NASA reduced its overall GHG emissions from this source by over 27 percent (DOE, 2014).

Table 3.7-4. Percent change in NASA greenhouse gas emissions covered by reduction targets (metric tons of CO_2-equivalent), from FY 2008 to FY 2013*

Scope and Category of Emissions	FY 2008	FY 2013	% Change
Scope 1			
On-Site Fuel Consumption at Federal Facilities	164,612.10	119,362.7	-27.5%
Mobile Emissions--Vehicles, Aircraft, Ships, and Equipment	47,209.0	56,174.2	19.0%
Mobile Emissions--Passenger Fleet Vehicles	12,000.3	8,812.0	-26.6%
Fugitive Emissions--Fugitive Fluorinated Gases and Other Fugitive Emissions (HFCs, PFCs, SF_6)	71,997.0	138,755.3	92.7%
Fugitive Emissions--On-site Wastewater Treatment	0.0	0.0	0.0%
Fugitive Emissions--On-site Landfills and Municipal Solid Waste Facilities	729.9	835.8	14.5%
Manufacturing and Industrial Process Emissions	0.0	0.0	0.0%
Subtotal Scope 1	**296,548.5**	**323,940.0**	9.2%
Scope 2			
Purchased Electricity	866,900.0	691,693.8	-20.2%
Purchased Biomass Energy	107.8	1,004.6	831.9%
Purchased Steam and Hot Water	202,172.6	182,963.5	-9.5%
Purchased Chilled Water	0	0.0	0.0
Purchased Combined Heat and Power Electricity, Steam & Hot Water	0	0.0	0.0
Reductions from Renewable Energy Use	0	-56,326.9	0.0
Subtotal Scope 1 & 2	**1,069,180.4**	**819,335.0**	-23.4%
Scope 3			
Transmission and Distribution (T&D) Losses	57,103.6	42,591.2	-25.4%
Federal Employee Business Air Travel	28,740.5	20,436.9	-28.9%
Federal Employee Business Ground Travel	9,995.8	3,163.1	-68.4%
Federal Employee Commuting	65,759.9	67,933.5	3.3%
Contracted Wastewater Treatment	90.6	87.6	-3.4%
Contracted Municipal Solid Waste Disposal	9,587.0	6,436.7	-32.9%
Subtotal Scope 3	**171,277.4**	**140,648.9**	-17.9%
Total GHG Emissions	**1,240,457.8**	**959,983.9**	-22.6%

*Due to considerations of space and relevance, biogenic CO_2 emissions are excluded from this table. These are defined by EPA as "emissions related to the natural carbon cycle [and] those resulting from the combustion, harvest, combustion, digestion, fermentation, decomposition, or processing of biologically based materials." Examples include CO_2 from combustion of biological fractions of municipal solid waste or wastewater treatment.

Source: DOE Federal Energy Management Program (DOE, 2014)

Emissions of CO_2 at KSC specifically are also primarily associated with energy use of buildings, 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 in 2010 with the following assumptions:

- An average workforce of 15,000 employees with 13,000 vehicles (NASA, 2010b), 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; KSC facilities 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, KSC energy use of 1,200,000 MMBtu, and no Space Shuttle launches (NASA, 2013a).

3.7.2 Environmental Consequences including Cumulative Impacts

Human land use changes (e.g., deforestation), 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 substances such as methane, nitrous oxide, and black carbon particulates on the Earth's climate have been well documented by thousands of peer-reviewed scientific studies compiled, reviewed and summarized by the Intergovernmental Panel on Climate Change (IPCC), and are the dominant reason for increasing societal interest in the carbon cycle (IPCC, 2014).

These impacts include overall warmer temperatures, rising sea levels, a melting polar ice cap, changes in rainfall patterns, a greater frequency of extreme weather events (e.g., droughts, deluges, severe storms, floods, prolonged heat waves) and other associated and often interrelated effects. The Fifth Assessment Synthesis Report of the IPCC states: "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen" (IPCC, 2014). At KSC, dunes (Figure 3.7-5) that historically protected KSC from high seas along the roughly six-mile stretch between launch pads 39A and 39B were leveled by Tropical Storm Fay in 2008, Hurricane Irene in 2011, and Hurricane Sandy in 2012. Recent studies there have determined that the cause was a gap in a near-shore sandbar that funnels the sea toward that section of beach and that climate change leading to sea level rise were key contributors (UF, 2014).

The CEQ's Revised Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions advises that actions subject to NEPA compliance should be evaluated along two dimensions relative to climate change impacts: (1) the potential effects of a proposed action and alternative actions on global climate change as indicated by its GHG emissions; and (2) the implications of climate change for the environmental effects of a proposed action or alternatives (CEQ, 2014). In addition, Executive Order 13514 (2009) requires that each agency "evaluate agency climate-change risks and vulnerabilities to manage the effects of climate change on the agency's operations and mission in both the short and long term" (Section 8(i)). Therefore, this analysis considers both the potential *impacts of the action on climate change*, and *the impacts that climate change may have on the proposed action*.

Figure 3.7-5. Coastal sand dunes at KSC provide a protective barrier between damaging waves, seawater and infrastructure

3.7.2.1 Methodology

With respect to climate change, adverse impacts to climate change can be characterized as follows:

- *Major*—Substantial impact on global climate change trends, in terms of increases in average temperature, extreme heat or precipitation events, drought or inland and coastal flooding, and/or mean sea level rise, that would contribute to the SLAMM sea level rise projections being exceeded (that is, rise of >0.4m inundating approximately 25% of the current KSC land area, converting extensive wetlands into open water).
- *Moderate*—An impact that produces a change in some global climate change trends but is not likely to increase sea level rise beyond SLAMM projections
- *Negligible*—Barely detectable impact on climate change trends

A beneficial impact on global change is one which reduces, or at least does not contribute to, the potential for adverse impacts.

At the programmatic level, it is not possible to develop emissions projections for the Proposed Action, because its components have not yet been specified. Instead, this programmatic analysis considers which activities have the potential to cause additional GHG emissions and the extent to which they could produce adverse or beneficial impacts to global climate change.

Adverse impacts of climate change to KSC's Proposed Action can be characterized as follows:

- *Major*—An impact that causes substantial disruption of planned activities, to the extent that the achievement of mission objectives is severely threatened, and for which adaptation is extremely unlikely to succeed or would be prohibitively expensive.
- *Moderate*—An impact that has the potential to cause substantial disruption to planned activities and mission objectives, but for which further adaptation has a high probability of success and is within the resource capabilities of the agency
- *Minor*—An impact that could cause noticeable disruption to planned activities on a limited basis, but does not threaten mission objectives
- *Negligible*—Minimal disruption of mission activities.

A beneficial impact of climate would be one that makes accomplishment of mission objectives more likely or less costly.

3.7.2.2 Potential Impacts of Global Climate Change on KSC Actions

Climate change impacts are of concern to NASA because many of the agency's assets are located in coastal areas, including KSC along the Florida coast, where sea level rise and increased frequency and intensity of high water levels associated with storms are expected, and where long-term changes in precipitation and temperature are expected to impact potable water supplies. Rising sea level has been identified as the single largest hazard to continued KSC/CCAFS operations and regional land management activities (NASA, 2014).

NASA's stated agency-wide climate change objective is to "create climate-resilient NASA Centers able to executive NASA's mission" (NASA, 2014). In complying with Executive Order 13514 ("Federal Leadership in Environmental, Energy, and Economic Performance"), NASA formalized its ongoing work on climate change risk management by developing a Climate Risk Management Plan and Report, updated most recently in 2014. The agency initially examined whether its long-term and short-term strategic objectives, roles and responsibilities could be compromised by climate risks, and concluded that there is potential for a changing climate to impact some of NASA's strategic objectives in six categories (NASA, 2014). KSC facilities and systems at risk from climate change impacts include:

- Launch facilities to provide access to space for humans, cargo, and research;
- Space assets and their operational support capabilities, such as space hardware, and the International Space Station;
- Ground systems, including IT, communication and data systems and Space Communication and Navigation systems;
- Test facilities, including research, development and demonstration facilities;

- Training facilities; and
- Supply chain for necessary materials and services.

These categories represent combinations of assets – physical infrastructure, land and natural resources, and the staff that operate, use and manage them – that can be impacted by various events, such as extreme heat events, drought or inland and coastal flooding. These types of climate events could compromise or interrupt particular KSC assets for short or long time periods.

Table 3.7-5 summarizes the potential impacts of climate change on KSC assets and capabilities that could therefore affect activities within its Center Master Plan and Future Plan Development. NASA anticipates short-term risks to result from extreme weather such as heat waves, precipitation, wind, flooding, and drought, each of which will become more difficult to manage because of changes in event intensity, duration, and frequency. Over a longer time horizon, NASA anticipates a continuation of short-term challenges experienced as a result of extreme weather, possibly exacerbated because of longer term gradual trends such as sea level rise and increased average temperatures (NASA, 2014).

Table 3.7-5. Key climate hazards and potential impacts to NASA assets and capabilities

Key Climate Hazards	Potential Impacts
More frequent and extreme high temperatures and humidity	Increased risk of heat-related ailments among outdoor workers; higher cooling costs; decreased utility reliability; damage to buildings
More frequent and intense droughts, seasonal shifts in water cycle	Reduced water availability; higher water costs; salt water intrusion; ground water changes
More intense precipitation events	More frequent flooding of low-lying indoor and outdoor areas
Sea level rise	Loss of usable land; inundation of coastal ecosystems
More frequent and intense coastal flood events	Coastal erosion; safety implications for surrounding communities

Source: NASA, 2014; Climate Risk Management Plan

From a long-term perspective, NASA sees the following risks as affecting its ability to carry out its mission:

- Loss of land to support launch capabilities on the coast.
- Downtime for facilities subject to extreme events, especially those subject to recurring nor'easters or hurricanes. Inland facilities could also be subject to downtime from impacts of extreme storms (flooding and/or electrical outages). As NASA has consolidated various functions at single Centers, downtime at a single facility may have a ripple effect across the Agency, such as when servers go offline. Additionally, as extreme events increase in the future, repeated recovery actions strain financial resources and the morale of emergency responders and employees whose work is disrupted.
- Competing cost priorities. Over the next 20-30 years, NASA may incur significant costs in implementing adaptation strategies (NASA, 2014).

As part of its climate adaptation strategy, KSC created a Dune Vulnerability Team to address beach and sand dune erosion as the sand dunes are the physical protection barrier for NASA's Launch Pads 39A and 39B from the sea. The Dune Vulnerability Team (CASI scientists, the U.S. Geological Survey, the University of Florida, and the U.S. Fish and Wildlife Service) developed a plan for restoring the coastal dune in an area of high beach erosion. KSC used Hurricane Sandy Emergency Funding to repair part of the most critically eroded shoreline. Further, beach dunes are habitats for a number of threatened and endangered species. Impacts from Hurricane Sandy exacerbated the conditions along Launch Complex 39. The project included the removal of a portion of the beach rail line and the construction of an inland dune. The dune is approximately 1.2 miles in length, 15 feet in height, and approximately 50 feet wide at the base. In some of the most critically eroded areas this dune is actually the primary dune feature along the beach. Construction of the dune is complete; vegetation planting was also completed in May 2014.

3.7.2.3 Impacts Associated With Proposed Action

3.7.2.3.1 Impacts of Proposed Action on Climate Change

The Revised Draft NEPA Guidance on Climate Change (Guidance) from the Council on Environmental Quality states, "Examples of projects or site-specific actions that can benefit from a programmatic NEPA review include: constructing transmission towers; conducting prescribed burns; approving grazing leases; granting a right-of way; authorizing leases for oil and gas drilling; authorizing construction of wind turbines; and approving hard rock mineral extraction" (CEQ, 2014). In considering when to disclose projected quantitative GHG emissions, CEQ's Guidance provides a reference point of 25,000 metric tons of CO2-e emissions on an annual basis below which a GHG emissions quantitative analysis is not warranted unless quantification below that reference point is easily accomplished. While individual actions may be considered for their potential to impact climate change when they are specifically proposed, they do not appear likely to meet the minimum quantitative emissions threshold to produce substantial impacts to climate change. One source for information on meeting the likely emissions threshold is a policy brief by the Nicholas Institute for Environmental Policy Solutions (Nicholas-Duke, 2014).

3.7.2.3.1.1 Land Use Plan, Future Development Plan, and Functional Areas

It is NASA's policy to fully comply with the requirements of the National Energy Conservation Policy Act, Executive Order 13423 (described above), and other statutory and Presidential directives regarding energy efficiency. The consolidation of NASA operations into a smaller geographic footprint, for example, a major component of the Future Land Use Plan, would allow NASA to recapitalize, over time, functions and capabilities into more efficient facilities on a smaller footprint and combine once spread-out non-hazardous functions into a smaller, more efficiently secured geographic footprint. Implementation of this concept can be expected to lead to further reductions in facilities' energy use, thereby reducing greenhouse gas emissions and producing beneficial impacts to climate change.

One land use which is increased in the Master Plan is renewable energy development. Continued and increased efforts to power NASA's facilities, programs, and activities using renewable sources of energy will have a beneficial impact on climate change by reducing greenhouse gas emissions (assuming that the entire energy production cycle is in fact net negative in producing CO2 emissions).

Other future land uses that are increased in the Proposed Action include Assembly, Testing, and Processing, and Horizontal Launch and Landing. During the construction phase of activities associated with these land uses (facilities construction, upgrade, and/or expansion), 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 (KSC, 2013b).

Another activity affecting the local carbon budget would be loss of vegetation from construction, to the extent that lands acting as carbon sinks are cleared for new development. Vegetation, alive or dead, is an important carbon stock. When land is cleared, carbon dioxide is released into the atmosphere through such processes as decomposition and burning. 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 could result in less land available for carbon sequestration.

Therefore, the clearing of land for the Proposed Action could 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, described below (KSC, 2013b).

While individual actions within these land use categories may be considered for their potential to impact climate change when they are specifically proposed, they do not appear likely to meet the minimum quantitative emissions threshold (producing >25,000 metric tons of carbon dioxide equivalent [CO_2e] annually) to produce adverse impacts to climate change.

3.7.2.3.1.2 Launch, Landing, Operations and Support

Operational launch impacts include the release of greenhouse gases from energy used to support 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.

In its 2013 Draft Environmental Assessment for Multi-Use of Launch Complexes 39A and 39B at KSC, NASA noted:

> "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" (KSC, 2013b).

Proposed increases in aircraft flight operations as part of the evolution of KSC to a multi-user space port would therefore contribute to local emissions of greenhouse gases. However, the extent of actual emissions can only be evaluated when a specific launch program is developed and the number and type of launches can be more precisely analyzed.

3.7.2.3.1.3 Future Transportation Plan

The elements of the Future Transportation Plan – road easements, improvements, expansions, bridge repairs and replacements, road and rail divestitures – would be the subject of future environmental study. While individual actions should be considered for their potential to impact climate change when they are specifically proposed, they do not appear likely to meet the minimum quantitative emissions threshold (producing >25,000 metric tons of CO_2e annually) to produce adverse impacts to global climate change.

3.7.2.3.2 Effects of Global Climate Change on the Proposed Action

3.7.2.3.2.1 Climate Change Mitigation

Because much of KSC land areas are low-lying, poorly drained, and vulnerable to inundation by periodic storm events, elements of the Proposed Action have been developed specifically to avoid, mitigate, or minimize the impacts of climate change on KSC operations and activities:

- KSC will implement elevation-based zoning and development controls to ensure that any future development is constructed at an elevation of six feet above mean sea level.
- Land areas that do not naturally offer this condition should be avoided or incur the cost of fill and drainage improvements, potentially making them economically less attractive.
- Areas of existing facilities or structures that are in 0-3 foot above mean sea level zones must be hardened or raised to accommodate future climate and weather or relocated to ground six feet or above.
- Critical facilities are to be moved outside the 500-year flood plain or, if not practicable, hardened to withstand a hurricane event.

The proposed actions to harden, improve, or move facilities in adaptation to potential climate change impacts will require financial investment and funding, which might reasonably be considered impacts of climate change on the Proposed Action. NASA would work with the commercial entity, NASA Environmental, and USFWS to determine appropriate site-specific mitigation measures.

While these actions take into account the best available science of sea level rise along the Florida space coast, increases in frequency and intensity of extreme weather events caused or contributed to by the forces driving climate change could still cause the impacts described in Table 3.7-5 above. The precise course and impacts of climate change cannot be specifically predicted with certainty.

3.7.2.4 Impacts Associated with Alternative 1

Direct, indirect and cumulative impacts of Alternative 1 related to climate change are anticipated to be the same as for the Proposed Action.

3.7.2.5 Impacts Associated with No Action Alternative

3.7.2.5.1 Impacts from No Action Alternative on Climate Change

If the No Action Alternative is selected, the status quo at KSC would be maintained and the proposed future (2012-2032) developments described in the 2013 Center Master Plan Update (the Proposed Action) would not proceed or be implemented. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Individual actions proposed from the Proposed Action or any of the alternatives may proceed but would have to do so after environmental assessment under separate environmental documentation.

Under the No Action Alternative, KSC would not implement elevation-based zoning and development controls to insure that any future development is constructed at an elevation of six feet above mean sea level, although this would not be consistent with NASA land management practices and Office of Strategic Infrastructure climate adaptation guidance and strategy. Areas of existing facilities or structures that are in 0-3 foot above mean sea level zones would not be hardened or raised to accommodate future climate and weather, nor would they be relocated to ground at or above six feet MSL. Critical facilities would not be moved outside the 500-year flood plain or hardened to withstand a hurricane activity.

However, under the No Action Alternative, NASA would continue to meet its commitments to implement Executive Orders 13514 (described above) and 13653, which builds on the requirements of EO 13514 and requires that agencies update their plans to integrate consideration of climate change into agency operations and overall mission objectives. Toward that end, 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 that 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.

KSC would also continue to implement its Strategic Sustainability Performance Plan (SSPP), established in 2010 to meet the requirements of EO 13514. The SSPP established a Scope 1 & 2 GHG emissions reduction target of 18.3 percent relative to an FY 2008 baseline estimate. Specific GHG-reduction goals include:

- Reduce Facility Energy Intensity – Buildings are the number one consumer of energy for NASA; therefore, facility energy intensity directly correlates to Scope 2 GHG emissions. Specific energy and building goals include the reduction of energy consumption per gross square foot of building area by 3 percent annually from the FY 2003 baseline for FY 2006 through FY 2015;
- Increase Renewable Electricity Use – Increase percentage of total electricity derived from renewable sources (from 3 percent FY 2007 – FY 2009 to 7.5 percent FY 2013 onward).
- Right-size the number of fleet vehicles through optimization;
- Increase the use of low emission and high fuel economy vehicles;
- Replace conventional senior executive fleet with low-GHG emission vehicles;
- Discuss consolidation of shuttle bus operations (if offered), and sustainable transportation options through development of alternative fuel infrastructure
- Direct spending on transportation training; and
- Procure environmentally preferable motor vehicles.
- Reduce Scope 3 GHG emissions by 12.6 percent by FY 2020 (NASA, 2012b)
- Reduce Scope 3 GHG emissions associated with contracted waste disposal by 23.1 percent by FY 2015, excluding Construction and Demolition waste.
- Reduce Scope 3 GHG emissions associated with Transmission and Distribution losses from purchased energy by 15.1 percent by FY 2020 (NASA, 2012b).

3.7.2.5.2 Impacts from Global Climate Change on No Action Alternative

Despite the GHG reduction efforts that would still occur under No Action, if the No Action Alternative were selected and the specific climate change-related proposed actions were therefore not implemented, NASA operations would be at somewhat greater risk from the impacts of sea level rise, more frequent and intense coastal flood events, and more intense precipitation events than they be would if the additional actions were taken. The sea level rise scenarios generated by sea level modeling for KSC and the surrounding Indian River Lagoon estuary suggest that sea level rise on the order of 0.4m (1.3 feet) will inundate approximately 25 percent of the current KSC land area, converting extensive wetlands into open water.

Warming weather and less frequent and intense cold spells will also allow for the expansion of mangrove forest into the region displacing current high marsh habitats that are home to numerous species of special concern. These impacts are long-term, and if elevation-based zoning were not instituted and development therefore restricted (although this would be in contravention of NASA’s land management practices and Office of Strategic Infrastructure climate adaptation guidance and strategy), the loss of land, inundation of wetlands, increases in coastal flooding events, and the resulting decreases in reliability of utility systems could produce major impacts to the predictability and stability of launches necessary to attract and retain commercial launch partners.

3.7.2.6 Cumulative Impacts

Climate change is a global trend and, by scientific understanding, it is a cumulative process: the persistence of greenhouse gases (especially CO_2) in the atmosphere has led to the accumulated concentration of gases that have intensified the greenhouse effect globally, which has warmed the planet over the last 150+ years. The trends specifically affecting KSC have cumulatively led to the sea rise levels described above. The SLAMM modeling projections are an expression of a cumulative impact (of the No Action Alternative, specifically).

The principal driver of greenhouse gas emissions is energy use in KSC facilities. Cumulative global impact from energy use under the Proposed Action, when added to past, ongoing, and anticipated future U.S. actions would be expected to be similar or perhaps less than the historical energy use, given the commitments to emissions reductions contained in KSC's Sustainability Strategy Performance Plan (Sustainability Plan). The Sustainability Plan has established a program to reduce facility energy intensity and associated greenhouse gas emissions as well as expanding the use of renewable energy for facilities and operational activities. It has made measurable interim progress in achieving these goals.

From FY 2008 to FY 2013, NASA reduced its agency-wide emissions of greenhouse gases by almost 23 percent, including reductions from purchased electricity by over 20 percent. Therefore, despite the potential for increased emissions from rocket exhaust due to greater launch activity, as well as from construction activities, land clearing, and activities related to transportation infrastructure, these potential increases would be expected to be minimized on a net basis by regional efforts to modernize energy production and energy conservation.

NASA emissions represent collectively less than 0.02% of projected annual U.S. GHG emissions (DOE, 2014; EIA, 2009), and KSC represents less than 20 percent of total NASA emissions. Given these indicators of relative scale, and the potential to minimize net emissions, it is expected that the Proposed Action would add a negligible amount to the U.S. emissions contributing to global climate change.

The climate change mitigation/adaptation activities included in the Proposed Action were designed to avoid the impacts of cumulative climate change to the KSC mission. Over a longer time horizon, NASA anticipates a continuation of short term challenges experienced as a result of extreme weather, possibly exacerbated because of longer term gradual trends such as sea level rise and increased average temperatures (NASA, 2014). Based on the SLAMM modeling and the sea level trends observed in the recent studies at KSC, the proposed mitigation/avoidance actions seem likely to avoid severe disruption to mission objectives from climate change impacts.

3.8 Acoustic Environment (Noise)

This section provides an overview of noise, a regulatory review, a description of nearby noise sensitive areas, and existing noise at KSC. The region of influence for noise encompasses the land within the KSC boundary, and communities close enough to be reasonably affected by noise from the Proposed Action.

3.8.1 Affected Environment

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, and are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Human response to noise varies depending on the type and characteristics of the noise distance between the noise source and the receptor, receptor sensitivity, and time of day. Noise is often generated by activities essential to a community's *quality of life,* such as construction or vehicular traffic.

Sound varies by both intensity and frequency. Sound pressure level, described in decibels (dB), is used to quantify sound intensity. The dB is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level. Hertz are used to quantify sound frequency. The human ear responds differently to different frequencies. "A-weighing", measured in A-weighted decibels (dBA), approximates a frequency response expressing the perception of sound by humans. Sounds encountered in daily life and their dBA levels are provided in Table 3.8-1.

Table 3.8-1. Common sounds and their levels

Outdoor	**Sound Level (dBA)**	**Indoor**
Motorcycle	100	Subway train
Tractor	90	Garbage disposal
Noisy restaurant	85	Blender
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio
Normal conversation	60	Sewing machine
Rainfall	50	Refrigerator
Quiet residential area	40	Library

Source: Harris, 1998

The dBA noise metric describes steady noise levels, although very few noises are, in fact, constant. Therefore, A-weighted Day-night Sound Level (DNL) has been developed. Day-night Sound Level is defined as the average sound energy in a 24-hour period with a 10-dB penalty added to the nighttime levels (10 p.m. to 7 a.m.). DNL is a useful descriptor for noise because: (1) it averages ongoing yet intermittent noise, and (2) it measures total sound energy over a 24-hour period. In addition, Equivalent Sound Level (L_{eq}) is often used to describe the overall noise environment. L_{eq} is the average sound level in dB.

3.8.1.1 Regulatory Review

The Noise Control Act of 1972 (PL 92-574) directs Federal agencies to comply with applicable Federal, state, and local noise control regulations. In 1974, the EPA provided information suggesting continuous and long-term noise levels in excess of DNL 65 dBA are normally unacceptable for noise-sensitive land uses such as residences, schools, churches, and hospitals. The Brevard County Code §46-131 includes a nuisance noise ordinance which does not set strict not-to-exceed noise levels. The county noise ordinance exempts construction noise between the hours of 7:00 a.m. and 8:00 p.m.

3.8.1.2 Noise Sensitive Areas and Background Noise

The closest residential areas to KSC are in the cities of Merritt to the southeast Island and Cape Canaveral to the south. Each is approximately seven miles from the Space Launch Complex (SLC) 40 launch pad. Sound levels in these areas are normally low, with higher levels occurring in industrial areas such as Port Canaveral, and along transportation corridors. Background noise levels (L_{eq} and DNL) were estimated for the surrounding areas using the techniques specified in the American National Standard *Quantities and Procedures for Description and Measurement of Environmental Sound Part 3: Short-term measurements with an observer present.* The land use category and the estimated background noise levels for the proposed site would typically be considered very quiet suburban or rural residential with levels of 43 dBA during daytime hours and 37 dBA at night (ANSI, 2013). Infrequent aircraft flyovers and rocket launches from CCAFS and KSC intermittently increase noise levels for short durations; however, the overall noise from all activities combined does not create any areas of incompatible land use near KSC.

3.8.1.3 Existing Noise

Existing sources of noise at KSC include aircraft operations, industrial operations, construction, traffic noise, horizontal landings, vertical launches, and natural noises such as the rustling of leaves and bird vocalizations. Below is a description of the prominent sources of noise at KSC:

- **Air Operations**--A small number of aircraft are utilized at KSC for payload delivery, ferry support, NASA executives, security and astronaut training. Typically, noise levels are no greater than those experienced near a small commercial airport (NASA, 2010a, 2015). Air operations do not create any areas of incompatible land use surrounding KSC.

- **Industrial Noise--**The loudest noise generated by industrial activities at KSC is produced by hydraulic pumps operating within the confines of their enclosures. Other intermittent noise occurs during operation of lifting equipment, diesel-powered generators and locomotives, heavy-duty service vehicles, and by certain sheet metal forming and cutting processes. Typical industrial activities have been measured between 57 and 116 dBA near industrial sources throughout KSC (NASA, 2010a, 2015). The highest levels of noise from industrial activities have no impact on areas beyond the KSC boundaries.

- **Roadway Traffic--**Noise due to roadway vehicles (including visitors to the Space Center, the Merritt Island National Wildlife Refuge, and the Canaveral National Seashore) is no greater than that experienced in a major shopping center parking lot.

3.8.1.4 Vertical Launch Operations

Other less frequent, but more intense, sources of noise at KSC are from missile and space launches. These currently include Space X Falcon 9 and Atlas V at CCAFS, as well as historical shuttle launches at LC-39. Table 3.8-2 outlines noise measured during historical launches at KSC. Depending on the launch vehicle and launch location on KSC, resulting noise levels may reach sound levels upward of 100 dB for a short duration after each launch. Because launches from KSC occur infrequently, and the launch noise generated from each event is of very short duration, the average noise levels in nearby areas are not affected appreciably by launch noise.

In addition to initial rocket ignition, launches from KSC generate sonic booms as launch vehicles ascend down range over uninhabited ocean waters. Clearance zones established by the launch trajectories keep sonic booms from having adverse impacts to nearby populated areas.

Table 3.8-2. Measured vertical launch noise at KSC

Source	Sound Level [dBA]	Distance [meters]
Vertical Launches		
Titan IIIC	94	9,388
Saturn I	89	9,034
Saturn V	91	9,384
Atlas	96	4,816
Space Shuttle [1]	90	9,384

Source: NASA, 2010a, 2015.

3.8.2 Environmental Consequences Including Cumulative Impacts

This section provides a discussion of the environmental impacts to the noise environment that would result from the Proposed Action and No Action alternatives. Impacts were primarily assessed by reviewing existing noise conditions at KSC, and determining the potential effects the Proposed Action would have on nearby noise sensitive areas. The extent of the noise impacts would depend on the size and nature of the project and proximity to noise sensitive land uses, such as residential areas. A significant impact to noise would: (1) result in the violation of applicable Federal, state, or local noise ordinance; (2) create incompatible land uses for areas with sensitive noise receptors outside the KSC boundary; or (3) would be loud enough to threaten or harm human health. See Section 3.9, Biological Resources for a discussion of noise impacts on wildlife.

3.8.2.1 Proposed Action

Short- and long-term minor adverse effects would be expected. The Proposed Action would result in the continuation of many of the types of noise presently occurring at KSC but potentially in greater amounts. Short-term increases in noise would result from the use of heavy equipment during construction and demolition activities. Long-term effects would be from the addition of stationary sources of noise such as standby generators, and changes in both vertical and horizontal launch activities. Increases in traffic volumes and changes in traffic patterns would have insignificant effects. The Proposed Action would not (1) result in the violation of applicable Federal, state, or local noise ordinance; (2) create incompatible land uses for areas with sensitive noise receptors outside the KSC boundary; or (3) be loud enough to threaten or harm human health.

3.8.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

Implementation of the land use plan, future development plan, and functional area plans would have short- and long-term minor adverse effects on the noise environment. Short-term effects would be from noise generated during demolition of aging or outdated facilities and construction of new facilities. Long-term effects would be from introduction of new noise sources such as generators and increases in transportation-based noise from launches and automotive traffic. This section outlines effects from planning activities, and demolition and construction activities. Effects from proposed changes in launch, landing, operations, and support activities are addressed in Section 3.8.2.1.2. Effects from proposed changes in non-space-based transportation activities and infrastructure upgrades are addressed in Section 3.8.2.1.4.

3.8.2.1.1.1 Planning Activities

The planning activities associated with the updated land use plan, future development plan, and functional area plans in and of themselves would not generate any noise. Therefore, planning activities and updating the land use designations would have no effect on the noise environment.

3.8.2.1.1.2 Demolition and Construction Activities

Future changes in land use would include an appreciable amount of construction activities at KSC. Individual pieces of heavy equipment typically generate noise levels of 80 to 90 dBA at a distance of 50 feet. With multiple items of equipment operating concurrently, noise levels can be relatively high at locations within several hundred feet of active construction sites. The zone of relatively high construction noise levels typically extends to distances of 400 to 800 feet from the site of major equipment operations. Locations more than 800 feet from construction sites seldom experience appreciable levels of heavy equipment noise. Table 3.8-3 presents typical noise levels (dBA at 50 feet) that EPA has estimated for the main phases of outdoor construction.

Table 3.8-3. Noise levels associated with outdoor construction

Construction Phase	Sound Level at 50 feet [dBA]
Ground clearing	84
Excavation, grading	89
Foundations	78
Structural	85
Finishing	89

Source: EPA, 1971.

The vast majority of any construction and demolition projects would be well within the KSC boundary, and would have no effect on nearby noise sensitive areas. Heavy equipment noise would end at the conclusion of the construction phase. Given the temporary nature of proposed construction activities, and the limited amount of noise that construction equipment would generate, this impact would be minor. Heavy equipment noise may be audible, but would be perceived as faint and/or distant at locations outside of KSC. Sounds generated from construction and demolition activities between 7:00 a.m. and 8:00 p.m. would be exempt from the county noise ordinance.

Although construction-related noise impacts would be minor, the following BMPs would be performed to further reduce any realized noise impacts:

- Construction would primarily occur during normal weekday business hours, and
- Construction equipment mufflers would be properly maintained and in good working order.
- Construction noise would dominate the soundscape for all on-site personnel. Construction personnel, and particularly equipment operators, would don adequate personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Most demolition projects would not involve blasting. If blasting were required, it would occur during the day in the early phases of demolition. Blasting noise would be clearly audible and intrusive at areas adjacent to the project. There would be airborne and ground-borne vibrations during demolition projects that require blasting. Although the exact amount and type of blasting are unknown at this time, steps would be taken to ensure the effects from these activities would remain less than significant. A blasting plan would be prepared to ensure safety and to minimize adverse effects due to noise and vibration at the proposed sites. Baseline vibration levels would be established, vibrations would be monitored, and thresholds for structural damage would be strictly adhered to during blasting activities. Notably, any nearby historic structures would be of particular interest during these activities. Although these effects would be less than significant, f*uture or tiered NEPA would require noise assessment for actions that include construction or demolition activities within 800 feet of the KSC boundary for more than 1 year or have blasting activities for which a blast management plan addressing noise and vibration has not been prepared.*

3.8.2.1.2 Launch, Landing, Operations and Support

Launch, landing, operations and support would have short- and long-term minor adverse effects on the noise environment. Short-term effects would be from construction and modification of launch and support facilities. Long-term effects would be from introduction of new noise sources such as launches and automotive traffic. This section outlines effects from:

- Site modifications and pre-launch preparations;
- Vertical launch activities; and
- Horizontal launch activities.

Noise effect from planning activities and associated demolition and construction activities are addressed in Section 3.8.2.1.1. Effects from proposed changes in non-space-based transportation activities and infrastructure upgrades are addressed in Section 3.8.2.1.4.

3.8.2.1.2.1 Site Modifications and Pre-Launch Preparations

For most launch programs, site modifications would normally be minor and limited to launch pads and facilities directly related to individual launches and test programs. Modifications to existing facilities may include clearing, grading, and limited construction. Noise from heavy equipment during site modifications and pre-test preparations are expected to be minimal, temporary, and occur well within the KSC property boundary. The noise effects would be similar in nature and overall level as demolition and construction noise outlined in Section 3.8.2.1.1. Because most of the activities would take place on KSC, the public in the surrounding areas would not normally detect an increase in noise levels; therefore, site modification and pre-launch preparations would not cause significant noise impacts. However, as with other construction activities, future or tiered NEPA would require noise assessment for actions that include construction within 800 feet of the KSC boundary for more than one year.

The use of portable generators may be necessary to support some launches. These would be intermittent and temporary sources of noise and occur well within the KSC property boundary. Effects due to noise from portable generators would be less that significant.

Prelaunch operations and assembly would not generate disruptive noise levels for any sensitive receptors or for any off-station areas. Most processing operations would occur within enclosed facilities. The Proposed Action would likely introduce a minor volume of local roadway traffic and a small increase in aircraft operations for delivery of launch vehicle components. These activities would be minute when compared to current activities, and would not appreciably change the current noise environment. The limited number of additional aircraft operations for component delivery would not affect compatible use zone requirements for KSC. As a result, prelaunch processing and assembly of launch vehicle components would not cause significant noise impacts.

3.8.2.1.2.2 Vertical Launch and Landing

Under the Proposed Action, vertical launches and landings would be ongoing at KSC. In the hours before launches, remote sensors and helicopters may be used to verify the hazard areas would be clear of non-mission-essential aircraft, vessels, and personnel. If helicopters were used to verify beach areas and near shore waters are clear of non-participants, they would generally limit their flights to the areas around KSC, thus limiting the noise effects on local communities. These individual helicopter overflights would be conducted in clear zones around the launch sites and would have insignificant noise effects.

Noise levels generated by individual launches and landings would vary, depending on the type of launch vehicle, its trajectory, and weather conditions during launch. Launch noise would be from the initial rocket ignition and sonic booms as the launch vehicle ascended down range. Noise levels from the rocket ignition would be comparable to the existing levels as outlined in Table 3.8-2. While these noise exposure levels can be characterized as very loud in some areas, they would occur infrequently, and are very short in duration (about 20 seconds of intense sound per launch). As with existing vertical launch activities, sonic booms generated by launch vehicles would normally occur down range, well off the Florida coast. Flight trajectories would normally be in an easterly direction, and as such, the resulting sonic boom would be inaudible over coastal areas. As with existing landing activities, sonic booms generated by vehicles would normally occur up range, over Florida. Flight trajectories would normally be in an easterly direction, and as such, the resulting sonic boom would be audible inland and over coastal areas. Typically, the sonic boom would last no more than a few hundred milliseconds. These effects would be less than significant.

Although the exact nature of future vertical launch and landing activities is unknown, the Proposed Action would result in the continuation of vertical launch noise comparable to that presently occurring at KSC. It is not expected that future vertical launch activities would violate any Federal, state, or local noise ordinance, create incompatible land uses for nearby areas, or be loud enough to harm human health. As a result, no significant impacts on the human environment are expected from vertical launch activities. Although effects would likely be minor, there are a wide range of possible vertical launch and landing vehicle types and operating scenarios. *Because of these uncertainties, future or tiered NEPA would require noise assessment for increases in vertical launch and landing activities at KSC.*

In the hours and days following vertical launches, a general safety check and cleanup of the launch sites would occur. There would be some small amount of noise from worker commuting, the removal of equipment from the launch site, and general refurbishment of the launch facilities. As with site modifications and pre-launch preparations, post-launch refurbishment activities would not cause significant noise impacts.

3.8.2.1.2.3 Horizontal Launch and Landing

Under the Proposed Action, horizontal launches and landings could become commonplace at KSC. Launch vehicles would likely consist of traditional commercial aircraft comparable to a Boeing 747 and designed to carry an additional launch vehicle that would be released in the upper atmosphere.

Carrier vehicles would have noise levels comparable to existing commercial aircraft. Individual launches of additional LV's in the upper atmosphere would be short-term discrete events. However, the cumulative effects associated with many aircraft operations may create areas near the runway normally not recommended for residential land uses. If future aircraft operations did not exceed 90,000 annual operations of propeller or small jet aircraft, or 700 annual operations of mid- and large-size jets, it is expected that areas where the DNL exceeded 65 dB would be confined to areas immediately adjacent to the runway. Based on the latest modeling technology, these levels of piston-powered or jet-powered general aviation operations would produce a DNL 60 dB contour less than 1.1 square miles in area and extending no more than 12,500 feet from the start of takeoff roll. The resulting maximum DNL 65 dB contour would be 0.5 square mile and would not extend more than 10,000 feet from the start of takeoff roll. All aircraft operations associated with horizontal launch and landing would be specifically exempt from the local noise ordinance (FAA, 2007; FAA, 1985). These effects would be less than significant.

Although the exact nature of future horizontal launch activities is unknown, the Proposed Action would result in the continuation of horizontal launch noise comparable to that presently occurring at KSC. Future horizontal launch activities would not violate any Federal, state, or local noise ordinance, create incompatible land uses for nearby areas, or be loud enough to harm human health. As a result, no significant impacts on the human environment are expected from horizontal launch activities. Although effects would likely be minor, there are a wide range of possible horizontal launch and landing vehicle types and operating scenarios. *Because of these uncertainties, future or tiered NEPA would require noise assessment for actions that increased the total number of annual operations above 90,000 of propeller or small jet aircraft, or 700 annual operations of medium and large jets.*

3.8.2.1.3 Climate Change

Implementation of the climate change and sea-level rise requirements would have short- and long-term minor adverse effects on the noise environment. Short-term effects would be from noise generated during demolition of aging or outdated facilities and construction of new facilities. Long-term effects would be from introduction of new noise sources such as backup generators and on-site water pumps. Effects from demolition and construction are addressed in Section 3.8.2.1.1. Any new construction stated under future planning efforts would naturally include climate change and sea-level rise requirements.

Modifications of existing facilities to meet climate change and sea-level rise requirements may include everything from minor hardening efforts to complete on-site demolition and reconstruction. Any demolition or construction required to meet climate change and sea-level rise requirements would be similar in nature and overall level as that outlined in Section 3.8.2.1. For similar reasons, future or tiered NEPA would require noise assessment for actions that include construction or demolition activities within 800 feet of the KSC boundary for more than 1 year or have blasting activities for which a blast management plan addressing noise and vibration has not been prepared.

In some cases, facilities may require backup generators and onsite water pumps. These would be intermittent sources of noise for emergency use only. Effects due to noise from emergency and back up equipment would be less that significant. It is expected that new permanent sources of noise would be intermittent or temporary or both; however, it is possible that some equipment will be permanent, and required to operate regularly or on an ongoing basis. A detailed list of equipment or locations is not available at this time; therefore, *future or tiered NEPA would require noise assessment for actions that include the addition of any permanent source of noise that would operate regularly or ongoing basis.*

3.8.2.1.4 Future Transportation Plan

Implementing the transportation plan would have short-term minor and long-term negligible adverse effects. Short-term effects would be from construction activities, where long-term effects would be from changes in roadway configurations, traffic patterns, and changes in other modes of transportation throughout KSC. Changes in overall noise for the vast majority of activities would be relatively small and would not violate any Federal, state, or local noise ordinance, create incompatible land uses for nearby areas, or be loud enough to harm human health. Effects from the demolition and construction are addressed in Section 3.8.2.1.1.

3.8.2.1.4.1 Roads, Bridges and Parking

Road, bridges and parking improvement and replacement projects would be specifically designed to relieve roadway congestion on and near KSC. Small changes in traffic patterns would have negligible long-term effects to noise. There would be some construction noise with these activities; however, as outlined in Section 3.8.2.1.1 and for similar reasons, construction noise would be very small and effects to the noise environment would be less than significant. Road and bridge divestiture would eliminate the vehicle traffic on and the maintenance of the divested infrastructure and any associated noise. There would be no permanent sources of noise associated with the roadway, bridge and parking projects.

Rerouted traffic and increases in traffic may cause a minute increase in noise in the centralized areas of KSC; however, these small changes in traffic patterns would have negligible long-term effects to the noise environment. Because noise is measured on a logarithmic scale, two line sources of equal level (e.g. traffic along a roadway) added together result in an increase of three (3) dBA at all distances. Therefore, a doubling in traffic volume would increase the noise level by three (3) dBA. For example, traffic generating 60 dBA plus the same amount of traffic on the same roadway would yield a total noise level of 63 dBA. Notably, a 3-dBA change in noise levels would be barely perceptible to individuals with average hearing (FHWA, 2011). The Proposed Action could add personnel and potentially increase traffic both on and off KSC. The additional vehicles would constitute an incremental change in traffic volumes along roadways near KSC; however, increases would only be a small fraction of the historical traffic. Even if the total amount of personnel and traffic were to double it would amount to an increase in noise of less than 3-dBA on any existing roadway, and no perceptible change on the existing noise environment. These effects would be negligible.

Although effects would likely be negligible, there is a wide range of possible roadway configurations and personnel changes throughout KSC. Because of these uncertainties, *future or tiered NEPA would require noise assessment for actions that added new roadways or had lane additions to access controlled highways.*

3.8.2.1.4.2 Rail and Water

Construction and operation of new rail spurs and seaports would have some level of noise and impacts. Although effects would likely be minor, there is a wide range of possible seaport operating scenarios. *Future or tiered NEPA would require noise assessment for the establishment of any new seaports at KSC.*

3.8.2.1.4.3 Air

Modifications to SLF facilities, infrastructure, the runway, and other airfield systems would have some level of noise. Construction noise would be relatively small and their effects to noise would be less than significant. Development of a new runway may constitute a relatively large effort with both temporary and ongoing sources of noise. *Future or tiered NEPA would require noise assessment for the establishment of any new runways at KSC.*

3.8.2.1.5 Programmatic Determinations

A programmatic approach to assess the effects of the Proposed Action on noise was performed for this EIS. In general, the overall effects of the action and its components would be less than significant. Site-specific and project-level details are not available at this time; however, based on existing information, no additional evaluation under future or tiered NEPA would be required for noise unless the project:

- Included construction or demolition activities within 800 feet of the KSC boundary for more than 1 year;
- Included blasting activities for which a blast management plan addressing noise and vibration had not been prepared;
- Included permanent sources of industrial noise that would operate regularly or on an ongoing basis;
- Increased the number of or change the types of vertical launches at KSC;
- Increased the total number of annual aircraft operations at KSC above 90,000 propeller or small jet aircraft, or 700 mid- to large-sized jets;
- Included new roadways or lane additions to access controlled highways;
- Included the establishment of any new seaports at KSC; or
- Included the establishment of any new runways at KSC.

Without these components, future or tiered NEPA could include this programmatic analysis by reference and eliminate noise as a resource area carried forward for detailed evaluation.

3.8.2.1.6 Cumulative Impacts

Minor short- and long-term cumulative effects would be expected. Noise effects would be primarily due to demolition and construction activities, the introduction of new noise sources such as generators, and increases in transportation-based noise from launches and automotive traffic. These activities would constitute incremental increases in the overall noise environment. Noise generated by activities would be concentrated on KSC and are expected to be less than significant. Implementation of the Proposed Action would not contribute appreciably to adverse cumulative effects to noise. There are no projects identified, including those in Section 3.2, that when combined with the Proposed Action that would have greater than significant effects.

3.8.2.2 Alternative 1

The direct, indirect, and cumulative impacts of Alternative 1 related to the acoustic environment or noise would be similar to those of the Proposed Action, but somewhat reduced, because the two seaports would not be constructed, and the proposed Horizontal Launch and Landing functional area north of Beach Road may not ever be built.

3.8.2.3 No Action Alternative

Selecting the No Action Alternative would result in no changes in the impact to the ambient noise environment. KSC operations and the current levels of activities would continue without changes, and the noise environment would remain unchanged when compared to existing conditions.

3.9 Biological Resources

Biological resources include vegetation, wildlife, and the habitats in which they live. Protected species and invasive species are also considered in this section. The habitats found on KSC and the adjacent federal properties provide for the greatest wildlife diversity among Federal facilities in the continental U.S. (NASA, 2007). This diversity can be attributed to several factors. KSC is located within a biogeographical transition zone, having faunal and floral assemblages derived from both temperate Carolinian and tropical/subtropical Caribbean biotic provinces. The area is encompassed within the Indian River Lagoon (IRL) watershed, considered to be the most diverse estuarine system in North America. KSC is bordered on the west by the IRL, on the southeast by the Banana River, and on the north by the Mosquito Lagoon. Further to the west of KSC lies the St. Johns River Basin ecosystem, one of the largest freshwater marsh systems in the state. In addition, KSC's proximity to the coast encourages an abundance of migratory birds. All of these factors contribute to the exceptional species diversity found here.

3.9.1 Affected Environment

3.9.1.1 Terrestrial Environment

3.9.1.1.1 Upland Plant Communities

3.9.1.1.1.1 Native Plants

Florida's geological history has largely been determined by sea level changes that directly influenced soil formation and topography, and resulted in the plant communities present today. A "ridge and swale" topography is present on KSC where there are adjacent bands of uplands and wetlands running in a generally north/south direction across the island. Natural upland communities occur on sites that are not flooded for extended periods. Forests occur on higher areas among marshes and lower areas among scrub and pine flatwoods. Upland communities are highly dependent on periodic fire for the maintenance of habitat structure and vegetation composition. The types of habitats found in these areas include scrub, flatwoods and hardwoods, and mixed forests.

Table 3.9-1 and Figure 3.9-1 present a summary of land cover and vegetation at KSC. These data follow the nomenclature of the Florida Land Use Cover and Forms Classification System (FLUCFCS) (NASA, 2010a, 2015).

Table 3.9-1. Land cover classes at KSC

Land Cover Class	Area (ac)	Area (ha)
Upland Vegetation	41,083	16,625
Wetland Vegetation	36,183	14,642
Urban and Developed	3,800	1,538
Water	54,228	21,945

Source: NASA, 2010a, 2015

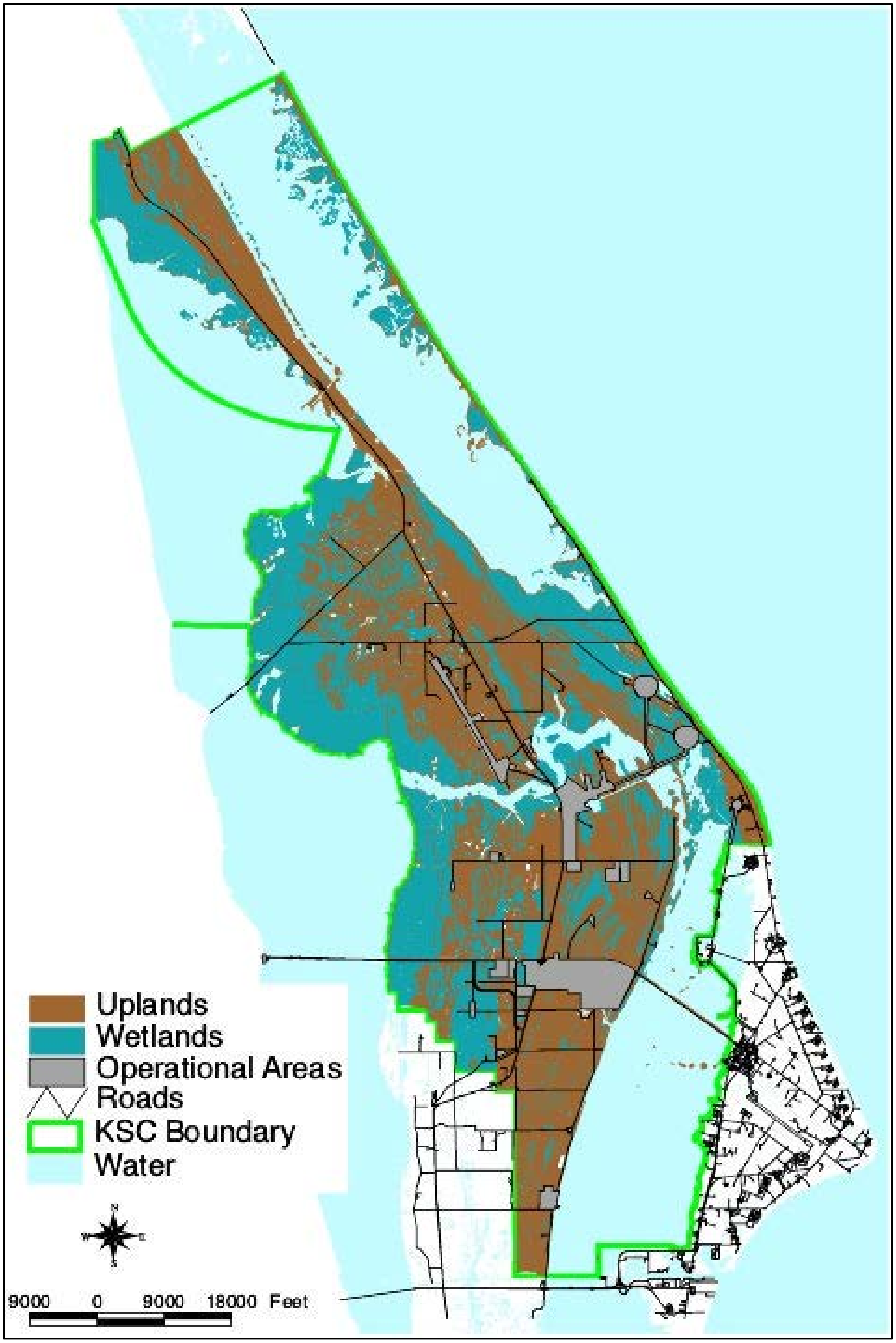


Figure 3.9-1. General land cover at KSC

The most recent land cover map for KSC is from 2003 and identifies 31 cover types (Figure 3.9-2 and Table 3.9-2). Types 1 through 19 are found in upland areas (wetland types are discussed in Section 3.9.1.2.1). The dominant upland communities are scrub and pine flatwoods (including coastal strand, oak scrub, palmetto scrub, slash pine flatwoods) and upland forest (including cabbage palm, hardwood hammock, coniferous forest, hardwood forest) (NASA, 2010a, 2015). Definitions for each upland type in Figure 3.9-2 and Table 3.9-2 are as follows (excluding disturbed areas with invasive vegetation, which are discussed in Section 3.9.1.1.1.2 Invasive Plants):

<u>KSC infrastructure</u>

1. Infrastructure – primary: structures and all paved surfaces
2. Infrastructure – secondary: unpaved roads

<u>Natural uplands devoid of vegetation</u>

3. Beach: zone of sparse or no vegetation between the ocean and coastal dune

<u>Upland scrub and pine flatwoods</u>

4. Coastal strand: includes saw palmetto (*Serenoa repens*), sea grape (*Coccoloba uvifera*), and other species
5. Oak scrub (Figure 3.9-3): includes scrub oak species (i.e., sand live oak [*Quercus virginiana var. geminata*], myrtle oak [*Q. myrtifolia*], Chapman oak [*Q. chapmanii*]), with scattered saw palmetto, wax myrtle (*Myrica cerifera*), gallberry (*Ilex coriacea*), lyonias, other shrub and brush species, intermixed with various types of herbs and grasses; generally less than 5 m tall, with interlocking canopy but may also contain small areas with little or no vegetation
6. Palmetto scrub: includes saw palmetto, wax myrtle, gallberry, lyonias, other shrub and brush species, intermixed with various types of herbs and grasses; generally less than 5 m tall, with interlocking canopy but may also contain small areas with little or no vegetation
7. Pine flatwoods: scattered pines, primarily slash pine (*Pinus elliotti*), with non-interlocking canopy, generally greater than 5 m tall, with a sub-canopy of palmetto or scrubby species

<u>Upland forest</u>

8. Upland coniferous forest: dense stands of slash pines (some planted), generally greater than 5 m tall with interlocking canopy; may contain an upland scrub sub-canopy
9. Upland coniferous/hardwood forest: contains tall oaks and pine trees generally greater than 5 m tall with interlocking canopy; composition may include red bay (*Persea borbonia*), laurel cherry (*Prunus caroliniana*), and cabbage palm (*Sabal palmetto*)
10. Upland hardwood forest: contains tall oaks generally greater than 5 m with interlocking canopy and an understory that includes saw palmetto; composition may include red bay, slash pine, laurel cherry, and cabbage palm
11. Cabbage palm: a forest community of predominantly cabbage palm and commonly found as hammock communities on shallow rises within wetland communities; generally greater than 5 m with interlocking canopy
12. Hardwood hammock: a forest community commonly found on shallow rises within wetland communities; greater than 5 m with interlocking canopy and predominantly

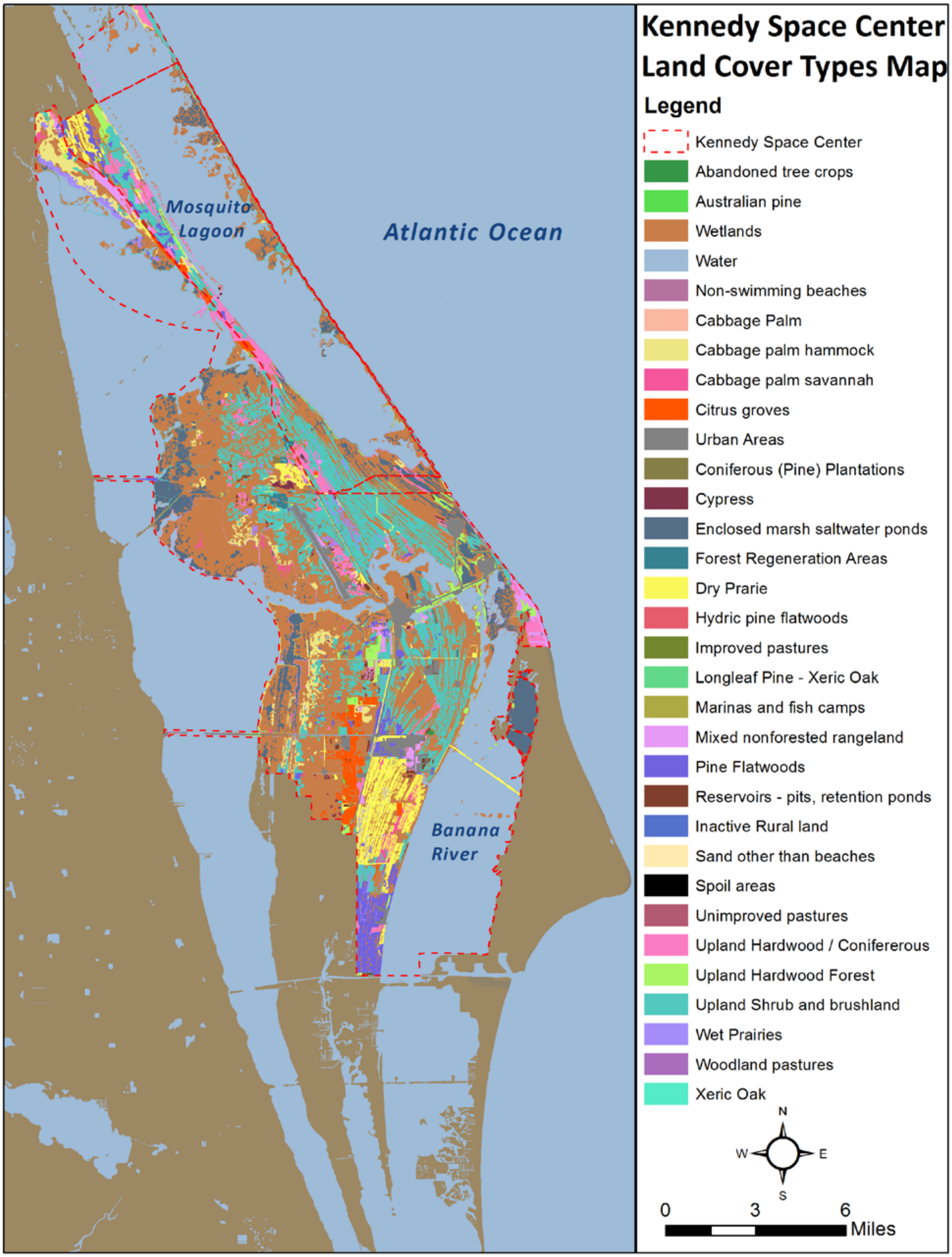


Figure 3.9-2. Land cover types at KSC

Table 3.9-2. Land cover types at KSC

Community	Land Cover Class	Hectares	Acres
Infrastructure		819	2024
Upland	Infrastructure – primary	564	1,394
Upland	Infrastructure – secondary	255	630
Natural uplands devoid of vegetation		122	301
Upland	Beach	122	301
Disturbed areas with exotic/invasive vegetation		2,889	7,139
Upland	Ruderal – herbaceous*	1,498	3,702
Upland	Citrus	748	1,848
Upland	Ruderal – woody*	598	1,478
Upland	Australian Pine	45	111
Upland scrub and pine flatwoods		9,011	22,268
Upland	Coastal strand	414	1,023
Upland	Oak scrub	6,105	15,086
Upland	Palmetto scrub	1,294	3,198
Upland	Planted oak scrub	10	25
Upland	Pine flatwods	1,188	2,936
Upland forest		6,128	15,140
Upland	Upland coniferous forest	109	269
Upland	Upland coniferous / hardwood forest	848	2095
Upland	Upland hardwood forest	236	583
Upland	Cabbage palm	1,093	2,701
Upland	Hardwood hammock	3,648	9,014
Upland	Planted hardwoods	113	279
Upland	Planted pine	81	200
Wetlands - estuary, marsh, shrub, forest		38,442	94,994
Wetland	Estuary	22,399	55,349
Wetland	Water - interior - salt	3,103	7,668
Wetland	Water - interior - fresh	381	941
Wetland	Barren land - may be inundated	103	255
Wetland	Ditch	151	373
Wetland	Marsh - saltwater	5,260	12,998
Wetland	Marsh - freshwater	2,381	5,884
Wetland	Mangrove	677	1,673
Wetland	Wetland scrub-shrub - saltwater	735	1,816
Wetland	Wetland scrub-shrub - freshwater	2,158	5,333
Wetland	Wetland coniferous/hardwood forest	632	1,562
Wetland	Wetland hardwood forest	462	1,142
TOTAL		**57,411**	**141,866**

* Ruderal refers to those plant species that first colonize disturbed land; this land cover class does not technically include only exotic and invasive plant species.

composed of Virginia live oak (*Q. virginiana*) with laurel oak (*Q. laurifolia*), cabbage palm, and American elm (*Ulmus americana*)

13. Planted oak scrub: planted oak scrub (see oak scrub above)
14. Planted hardwood: planted hardwoods (see upland hardwood forest above)
15. Planted pine: planted slash pines

A list of the vascular plant flora of KSC can be found in Appendix D of NASA (2010a) and includes 1,105 taxa, of which 874 species are native. Fifty-seven taxa are endemic or nearly endemic to Florida. The bryophyte flora of the KSC area includes 23 mosses and 20 liverworts and hornworts. The lichen flora is currently unknown.

Figure 3.9-3. Oak scrub habitat at KSC

3.9.1.1.1.2 Invasive Plants

Invasive plants are highly competitive and can often out-compete native vegetation, especially on recently disturbed sites. They decrease biodiversity, put endangered and threatened species at further risk, cause animal population decline and extinction worldwide, displace native plants that wildlife and fish depend on for food, increase soil erosion and cause major damage to streams and other wetland areas, increase the frequency and risk of wildfires, and reduce agricultural production and property values (CISM, 2014). Because they are often highly competitive, invasive plants alter the plant composition of ecosystems and may change their structure and function over large landscape areas. Climate change is exacerbating these changes by altering the amount and seasonal distribution of precipitation and seasonal temperature patterns in ways that often favor invasive species. Invasive plant infestations can impact an area for decades and may become permanent if left untreated.

Most of the areas on KSC that are disturbed, including roadsides, utility corridors, and launch complexes, have a substantial invasive species component. Only some of these species have become naturalized. Brazilian pepper (*Schinus terebinthifolius*) is most prominent on the KSC landscape, but Australian pine (*Casuarina* cf. *equisetifolia*) and melaleuca (*Melaleuca quinquenirvea*) are locally abundant (Schmalzer et al., 2002). These three species are among the most common and damaging invasive exotic plants in Florida because they form dense stands displacing all other plant species. Cogongrass (*Imperata cylindrica*) has spread in recent years and has the potential to invade upland communities and disrupt natural fire regimes. Also of concern is the appearance of Old World climbing fern (*Lygodium microphyllum*) and valamuerto (*Senna pendula* var. *glabrata*). Old world climbing fern is well established in south Florida and can cover native trees. Mistletoe (*Phoradendron serotinum*) and small populations of thistles (*Cirsium* spp.) and nettles (*Urtica spp*.) are also present.

The most recent land cover map for KSC identifies 31 cover types (Figure 3.9-2 and Table 3.9-2). Types 4 through 7 contain exotic/invasive vegetation potentially interspersed with native vegetation. Note that ruderal refers to those plant species that first colonize disturbed land; this this land cover class does not technically include only exotic and invasive plant species.

<u>Disturbed areas with exotic/invasive vegetation</u>

1. Ruderal - herbaceous: herbaceous areas with sparse and/or widely scattered woody vegetation and/or bare soil that is often the result of disturbance, includes abandoned groves
2. Citrus - includes maintained orange and grapefruit groves
3. Ruderal - woody: disturbed areas of dense woody vegetation generally with a closed canopy but may be mixed with ruderal - herbaceous; the dominant vegetation is often Brazilian pepper but may include willow, wax myrtle, and vines (i.e., grape vine, green briar); mangroves may occur along the inundated edge of dikes
4. Australian pine: Australian pine is a hardwood whose name is derived from its needle-like leaves and its characteristic cone shaped crown structure; Australian pine was introduced to Florida from Australia and occurs on disturbed sites forming dense thickets; used to form wind breaks and area extent may be linear in configuration; generally more than 5 m tall, with interlocking canopy

A complete list of the introduced plant species at KSC can be found in Appendix D of NASA (2010a). Of the 231 introduced plants at KSC, 33 are Category I invasive exotics and 24 are Category II invasive exotics as indicated by the Florida Exotic Pest Plant Council (FLEPPC). Invasive exotic plants are termed Category I invasives when they are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives (FLEPPC, 2014). Category II plants have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species. These species may become Category I if ecological damage is demonstrated. Table 3.9-3 lists the Category I and II species that can be found on KSC uplands.

Table 3.9-3. Category I and II invasive upland plant species at KSC

Category	Scientific Name	Common Name
I	*Abrus precatorius*	Rosary pea
I	*Albizia julibrissin*	Mimosa, Silk tree
I	*Albizia lebbeck*	Woman's tongue
I	*Asparagus aethiopicus*	Asparagus-fern
I	*Bauhinia variegata*	Orchid tree
I	*Casuarina equisetifolia*	Australian-pine, Beach she-oak
I	*Casuarina glauca*	Suckering Australian-pine, Gray she-oak

Category	Scientific Name	Common Name
I	*Dioscorea bulbifera*	Air-potato
I	*Eugenia uniflora*	Surinam cherry
I	*Imperata cylindrica*	Cogon grass
I	*Lantana camara*	Lantana, Shrub verbena
I	*Lonicera japonica*	Japanese honeysuckle
I	*Lygodium microphyllum*	Old World climbing fern
I	*Melaleuca quinquenervia*	Melaleuca, Paper bark
I	*Melinis repens*	Natal grass
I	*Nephrolepis cordifolia*	Sword fern
I	*Panicum repens*	Torpedo grass
I	*Pennisetum purpureum*	Napier grass, Elephant grass
I	*Psidium cattleianum*	Strawberry guava
I	*Psidium guajava*	Guava
I	*Pueraria montana* var. *lobata*	Kudzu
I	*Ruellia simplex*	Mexican petunia
I	*Sapium sebiferum*	Popcorn tree, Chinese tallow tree
I	*Schinus terebinthifolius*	Brazilian-pepper
I	*Senna pendula* var. *glabrata*	Climbing cassia, Christmas cassia
I	*Syngonium podophyllum*	Arrowhead vine
I	*Syzygium cumini*	Jambolan-plum, Java-plum
I	*Urena lobata*	Caesar’s weed
I	*Urochloa mutica*	Para grass
II	*Agave sisalana*	Sisal hemp
II	*Antigonon leptopus*	Coral vine
II	*Aristolochia littoralis*	Calico flower
II	*Asystasia gangetica*	Ganges primrose
II	*Broussonetia papyrifera*	Paper mulberry
II	*Casuarina cunninghamiana*	River she-oak, Australian pine
II	*Kalanchoe pinnata*	Life plant
II	*Koelreuteria elegans* ssp. *formosana*	Flamegold tree
II	*Leucaena leucocephala*	Lead tree
II	*Melia azedarach*	Chinaberry
II	*Panicum maximum*	Guinea grass
II	*Phoenix reclinata*	Senegal date palm
II	*Ricinus communis*	Castor bean
II	*Sansevieria hyacinthoides*	Bowstring hemp
II	*Sphagneticola trilobata*	Wedelia
II	*Syagrus romanzoffiana*	Queen palm
II	*Syzygium jambos*	Malabar plum, Rose-apple
II	*Talipariti tiliaceum*	Mahoe, Sea hibiscus
II	*Tribulus cistoides*	Puncture vine, Burr-nut
II	*Vitex trifolia*	Simple-leaf chaste tree
II	*Washingtonia robusta*	Washington fan palm
II	*Wisteria sinensis*	Chinese wisteria

Note: Some species are found in both upland and wetland habitats.
Source: NASA, 2010a, 2015; FLEPPC, 2014

3.9.1.1.1.3 Special Status Plants

The Endangered Species Act of 1973 (PL-93-205) provides guidance regarding the management and protection of certain species based on determinations made regarding their relative ability to survive. The U.S. Fish and Wildlife Service is responsible for determining which species are listed as either Threatened or Endangered and for maintaining this listing. In addition, Section 7 of the statute provides for a consultation process between the Service and any federal agency that may, through one of its proposed actions, impact one of these species or their critical habitat.

The State of Florida also develops and maintains its own list of species suffering threats to populations and habitats. The Florida Fish and Wildlife Conservation Commission (FFWCC) Endangered Species Coordinator is responsible for the review of species, designating their status and formally listing them in the State's Official List of Endangered and Potentially Endangered Fauna and Flora in Florida. This official list provides a comprehensive directory of the biota requiring special consideration in the State of Florida.

No federally listed plant species have been found to occur on KSC. Thirty nine taxa occurring on KSC are listed as threatened, endangered, or of special concern on Florida state lists (NASA, 2010a, 2015; FDACS, 2013; FNAI, 2014; Atlas of Florida Vascular Plants, 2014; NRCS, 2014). Twenty eight of these are found in upland habitats. Taxa of special concern occur in all major habitats, but many are restricted to hammocks and hardwood swamps that constitute a minor proportion of the terrestrial vegetation. For some of these taxa (e.g., *Calamovilfa curtissii*), populations on KSC appear to be important for their regional and global survival. Table 3.9-4 lists the special status species that occur on uplands and Table 3.9-5 shows the habitat, population status, and threats for upland special status species.

Table 3.9-4. Special status upland plants of the KSC area, including adjacent federal property

Scientific Name	Common Name	USFWS[2]	FDACS[1,3]	FCREPA[1,4]	FNAI[5]
Asclepias curtissii	Curtiss milkweed		E		
Calamovilfa curtissii	Curtiss reedgrass	FC2	T		G3, S3
Calopogon multiflorus	Many-flowered grass pink		E		G2G3, S2S3
Chamaesyce cumulicola	Sand dune spurge	FC2	E		G2,S2
Chrysophyllum oliviforme	Satinleaf		T		
Cyperus pedunculatus	Beach-star		E		
Glandularia maritima	Coastal vervain	FC2	E		G3, S3
Glandularia tampensis	Tampa vervain	FC1	E		G2, S2
Gonolobus suberosus	Angle-pod		T		
Hexalectris spicata	Crested coralroot		E		
Lantana depressa var. *floridana*	East coast lantana	FC2	E		G2T1, S1
Lechea cernua	Nodding pinweed	FC2	T		G3, S3
Lechea divaricata	Pine pinweed	FC2	E		G2, S2
Lilium catesbaei	Catesby lily		T		
Myrcianthes fragrans	Nakedwood	FC2	T		
Nemastylis floridana	Fall-flowering ixia		E		G2, S2

Scientific Name	Common Name	USFWS[2]	FDACS[1,3]	FCREPA[1,4]	FNAI[5]
Ophioglossum palmatum	Hand fern		E	E	G4, S2
Opuntia stricta	Shell mound prickly-pear		T		
Pavonia spinifex	Yellow hibiscus				G4G5, S2
Pecluma plumula	Plume polypody		E		G5, S2
Peperomia humilis	Peperomia		E		G5, S2
Peperomia obtusifolia	Florida peperomia		E		G5, S2
Persea borbonia var. humilis	Scrub bay				G3, S3
Pteroglossaspis ecristata	False coco		T		G2G3, S2
Scaevola plumieri	Scaevola		T		
Sophora tomentosa	Yellow necklace pod				G4G5, S3
Tephrosia angustissima var. *curtissii*	Narrow-leaved hoary pea	FC2	E		G1T1, S1
Zamia pumila	East coast coontie			T	

Sources: NASA, 2010a, 2015; FDACS, 2013; FNAI, 2014; Atlas of Florida Vascular Plants, 2014; NRCS, 2014

[1] Designated Status: E = Endangered; T = Threatened; SP = Special Concern; C = Commercially Exploited

[2] United States Fish and Wildlife Service. FC1 and FC2 indicate species that were formerly under consideration for listing.

[3] Florida Department of Agriculture and Consumer Services

[4] Florida Committee on Rare and Endangered Plants and Animals

[5] Florida Natural Areas Inventory. FNAI assigns two ranks for each element. The global element rank is based on an element's worldwide status; the state element rank is based on the status of the element in Florida. Element ranks are based on factors including estimated number of element occurrences, estimated abundance, range, estimated adequately protected element occurrences, relative threat of destruction, and ecological fragility.

Global Element Rank:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some biological or man-made factor.

G3 = Either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals), or found locally in a restricted range, or vulnerable to extinction because of other factors.

G4 = Apparently secure globally (may be rare in parts of range)

G5 =Demonstrably secure globally

G#T# = Rank of taxonomic subgroup such as subspecies or variety; numbers have same definition as Above

State Element Rank:

Definitions parallel global element ranks: substitute "S" for "G" in global ranks, and "in state" for "globally" in global rank definitions.

Table 3.9-5. Common habitats of special status upland plants of the KSC area, including adjacent federal property

Scientific Name	Habitat	Population Status	Threats to Existence
Asclepias curtissii	Oak scrub	Several small populations	Habitat loss, fire exclusion
Calamovilfa curtissii	Shallow swales in pine flatwoods	Several populations	Habitat loss, fire exclusion
Calopogon multiflorus	Pine flatwoods	Unknown	Habitat loss

Scientific Name	Habitat	Population Status	Threats to Existence
Chamaesyce cumulicola	Coastal dunes, strand and scrub	Several small populations	Habitat loss, fire exclusion
Chrysophyllum oliviforme	Hammocks	Unknown	Habitat loss
Cyperus pedunculatus	Coastal dunes	Occasional within habitat	Habitat loss
Glandularia maritima	Coastal dunes and strand - openings	Common within habitat	Habitat loss
Glandularia tampensis	Edge of hammocks	A few small populations	Habitat loss
Gonolobus suberosus	Hammocks	One population	Habitat loss
Hexalectris spicata	Hammocks	Unknown	Habitat loss
Lantana depressa var. *floridana*	Coastal strand and scrub, coquina scrub	Several populations	Habitat loss, hybridization with *L. camara*
Lechea cernua	Scrub openings	Not relocated on KSC/MINWR	Habitat loss, fire exclusion
Lechea divaricata	Scrub openings	Several small populations	Habitat loss, fire exclusion
Lilium catesbaei	Pine flatwoods	Unknown	Habitat loss
Myrcianthes fragrans	Hammocks, coastal strand	Common within habitat	Habitat loss
Nemastylis floridana	Hammocks, wet flatwoods	One population	Habitat loss
Ophioglossum palmatum	Hammocks - epiphytic on cabbage palm	3 extant populations, 1 historic population	Habitat loss, freezes
Opuntia stricta	Coastal dunes and strand	Common within habitat	Habitat loss, introduced insect
Pavonia spinifex	Hammocks	Several populations	Habitat loss
Pecluma plumula	Hammocks - epiphytic	Unknown	Habitat loss
Peperomia humilis	Hammocks	Unknown	Habitat loss
Peperomia obtusifolia	Hammocks - epiphytic	Unknown	Habitat loss
Persea borbonia var. humilis	scrub	A few small populations	Habitat loss, fire exclusion
Pteroglossaspis ecristata	Scrub and dry flatwoods	One population	Habitat loss, fire exclusion
Scaevola plumieri	Coastal dunes and strand	Occasional within habitat	Habitat loss
Sophora tomentosa	Coastal strand and hammocks	One population	Habitat loss
Tephrosia angustissima var. *curtissii*	Coastal dunes and strand	Two small populations	Habitat loss, fire exclusion
Zamia pumila	Coastal hammocks	Several populations	Habitat loss, collection

Source: NASA, 2010a, 2015

3.9.1.1.2 Terrestrial Wildlife

The diverse habitats of the Kennedy Space Center/Merritt Island National Wildlife Refuge support a wide variety of animal species. The refuge's biodiversity is important to the overall ecological integrity of the North Florida Ecosystem in general and the Indian River Lagoon system in particular. KSC/MINWR also serves as an important site for the recovery of federally and state listed threatened and endangered species. KSC/MINWR's habitats provide protection and management opportunities for 10 regularly occurring federally listed threatened and endangered species (where a total of 93 species have some level of management concern by the federal government or by the State of Florida) (Epstein and Blihovde, 2006, Appendix C). The wildlife described for the upland communities of KSC include those for dry interior types such as scrub pine habitats as well as beach habitats, which are dry environments supporting mice, nesting birds, and the nests of sea turtles.

3.9.1.1.2.1 Native Wildlife

Reptiles and Amphibians
It is believed that KSC/MINWR's habitats support more than 71 species of reptiles and amphibians. Terrestrial herpetofauna (Table 3.9-6) have been studied on at KSC/MINWR since the 1970s. Long-term monitoring has provided considerable data on the biodiversity of "herps" on the refuge (Seigel and Pike 2003). These data should be beneficial in detecting long-term changes in these species. Reptiles and amphibians are a critical component of refuge ecosystems. The biomass of reptiles and amphibians may exceed that of all other vertebrates in aquatic and terrestrial systems (Seigel and Seigel, 2000). The ecological distribution of reptiles and amphibians on Merritt Island would be a function of available habitat, primarily wetland, freshwater communities. However, several species are specific to terrestrial habitats. Exotic species are becoming potential threats to the refuge. Presently on the refuge, the brown anole (*Anolis sagrei*) may be displacing native species (Campbell, 2000; Campbell and Echternacht, 2002). The Cuban frog (*osteopilus septentrionalis*), which consumes smaller species, has been positively identified on the southern portion of the refuge. Additional research and monitoring is being conducted on gopher tortoise distribution and fecundity, as well as on upper respiratory tract disease in gopher tortoises.

Table 3.9-6. Terrestrial amphibians and reptiles of KSC

Scientific Name	Common Name	Abundance Based on Sightings
Amphibians		
Frogs		
Bufo quercicus	oak toad	occasionally seen, commonly heard
Bufo terrestris	southern toad	commonly seen and heard
Hyla cinerea	green tree frog	commonly seen and heard
Hyla femoralis	pinewoods tree frog	occasionally heard at night, rarely
Hyla gratiosa	barking tree frog	occasionally heard at night, rarely
Hyla squirella	squirrel tree frog	commonly seen and heard
Pseudacris ocularis	little grass frog	rarely seen, occasionally heard
Eleutherodactylus planirostris	greenhouse frog (E)	occasionally seen
Gastrophryne carolinensis	narrow-mouthed toad	occasionally seen, commonly heard
Scaphiopus holbrookii	eastern spadefoot toad	occasionally seen and heard
Rana capito	gopher frog	rarely seen or heard
Reptiles		
Turtles		
Terrapene carolina	box turtle	occasionally seen

Scientific Name	Common Name	Abundance Based on Sightings
Gopherus polyphemus	gopher tortoise	commonly seen
Lizards		
Ophisaurus attenuatus	slender glass lizard	rarely seen
Ophisaurus compressus	island glass lizard	rarely seen
Ophisaurus ventralis	eastern glass lizard	occasionally seen
Hemidactylus garnotii	Indo-Pacific gecko (ex)	rarely seen
Hemidactylus turcicus	Mediterranean gecko (ex)	rarely seen
Anolis carolinensis	green anole	commonly seen
Anolis sagrei	brown anole (ex)	commonly seen
Eumeces egregious	mole skink	rarely seen
Eumeces inexpectatus	southeastern five-lined skink	commonly seen
Scincella lateralis	ground skink	occasionally seen
Cnemidophorus sexlineatus	six-lined racerunner	commonly seen
Snakes		
Cemophora coccinea	scarlet snake	rarely seen
Coluber constrictor	black racer	commonly seen
Diadophis punctatus	ring-necked snake	rarely seen
Drymarchon corais couperi	indigo snake	occasionally seen
Elaphe guttata	corn snake	occasionally seen
Elaphe obsolete	yellow rat snake	occasionally seen
Heterodon platirhinos	eastern hog-nosed snake	rarely seen
Lampropeltis getula	common kingsnake	rarely seen
Lampropeltis triangulum	scarlet kingsnake	rarely seen
Masticop his flagellum	coachwhip	occasionally seen
Opheodrys aestivus	rough green snake	occasionally seen
Pituophis melanoleucus mugitus	Florida pine snake	rarely seen
Rhadinaea flavilata	pine woods snake	rarely seen
Storeria dekayi	brown snake	rarely seen
Tantilla relicta	coastal dunes crowned snake	rarely seen
Thamnophis sauritus	ribbon snake	commonly seen
Thamnophis sirtalis	garter snake	commonly seen
Micrurus fulvius	Coral snake (v)	rarely seen
Crotalus adamanteus	diamondback rattlesnake (v)	occasionally seen
Sistrurus miliarius	pygmy rattlesnake (v)	rarely seen
ex = exotic or non-native to the area; v = venomous		

Figure 3.9-4. Snowy egret at MINWR

Birds

More than 330 bird species use KSC/MINWR for nesting, roosting, feeding, or loafing. The refuge hosts a great diversity of passerines, including thrushes, vireos, warblers, finches, corvids and other perching birds, with approximately 170 species regularly occurring on the refuge. Ninety species nest at KSC, 111 species are regular winter visitors, and 66 species are considered to be transients (NASA, 2010a, 2015). The great majority of passerines are transient, using refuge habitats during spring and fall migrations. The threatened Florida scrub-jay (discussed below) is the only federally listed passerine that occurs on the refuge.

Mammals

The Refuge provides habitat for more than 30 species of both terrestrial and aquatic mammals. This count does not include the numerous species of dolphins and whales that occur offshore in the Atlantic and occasionally wash up dead on KSC beaches. The mammalian fauna of the refuge is characteristic of the central Florida coastal barrier ecosystem. Table 3.9-6 lists the terrestrial mammals of KSC.

Several mammals are of note at KSC. A large bat colony exists in the SR 405 bridge crossing over SR 3. Two species, the Brazilian free-tailed bat (*Tadarida brasiliensis*) and the southeastern bat (*Myotis austroriparius*), have been identified using the bridge as a roosting site. The bridge is also used as a maternity colony site and pre-fledgling bats have been observed. Routine maintenance and repair operations on the bridge have been done on several occasions with no apparent impacts to the colony. In recent years, bat roosts have been identified in five other buildings/structures and may very likely occur elsewhere on KSC. Six bat houses have been installed; one near a pavilion at KARS Park I and five near the Logistics Facility.

The largest mammalian predators remaining on KSC are the bobcat and river otter. There are no population estimates available for these animals, and although they are commonly observed in many areas, the status of their populations is unknown. In data collected between 1992 and 1995, 31 bobcats and 17 otters were documented road mortalities on KSC. Many of the bobcats were juveniles, but all of the otters were adults. Loss of large predator populations can lead to increased densities of prey populations and a proliferation of smaller predators, such as the raccoon. Table 3.9-7 lists upland mammals potentially found at KSC.

A black bear population no longer occurs on KSC, though an occasional individual will wander in from areas north of the property. Habitat fragmentation leading to smaller patches of suitable habitat and increased road mortality are probable causes for the loss of black bears on KSC.

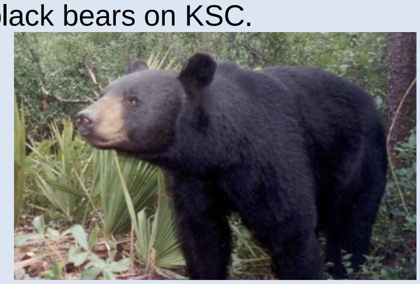


Table 3.9-7. Upland mammals of KSC

Scientific name	Common name	Abundance as indicated by sightings
Didelphis virginiana	Virginia opossum	commonly seen
Cryptotis parva	least shrew	rarely seen
Scalopus aquaticus	eastern mole	rarely seen
Myotis austroriparius	southeastern bat	occasionally seen
Tadarida brasiliensis	Brazilian free-tailed bat	occasionally seen
Dasypus novemcinctus	nine-banded armadillo (ex)	commonly seen
Sylvilagus floridanus	eastern cottontail	commonly seen
Sciurus carolinensis	gray squirrel	rarely seen
Sigmodon hispidus	hispid cotton rat	occasionally seen
Podomys floridanus	Florida mouse	rarely seen
Peromyscus polionotus	southeastern beach mouse	rarely seen
Peromyscus gossypinus	cotton mouse	rarely seen
Ochrotomys nuttalli	golden mouse	rarely seen
Rattus rattus	black rat (ex)	rarely seen
Procyon lotor	raccoon	commonly seen
Mustela frenata	long-tailed weasel	rarely seen
Spilogale putorius	eastern spotted skunk	occasionally seen
Urocyon cinereoargenteus	gray fox	rarely seen
Vulpes vulpes	red fox (ex)	rarely seen
Canis latrans	coyote (ex)	rarely seen
Felis rufus	bobcat	occasionally seen
Sus scrofa	wild hog (ex)	commonly seen
Odocoileus virginianus	white-tailed deer	rarely seen

ex = exotic or non-native to the area

Invertebrates
A wide variety of marine, freshwater, and terrestrial invertebrates are found within the refuge's boundary. While some research has been conducted regarding benthic macro-invertebrates inhabiting the open estuary and select impoundments, no systematic survey has been performed for freshwater or terrestrial invertebrates of the Refuge.

3.9.1.1.2.3 Special Status Species

Regulatory Overview
The Endangered Species Act of 1973 (PL-93-205) provides guidance regarding the management and protection of certain species based on determinations made regarding their relative ability to survive. The U.S. Fish and Wildlife Service is responsible for determining which species are listed as either Threatened or Endangered and for maintaining this listing. In addition, Section 7 of the statute provides for a consultation process between the Service and any federal agency that may, through one of its proposed actions, impact one of these species or their critical habitat.

The State of Florida also develops and maintains its own list of species suffering threats to populations and habitats. The FFWCC Endangered Species Coordinator is responsible for the review of species, designating their status and formally listing them in the State's Official List of Endangered and Potentially Endangered Fauna and Flora in Florida. This official list provides a comprehensive directory of the biota requiring special consideration in the State of Florida. Table 3.9-8 lists the terrestrial Federal and State protected wildlife species found at KSC.

Table 3.9-8. Federal and state protected terrestrial wildlife of KSC

Scientific Name	Common Name	Level of Protection	
Amphibians and Reptiles		**FEDERAL**	**STATE**
Rana capito aesopus	Florida gopher frog		SSC
Gopherus polyphemus	Gopher tortoise	C	SSC
Drymarchon couperi	Eastern indigo snake	T	T
Pituophis melanoleucus mugitus	Florida pine snake		SSC
Birds			
Falco peregrinus	Peregrine falcon		E
Falco sparverius paulus	Southeastern American kestrel		T
Aphelocoma coerulescens	Florida scrub-jay	T	T
Rostrhamus sociabilis plumbeus	Snail kite		E
Polyborus plancus audubonii	Audubon’s Crested caracara		T
Grus canadensis pratensis	Florida sandhill crane		T
Mammals			
Peromyscus polionotus niveiventris	Southeastern beach mouse	T	T
Podomys floridanus	Florida mouse		SSC
Key: SSC = Species of Special Concern; T = threatened; E = endangered.			

Amphibians and Reptiles

The eastern indigo snake (*Drymarchon couperi*) is the longest snake in the U.S., reaching lengths greater than 2.5 m (8 ft.). Eastern indigo snakes became federally listed as threatened under the Endangered Species Act in 1978. Once common from the southern tip of South Carolina west to southeastern Mississippi and throughout Florida, the current range is restricted to southern Georgia and peninsular Florida, with a few small populations located in the Florida panhandle and Key Largo. Eastern indigo snakes have very large home ranges and use a variety of habitat types found within the refuge, including oak scrub, oak hammock, pine flatwoods, fresh and brackish

Figure 3.9-5. Eastern indigo snake

wetlands, and disturbed habitats (Breininger et al. 2004). The species also shares a commensal relationship with the state-listed gopher tortoise (*Gopherus polyphemus*), whose burrows it uses as shelter from predation and temperature extremes.

Though the eastern indigo snake is federally listed as a threatened species, protection and conservation are difficult due to the lack of knowledge regarding their biology and their reclusive nature. There is little life history information available, and no reliable survey techniques exist to determine presence, absence, or abundance at a site. Eastern indigo snake radio-tracking first took place on KSC between 1990 and 1992. A small number of snakes were tagged to determine home range sizes and habitat use. From 1998 to 2002, in a study funded by a private wildlife foundation with support from NASA and the USFWS, more than 70 eastern indigo snakes were captured from throughout Brevard County and radio-tracked. Home range sizes were variable, with males generally using a larger area than females. It was found that indigo snakes used a wide variety of habitats, including suburban areas where they regularly come into contact with people. Road mortality and intentional killing by humans were two major sources of mortality. Land development, resulting in the fragmentation of habitat, is the greatest threat to indigo snake populations for a number of reasons: snakes are forced to cross more roads in their daily travels, are more likely to be seen and possibly killed by people, and the fire-maintained habitats that they use are degraded due to lack of naturally occurring fire.

The Florida gopher frog is a state-listed Species of Special Concern. The gopher frog lives in the dry upland scrub and pine habitats where it typically shelters in gopher tortoise burrows. During the breeding season, gopher frogs migrate to seasonally flooded freshwater swales that are found adjacent to the uplands habitats. Although gopher frogs have been documented from three sites on KSC, they are not thought to be very common and little is known about the population's distribution or abundance.

Figure 3.9-6. Gopher tortoise at Canaveral National Seashore

Gopher tortoises are a Candidate species for listing under the ESA and a state-protected Species of Special Concern. They are long-lived terrestrial animals that dig burrows to use as refuge from inclement weather, fire, and predators. The burrow provides important habitat for hundreds of invertebrate and vertebrate species, earning the gopher tortoise the distinction of being a "keystone species". Several of the animals that use tortoise burrows are also state or federally protected, and the value of healthy, reproductive gopher tortoise colonies cannot be overstated from a conservation perspective. Several studies of gopher tortoises have been conducted on KSC. In the mid-1980s, 112 plots were established in tortoise habitats to determine burrow and tortoise densities, and to develop corrections factors to correlate the number of burrows seen to the number of tortoises in the population. From

1989 – 1991, tortoises were radio-tracked to determine home range sizes and numbers of burrows used. Tortoise burrows were found in the typical high, dry habitats, but radio-tracking showed that they also utilize wetter habitats, such as the freshwater swales, for feeding.

Work began in 1998 to determine if the deadly bacterial disease, Upper Respiratory Tract Disease (URTD), was present in KSC gopher tortoise populations. Antibodies for URTD were found in several populations spread across KSC and CCAFS. Monitoring of URTD continues and several sites may potentially have had die-offs that could be contributed to URTD (NASA, 2010a, 2015).

Other than the low-intensity URTD monitoring that continues, most of the work currently occurring with gopher tortoises at KSC involves moving them from harm's way for operational requirements. New construction, renovations, repairs, and environmental cleanup efforts often occur in areas occupied by tortoises. In these instances, the sites are surveyed to determine the locations of all burrows, which are marked. The interiors of the burrows are examined with an infrared burrow camera to determine occupancy. When tortoises are found, they are removed from the burrow either by bucket trapping or excavation with a backhoe. In most instances, the tortoises are relocated a short distance away, out of harm's way, but still within their home range and familiar surroundings. When the occasional longer distance relocation is required, suitable recipient sites are identified, ideally in newly restored habitat that is capable of supporting an increased tortoise population.

Birds

The Florida scrub-jay is a federally protected threatened species that was elevated from subspecies status in 1997. The four largest remaining populations of scrub-jays occur on KSC, CCAFS, Ocala National Forest, and the mainland of Brevard County and Indian River County. Kennedy Space Center has a potential population size of 700 breeding pairs but the population has declined to perhaps half this number because of habitat degradation (NASA, 2010a, 2015).

Figure 3.9-7. Florida scrub-jay

Research on color-banded scrub-jay populations on KSC began in 1987 and showed that territory sizes averaged 10 ha. Major sources of mortality for adults are hawk predation and road mortality. A large number of nests (between 43% and 80% of the total, depending on the site) are depredated, resulting in a decreasing population in some areas. Two years of remote recording of egg and nestling predation events found that 13 of 19 were due to yellow rat snakes. Radio-tracking data showed that small mammals, other birds, and snakes readily eat the fledgling scrub-jays before they become efficient fliers. Florida scrub-jays are restricted to shrublands that have many scrub oaks and few trees (NASA, 2010a, 2015). They have their greatest demographic success when territories include a matrix of recently burned scrub (<3 years since fire and patches of scrub oaks that are 120-170 cm [4 to 5.5 ft.] tall).

Fragmentation of scrub habitat and isolation of small patches of scrub result in habitat degradation from fire suppression, increased predation, and increased road mortality. Major scrub-jay populations are found in four areas on KSC as shown in Figure 3.9-8.

Figure 3.9-8. Distribution of oak scrub habitat and major Florida scrub-jay populations

Mammals

The southeastern beach mouse (*Peromyscus polionotus niveiventris*) is federally protected as threatened while the Florida mouse (*Podomys floridanus*) is protected by the State of Florida as a Species of Special Concern. The USFWS at MINWR ranks management issues associated with the conservation of southeastern beach mice as one of their highest priorities due to the limited range and rapid loss of habitat outside of the refuge. Small mammal trapping, primarily done in coastal habitats expected to support southeastern beach mouse populations, has provided data on several species, including beach mice, cotton mice (*Peromyscus gossypinus*), cotton rats (*Sigmodon hispidus*), Florida mice, and golden mice (*Ochrotomys nuttalli*). In the mid-1970s, southeastern beach mice were trapped along the dunes at MINWR/KSC and were considered abundant with 771 captures in 2,256 trap nights (NASA, 2010a, 2015).

In 1990-1991, a baseline distribution survey (29 transects) at MINWR/KSC was conducted in the coastal dunes, strand, and scrub, which resulted in 539 beach mouse captures over 3,937 trap nights. In 1996-1998, surveys were conducted to evaluate space shuttle impacts on southeastern beach mice at four sites in the vicinity of the shuttle pads. Two areas (one near LC39A and one near LC39B) with the most frequent occurrence of near-field deposition were selected as treatment sites, and two areas not impacted by near-field deposition were selected as reference sites. A total of 479 beach mice were captured, 64% of which were adults, 28% were juveniles, and 4% were dependent young. No effects of launch could be inferred from the data collected (NASA, 2010a, 2015).


Figure 3.9-9. Southeastern beach mouse

Overall, surveys indicated that the number of southeastern beach mice has remained relatively stable since 1990-1991 although year to year variation at a specific site can be high. MINWR/KSC is one of the last remaining intact areas to have a viable southeastern beach mouse population, but little is known about its habitat occupancy across the KSC landscape. Specimens have been captured as far inland as State Road 3 west of Happy Creek.

Live trapping for Florida mice was conducted four times between July 2001 and July 2002 at Happy Creek. Trapping grids were set in scrub habitat that was interspersed with shallow freshwater swale marshes. The July 2001 sample period consisted of six consecutive nights, and the remaining sample periods consisted of two consecutive nights each. There were 24 captures of 17 individual Florida mice. Eight were males and nine were females. Of these, 12 were adults and five were juveniles (NASA, 2010a, 2015).

3.9.1.1.2.3 Non-native and Invasive Wildlife

At least 15 species of non-native wildlife have been documented on KSC. These include introduced exotics, non-native species extending their ranges, and feral populations of domesticated species.

Introduced Exotics

Amphibians and Reptiles – The greenhouse frog (*Eleutherodactylus planirostris*) is native to the West Indies, but has become well established throughout peninsular Florida. It is nocturnal and prefers moist conditions, even within uplands habitats. It is one of our most common frogs.

Three species of lizards, the Cuban anole (*Anolis sagrei*), Indo-Pacific gecko (*Hemidactylus garnoti*), and Mediterranean gekko (*Hemidactylus turcicus*) were never reported in herpetological surveys done in the 1970s. All three species are now found around buildings and other facilities on KSC. The Cuban anole is native to Cuba, Jamaica, and the Bahamas, but is now well established in Florida, with populations also occurring in Texas, Louisiana, and Georgia. They probably were imported into the U.S. accidentally on landscaping plants. The Indo-Pacific gecko came to the U.S. from Southeast Asia and has spread throughout central and south Florida. One reason that these lizards are successful colonizers is that they are all self-fertilizing females. It only takes the introduction of one lizard into a new area to start a population. The Mediterranean gecko was introduced from the Mediterranean and is found in the Gulf States, Mexico, and Cuba. It is nocturnal, feeding on insects attracted to facility lighting (NASA, 2010a, 2015).

Birds – The rock dove (*Columba livia*) or pigeon was introduced to North America from Eurasia in the 1800s. Individuals are extremely common around human habitations and are often considered pests. On KSC and CCAFS, rock doves are year-round residents and may take up residence in hangars and other open buildings, causing safety and sanitation concerns. Occasionally, the bodies of banded pigeons are retrieved, and these birds typically have traveled thousands of miles from the northeastern U.S.

The European starling (*Sturnus vulgaris*), intentionally introduced into New York City's Central Park in 1890, had become established across the entire U.S by 1950. Starlings are an ecological concern because they often usurp cavities for nesting that are being used, or could be used, by native species such as screech owls, woodpeckers, bluebirds, and wrens. On KSC, there is a population of year-round residents and also an influx of migrant starlings in winter. Starlings often gather in huge flocks which are capable of devouring large quantities of food resources.

The English house sparrow (*Passer domesticus*) is the most widely introduced bird species in the world. They were purposely imported from Europe to Brooklyn, New York, in 1850, and within 20 years, they had spread in all directions across the continent. House sparrows are extremely aggressive and will extricate even larger birds from their nest sites. On KSC, they are extremely common around buildings and often get into buildings and hangars, causing safety and sanitation problems (NASA, 2010a, 2015).

Mammals – Originally native to South America, the nine-banded armadillo (*Dasypus novemcinctus*) extended its range into the U.S. through Texas in the late 1800s. It was intentionally introduced into Florida in the 1920s. Armadillos are extremely abundant, more so than is immediately evident, because they are generally crepuscular or nocturnal. They eat a variety of insects and other invertebrates, carrion, and eggs, and dig burrows for den and nesting sites. Nine-banded armadillos are not well studied, and their impacts on native wildlife are not known. They could potentially compete with gopher tortoises for burrows, and may eat eggs of native birds, amphibians, and reptiles.

Black rats (*Rattus rattus*) were stowaways on the ships of European explorers to the U.S. in the mid-1500s. They are found primarily associated with buildings. However, during beach mouse surveys occurring from 1996 – 1998 on the dunes near the Space Shuttle launch pads, nine black rats were captured in traps. Because these animals constituted a threat to the federally protected southeastern beach mouse, they were humanely destroyed. The extent to which black rats occur in natural habitats on KSC is not known, but could be a significant concern.

The red fox (*Vulpes vulpes*) was brought from England to the U.S. in the mid-18th century by hunters. They were released in the northeast U.S. and have since spread throughout most of the U.S. and Canada. Hunting kept populations in check for many years, but the devaluation of the fur market has caused red foxes to become more common. In some urban areas, they are considered to be pests and potential sources of rabies. The occurrence of red fox on KSC was documented from a single road mortality on SR 405 in front of the Space Station Processing Facility.

Typically associated with the southwest U.S., coyotes (*Canis latrans*) have taken advantage of human activities and impacts to increase their range to include every state in the U.S. except Hawaii. Although coyotes were introduced into Florida in the 1920s for hunting with dogs, their natural range expansion was probably inevitable. The coyote's great success can be attributed to several factors. They are generalists in their habitat and food requirements, and they produce large litters that mature quickly. Several of the other large predators that were competitors with the coyote (e.g., red wolf and panthers) have been extirpated from many areas. Most importantly, coyotes are able to capitalize on and benefit from human activities such as farming, ranching, and urbanization in general. Coyote numbers have been increasing in Florida during the last 20 years, and the impacts on native wildlife are not well studied. They have been documented depredating marine turtle nests on KSC and CCAFS. Coyotes may directly compete with bobcats for food resources. However, they may also help mitigate the loss of other large predators that once kept prey populations of raccoons, rodents, rabbits, etc., in check (NASA, 2010a, 2015).

Range Extensions

The cattle egret (*Bubulcus ibis*) and brown-headed cowbird (*Molothrus ater*) are both examples of species that have managed to colonize Florida on their own (i.e., not introduced); both of these range extensions have occurred because of habitat changes caused by humans. The cattle egret reached Florida in the 1940s, via South America from Africa. Their entry was facilitated by deforestation, irrigation, and the cattle industry, all of which provided ample food resources. They may compete with native herons for food and nesting resources.

The brown-headed cowbird is native to the Great Plains and was originally associated with the American bison. The proliferation of the cattle industry and the conversion of land to agriculture have allowed the cowbird to occupy the entire U.S. mainland. Cowbirds have completely abandoned nest building and deposit their eggs in the nests of other birds, often destroying the host birds' eggs in the process. Not all species of birds are susceptible to brown-headed cowbird parasitism, and as of yet, they have not been documented using Florida scrub-jay nests (NASA, 2010a, 2015).

Feral Populations of Domestic Species

Free-ranging feral house cats (*Felis domesticus*) are known to pose a significant threat to native species of wildlife. There is overwhelming evidence to show that feral cats eat adult birds, amphibians, and reptiles, their young, and eggs. They are also vectors for diseases infecting other wildlife (e.g., feline leukemia and distemper) and humans (e.g., rabies). In 1996, KSC workers concerned for the welfare of cats formed the Space Cats Club. By 1999, 100 feral cats had been trapped, neutered, and vaccinated, and were either adopted or housed in a closed facility on KSC.

After 1999, operations were moved off KSC into Brevard County. At this time, feral cat populations do not appear to be large or constitute a major impact to KSC wildlife. However, it is against federal regulations to feed or house feral cats on KSC.

Before NASA took control of the property that is now KSC, the area was home to many people who had livestock and/or citrus groves. As the people relocated to surrounding towns, their domestic hogs (*Sus scrofa*) were occasionally left behind. The mild central Florida winters and abundance of food resources made it possible for feral hog populations to explode. Hogs constitute an environmental problem for a number of reasons. They eat plants, small species of wildlife, and any eggs deposited on the ground. Their method of foraging is very destructive because they turn over large amounts of dirt and cause significant soil disturbance, allowing increased opportunity for exotic and pest vegetation germination (e.g., cogon grass, *Imperata cylindrica*). Hogs can seriously damage the shallow freshwater marshes that are crucial breeding habitat for amphibians, and feeding habitat for a large number of species, including gopher tortoises, indigo snakes, and several waterbirds (e.g., ducks, wading birds, shorebirds). Feral hogs also pose a safety concern because they are often killed on KSC roads each year, causing property damage and injury to the KSC workforce (NASA, 2010a, 2015).

3.9.1.2 Aquatic Environments

3.9.1.2.1 Wetlands (Freshwater and Brackish)

This section describes the biota of KSC's extensive complex of wetlands and waterways. KSC is surrounded by the Indian River Lagoon System (IRL) and the Atlantic Ocean. The IRL (Figure 3.4-2) consists of the Mosquito Lagoon to the north, Banana River to the south, and Indian River to the west. This system was formed by changing sea levels and its prominent features are the southern barrier islands, the Cape Canaveral foreland formation, the western mainland ridges, and the valleys and sloughs between the ridges. These basins are shallow, aeolian, lagoons with depths averaging 1.5 m and maximums of 9 m generally restricted to dredged basins and channels (NASA, 2010a, 2015).

The Indian River Lagoon proper is almost entirely outside the western boundary of KSC, which is undeveloped and part of the MINWR. Most of the shoreline on KSC/MINWR is impounded with no direct runoff into the lagoon. The eastern shore of the IRL is highly developed in the area from Titusville south with many areas of point and non-point runoff. Mosquito Lagoon and the Indian River are connected by Haulover Canal and the Intracoastal Waterway. Water flow between these two systems is primarily wind-driven. Because of the various man-made modifications related to the space program and mosquito control, circulation between Mosquito Lagoon and the Banana River was blocked in the earlier 1960s.

The Indian and Banana Rivers mix in the southern region near Eau Gallie and through a man-made canal located just south of KSC. This navigation canal accesses the Atlantic Ocean through the Port Canaveral Locks, whose oceanic waters influence surface water quality in the northern Banana River. The northern-most Banana River is inside KSC property and closed to motorized boat traffic. It is part of the Merritt Island National Wildlife Refuge and its water quality is one of the best in the Indian River Lagoon System. The region of the Banana River north of the NASA Causeway includes Pintail Creek and Max Hoeck Back Creek. Very little tidal fluctuation occurs, and the water movement in this location is influenced primarily by wind and evaporation (NASA, 2010a, 2015).

Figure 3.9-10. Typical scene at edge of Indian River Lagoon System on KSC

Within KSC property is Banana Creek, which drains the area adjacent to the Space Shuttle launch pads via a canal located northwest of the Vehicle Assembly Building to the Indian River. Salinity usually increases in a westward direction, but depending on wind direction, the Indian River system can have a greater or lesser effect on the Banana Creek water quality. Freshwater inputs to the estuarine system surrounding KSC include direct precipitation, stormwater runoff, discharges from impoundments, and groundwater seepage.

This area is very biologically diverse as it includes the temperate Carolinian and the subtropical Caribbean zoogeographic Provinces. The lagoonal waters surrounding KSC are shallow flats that support dense growths of submerged aquatic vegetation including manatee grass (*Syringodium filiformis*), shoal grass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*), gulf halophila (*Halophila engelmanii*) and various macroalgae such as Gracilaria, Caulerpa, Sargassum, Laurencia, Penicillus, Acetabularia and Acanthophora. Cool winter temperatures preclude the growth of turtle grass (*Thalassia testudinum*) in the KSC area. Shorelines of the system near

KSC are dominated by white mangrove (*Laguncularia racemosa*) and black mangrove, *Avicennia germinans*) with red mangrove (*Rhizophora mangle*) occurring in small patches; however, this region represents the northern limit of their range and the winter freezes of 1983, 1984, and 1989 significantly impacted their populations.

Fauna in the lagoon system near KSC represents both the Carolian and subtropical provinces. Most common species mullet (*Mugil cephalus*), spotted sea trout (*Cynoscion nebulosus*), red fish (*Sciaenops ocellatus*), sea catfish (*Arius felis*), and blue crabs (*Callinectes sapidus*). Subtropical species are present but become more prevalent to the south of KSC. This unique environmental setting makes the KSC one of the most diverse areas in the United States (NASA, 2010a, 2015).

3.9.1.2.1.1 Native Plants

Wetland vegetation on KSC consist of both coastal and freshwater communities and cover approximately 14,600 ha (36,000 ac). Natural wetland communities occur on sites that are flooded for short to long periods in most years. Long, narrow freshwater marshes are interspersed among bands of uplands. Wetland communities include hardwood swamp, willow swamp, freshwater swale swamp, cattail marsh, cabbage palm savanna, brackish or saline wetlands, sand cordgrass/black rush, mixed salt-tolerant grasses marsh, sea oxeye, saltwort-glasswort, saltmarsh cordgrass, and mangrove (NASA, 2010a, 2015).

The most recent land cover map for KSC identifies 31 cover types (Figure 3.9-2 and Table 3.9-2). Types 20 through 31 are wetlands and open waters:

<u>Wetlands – estuary, marsh, shrub, forest</u>

20. Estuary: includes the Indian River, Banana River, Mosquito Lagoon, Banana Creek, and connected navigable waters. Does not include waters that may be connected via underground culverts
21. Water - interior – salt: waters surrounded by dikes that may be connected to estuarine waters via underground culverts and other more isolated waters that are salt or brackish
22. Water - interior – fresh: isolated waters and drainage areas that may be inundated for only brief periods
23. Barren land - may be inundated: lowland areas devoid of vegetation that may be periodically inundated
24. Ditch: areas excavated for drainage
25. Marsh - saltwater : herbaceous wetlands that includes impounded and unimpounded systems. Species composition includes sand cordgrass (*Spartina bakeri*), black rush (*Juncus roemerianus*), salt-tolerant grasses (including saltgrass [*Distichlis spicata*], seashore paspalum [*Paspalum vaginatum*], and seashore dropseed [*Sporobolus virginicus*]), and other species
26. Marsh – freshwater: herbaceous wetlands that include beardgrass (*Bothriochloa laguroides*), sand cordgrass, sawgrass (*Cladium jamaicense*), cattail (*Typha* spp.), and other species
27. Mangrove: includes white mangrove (*Laguncularia racemosa*), black mangrove (*Avicennia germinans*), red mangrove (*Rhizophora mangle*), and buttonwood (*Conocarpus erectus*). Woody vegetation along dikes (classified as ruderal - woody) may contain mangroves along the inundated edge mixed with Brazilian pepper (*Schinus terebinthifolius*)

28. Wetland scrub - shrub – saltwater: vegetation composition consists of low height, generally less than 5 m, woody species include saltwort, glasswort, and other species
29. Wetland scrub - shrub – freshwater: vegetation composition consists of low height, generally less than 5 m, woody species including Carolina willow (*Salix caroliniana*) intermixed with other species
30. Wetland coniferous / hardwood forest: mix of conifers, primarily slash pine (*Pinus elliotti*), and assorted hardwood trees including laurel oak (*Quercus laurifolia*), Virginia live oak (*Quercus virginiana*), cabbage palm (*Sabal palmetto*), red maple (*Acer rubrum*), American elm (*Ulmus americana*), and bay (*Persea borbonia*); generally greater than 5 m tall, with interlocking canopy
31. Wetland hardwood forest: hardwood trees including red maple, American elm, laurel oak, live oak, cabbage palm, and bay, generally greater than 5 m tall, with interlocking canopy

3.9.1.2.1.2 Invasive Plants

Invasive species pose a significant threat to aquatic and wetland resources. Invasive species thrive in new habitats because they generally lack predators and other natural controls, they have reproductive adaptations which allow them to disperse successfully, they can tolerate and adapt to a variety of environmental conditions and they establish self-sustaining populations. Invasive species can threaten the diversity or abundance of native species and the ecological stability of the whole habitat. Invasive species displace native species by outcompeting natives for breeding sites, prey and other needed resources. They disrupt food webs, degrade habitats and alter biodiversity.

Many invasive aquatic and wetland plants produce abundant fruit and seeds that are widely dispersed and remain viable in the substrate for years. Wetland invaders differ from many upland invaders in that seeds are often dispersed via water; whole plants and plant fragments can be dispersed via flotation; they have abundant air tissue that protects belowground plant tissues from flooding and anoxic (depleted of oxygen) soils; and they can take up nutrients rapidly, allowing rapid growth (Zedler and Kircher, 2004).

A complete list of the introduced plant species at KSC can be found in Appendix D of NASA (2010a). Of the 231 introduced plants at KSC, 33 are Category I invasive exotics and 24 are Category II invasive exotics as indicated by the FLEPPC. Invasive exotic plants are termed Category I invasives when they are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives (FLEPPC, 2014). Category II invasive exotics have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species. These species may become Category I if ecological damage is demonstrated. Table 3.9-9 lists the Category I and II species that can be found in wetlands of KSC.

Table 3.9-9. Category I and II invasive wetland species at KSC

Category	Scientific Name	Common Name
I	*Casuarina equisetifolia*	Australian-pine, beach she-oak
I	*Casuarina glauca*	Suckering Australian-pine, Gray she-oak
I	*Colocasia esculenta*	Wild taro
I	*Eichhornia crassipes*	Water-hyacinth
I	*Imperata cylindrica*	Cogon grass

Category	Scientific Name	Common Name
I	*Ludwigia peruviana*	Peruvian primrose willow
I	*Lygodium microphyllum*	Old World climbing fern
I	*Melaleuca quinquenervia*	Melaleuca, Paper bark
I	*Melinis repens*	Natal grass
I	*Panicum repens*	Torpedo grass
I	*Pennisetum purpureum*	Napier grass, Elephant grass
I	*Pistia stratiotes*	Water lettuce
I	*Psidium cattleianum*	Strawberry guava
I	*Ruellia simplex*	Mexican petunia
I	*Sapium sebiferum*	Popcorn tree, Chinese tallow tree
I	*Schinus terebinthifolius*	Brazilian-pepper
I	*Urena lobata*	Caesar's weed
I	*Urochloa mutica*	Para grass
II	*Alternanthera philoxeroides*	Alligator weed
II	*Asystasia gangetica*	Ganges primrose
II	*Casuarina cunninghamiana*	River she-oak, Australian pine
II	*Melia azedarach*	Chinaberry
II	*Panicum maximum*	Guinea grass
II	*Sesbania punicea*	Purple sesban, Rattlebox
II	*Sphagneticola trilobata*	Wedelia
II	*Syagrus romanzoffiana*	Queen palm
II	*Talipariti tiliaceum*	Mahoe, Sea hibiscus

Note: Some species are found in both upland and wetland habitats.
Source: NASA, 2010a, 2015; FLEPPC, 2014

3.9.1.2.1.3 Special Status Plants

The Endangered Species Act of 1973 (PL-93-205) provides guidance regarding the management and protection of certain species based on determinations made regarding their relative ability to survive. The U.S. Fish and Wildlife Service is responsible for determining which species are listed as either Threatened or Endangered and for maintaining this listing. In addition, Section 7 of the statute provides for a consultation process between the Service and any federal agency that may, through one of its proposed actions, impact one of these species or their critical habitat.

The State of Florida also develops and maintains its own list of species suffering threats to populations and habitats. The FFWCC Endangered Species Coordinator is responsible for the review of species, designating their status and formally listing them in the State's Official List of Endangered and Potentially Endangered Fauna and Flora in Florida. This official list provides a comprehensive directory of the biota requiring special consideration in the State of Florida.

No federally listed plant species have been found to occur on KSC. Thirty-nine taxa occurring on KSC are listed as threatened, endangered, or of special concern on state lists (NASA, 2010a, 2015). Eleven of these are found in wetland habitats. Taxa of special concern occur in all major habitats, but many are restricted to hammocks and hardwood swamps that constitute a minor proportion of the wetland vegetation. Table 3.9-10 lists the special status species that occur in wetlands and Table 3.9-11 shows the habitat, population status, and threats for wetland special status species.

Table 3.9-10. Special status wetland plants of the KSC area, including adjacent federal property

Scientific Name	Common Name	USFWS[2]	FDA[1,3]	FCREPA[1,4]	FNA[5]
Avicennia germinans	Black mangrove			SP	
Encyclia tampensis	Butterfly orchid		C		
Epidendrum conopseum	Greenfly orchid		C		
Harrisella filiformis	Threadroot orchid		T		
Osmunda cinnamomea	Cinnamon fern		C		
Osmunda regalis var. *spectabilis*	Royal fern		C		
Pogonia ophioglossoides	Rose pogonia		T		
Rhizophora mangle	Red mangrove			SP	
Spiranthes laciniata	Lace-lip ladies'-tresses		T		
Tillandsia fasciculata	Common wild pine		E		
Tillandsia utriculata	Giant wild pine		E		

Sources: NASA, 2010a, 2015; FDACS, 2013; FNAI, 2014; Atlas of Florida Vascular Plants, 2014; NRCS, 2014

[1] Designated Status: E = Endangered; T = Threatened; SP = Special Concern; C = Commercially Exploited

[2] United States Fish and Wildlife Service. FC1 and FC2 indicate species that were formerly under consideration for listing.

[3] Florida Department of Agriculture and Consumer Services

[4] Florida Committee on Rare and Endangered Plants and Animals

[5] Florida Natural Areas Inventory.

Table 3.9-11. Common habitats of special status wetland plants of the KSC area, including adjacent federal property

Scientific Name	Habitat	Population Status	Threats to Existence
Avicennia germinans	Mangrove swamps	Common within habitat	Habitat loss, freezes
Encyclia tampensis	Hammocks, hardwood swamps - epiphytic	One small population	Habitat loss
Epidendrum conopseum	Hammocks, hardwood swamps - epiphytic	Two small populations	Habitat loss
Harrisella filiformis	Hardwood swamps - epiphytic	Unknown	Habitat loss
Osmunda cinnamomea	Hardwood swamps	Common within habitat	Habitat loss, collection
Osmunda regalis var. *spectabilis*	Hardwood swamps	Common within habitat	Habitat loss, collection
Pogonia ophioglossoides	Marshes and wet pine flatwoods	Unknown	Habitat loss
Rhizophora mangle	Mangrove swamps	Occasional within habitat	Habitat loss, freezes
Spiranthes laciniata	Marshes	Unknown	Habitat loss
Tillandsia fasciculata	Hammocks and hardwood swamps - epiphytic	Five small populations	Exotic insect, habitat loss
Tillandsia utriculata	Hammocks and hardwood swamps - epiphytic	Three small populations	Exotic insect, habitat loss

Source: NASA, 2010a, 2015

Seagrasses
During the last thirty years, attention has focused on the role of seagrasses in ecosystem productivity and the associated documentation of human influence on the worldwide decline in abundance and distribution. Numerous recreational and commercial fish found offshore spawn and grow in shallow seagrass beds. Seagrasses and submerged aquatic vegetation (SAV) are currently considered the ecological foundation of the IRL system (NASA, 2010a, 2015).

The decline of SAV in various estuaries has been attributed to increases in stormwater runoff associated with urbanization of watersheds, industrial discharges, agricultural herbicides, increased nutrient loads, suspended sediments, and other noxious discharges. Any factor that negatively influences the underwater light field has the potential to causes a major effect on production, biomass, and morphology.

Seagrass beds are found in varying sizes along the IRL shoreline (Figure 3.9-11). There are seven species with distributions that vary along the north-south axis of the IRL. All seven species occur in the southern third. Three of the seven (*Thalassia testudinum* and *Halophila johnsonii*, and *Halophila dicipiens*) are not found in the northern IRL where *Halodule wrightii*, *Syringodium filiforme*, *Ruppia maritima*, and *Halophila engelmannii* do occur. Primary production and habitat/species interactions research has been predominantly conducted in the southern part of the lagoon.

The seagrass beds in Mosquito Lagoon provide direct forage for marine turtles (*Chelonia mydas*) and manatees (*Trichechus manatus*). The Banana River portion of the study area supports fewer marine turtles but provides habitat for large numbers of manatees. Several studies have begun to explore the relationships between this large herbivore and its seagrass forage.

KSC began supporting baseline ecological studies in the 1970s in preparation for the space transportation system EIS and operations. In 1983, Brevard County and the Space Center began a cooperative project to set up transects in various seagrass beds that would provide ground truth sites to coordinate with aerial photography. The objective was to create a baseline dataset from each transect to provide descriptive information regarding species composition, percent cover, and frequency of occurrence. Collected over a long term, these data provide time series information for assessment of trends in seagrasses in northern IRL.

Assessments of long-term trends of seagrass beds in waters of KSC, using aerial photography from the 1940's through 2005 suggest little or no change in bed distributions. Analyses of field data from collected between 1983 and 1996 were conducted to assess local trends in more detail. These analyses included 8,150 samples collected along 37 shallow water transects. Species composition and percent cover were determined at 5-m intervals along each transects using a canopy-coverage technique originally developed for terrestrial systems.

Four seagrass species and one attached algae are typically the most commonly occurring submerged aquatic vegetation in KSC waters. The overall frequency of occurrence for each species, indicated the following dominance: *Halodule wrightii* (71.9%), *Ruppia maritime* (23.7%), *Syringodium filiforme* (9.4%), *Halophila engelmannii* (2.3%) and *Caulerpa prolifera* (5.4%). *H. wrightii* and *R. maritima* are represented on most transects. Temporal trends in percent cover for *H. wrightii* indicates a significant long-term decline. Variation in overall species composition and coverage appears to be linked to salinity trends. These data provide a benchmark that will be useful to researchers and managers in comparing trends observed elsewhere in the lagoon and determining if these are site specific or regional trends.

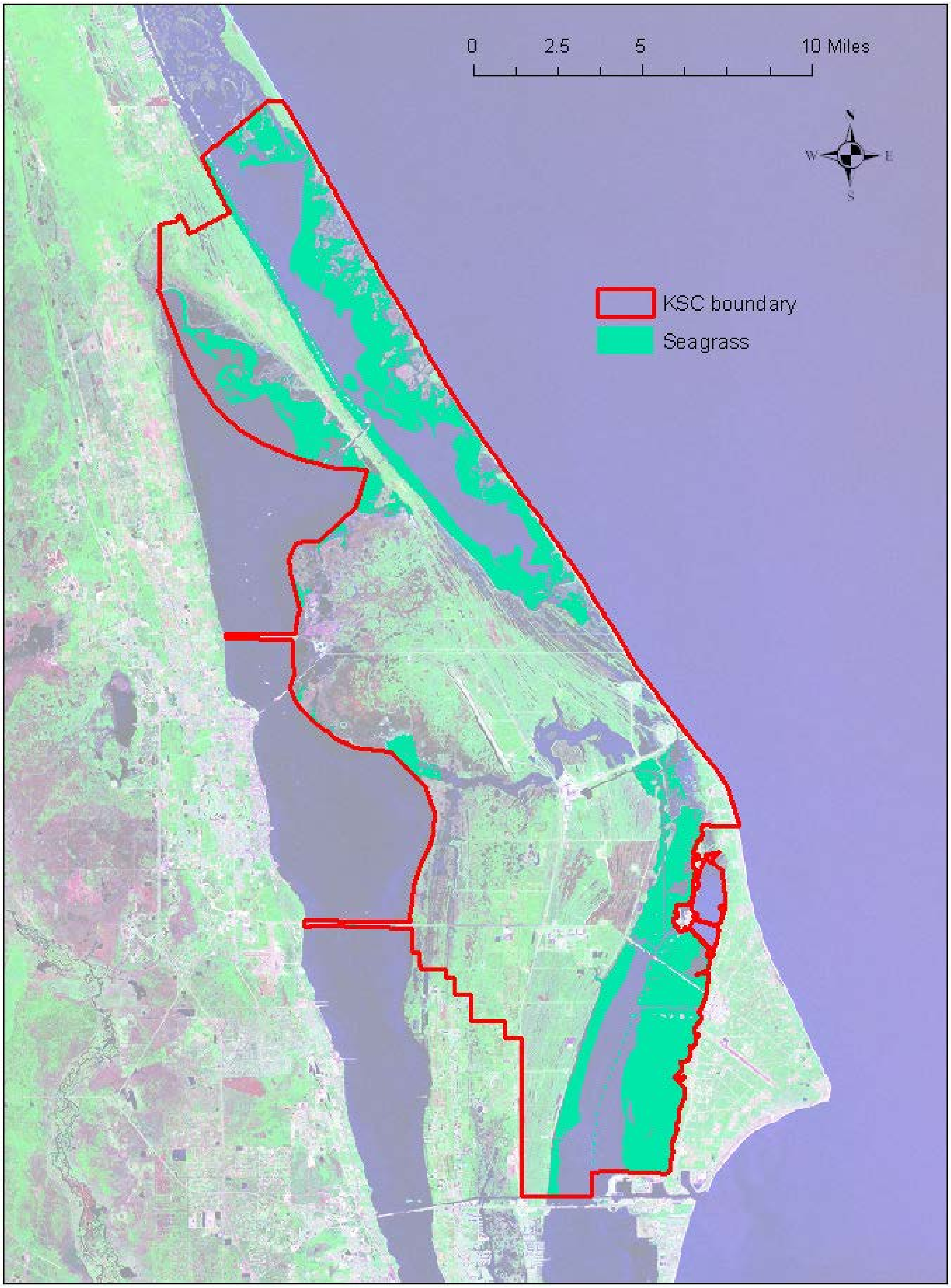


Figure 3.9-11. Seagrass beds at KSC prior to 2011
Source: NASA, 2015

3.9.1.2.2 Wildlife and Aquatic Biota

3.9.1.2.2.1 Native Species

Amphibians and Reptiles

The wetlands and waterways of KSC support a variety of amphibian and reptile species (Table 3.9-12) including the American alligator, sirens and other salamander species and a number of water snakes. The American alligator (*Alligator mississippiensis*) is federally listed as threatened only as a result of its similarity in appearance to the federally endangered American crocodile. The species is not regulated under Section 7 of the Endangered Species Act and is not in danger of becoming extinct. American alligators are abundant on MINWR, with an estimated population of over 3,000 individuals (NASA, 2010a, 2015).

Table 3.9-12. Amphibians and reptiles of KSC wetlands and waterways

Scientific Name	Common Name	Abundance as indicated by Sightings
Amphibians		
Salamanders		
Amphiuma means	two-toed amphiuma	rarely seen
Notophthalmus viridescens	red-spotted newt	common, but rarely seen
Siren intermedia	lesser siren	very common, but rarely seen
Siren lacertian	greater siren	very common, but rarely seen
Frogs		
Rana utricularia	southern leopard frog	commonly seen and heard
Pseudacris nigrita	chorus frog	rarely seen, commonly heard
Rana grylio	pig frog	rarely seen, commonly heard
Acris gryllus	cricket frog	rarely seen, commonly heard
Reptiles		
Snakes		
Nerodia clarkia	Atlantic saltmarsh snake	rarely seen
Nerodia fasciata	banded water snake	commonly seen
Nerodia floridana	green water snake	occasionally seen
Regina alleni	striped crayfish snake	common, but rarely seen
Turtles		
Caretta caretta	loggerhead	commonly seen while nesting
Chelonia mydas	Atlantic green turtle	occasionally seen while nesting
Chelydra serpentina	snapping turtle	occasionally seen
Deirochelys reticularia	chicken turtle	rarely seen
Dermochelys coriacea	leatherback sea turtle	rarely seen
Malaclemys terrapin	diamondback terrapin	rarely seen
Pseudemys peninsularis	Florida cooter	commonly seen
Kinosternon baurii	striped mud turtle	occasionally seen
Kinosternon subrubrum	common mud turtle	occasionally seen
Sternotherus odoratus	common musk turtle	occasionally seen
Apalone ferox	Florida softshell turtle	commonly seen

Figure 3.9-12. The southern leopard frog is commonly seen and heard at KSC

Birds
The extensive wetlands on KSC provide habitat for many species of aquatic birds, several of which are protected by State or Federal laws. The herons, egrets, ibises, and other birds in the Order Ciconiiformes are collectively called wading birds. Thirteen species of wading birds are year-round residents on KSC, and due to the large numbers of waders using the habitats here for feeding and nesting, KSC is crucial for the conservation of several species. The impounded saltmarsh habitat and shallow areas along the estuarine shorelines are extensively used by wading birds. While the roadside ditches and natural freshwater swales are not used by as many wading birds as are the impoundments, they are also an important component of the overall feeding habitat. This is particularly true in the winter (Oct. – Jan.), when the number of waders feeding in roadside ditches increases**.** KSC is also important for breeding sites for several species of wading birds including white ibis, great egret, snowy egret, and tricolored heron. For example, species and numbers of nests of wading birds were monitored yearly from 1987 through 2000, excluding 1991. The number of nests and islands used for nesting was variable between years with White Ibis nests accounting for 53% of the total nests counted (NASA, 2010a, 2015).

Reddish egrets and roseate spoonbills, two species of wading birds mostly found in the Caribbean and South America are found at the northern limits of their ranges in the KSC region. The reddish egret is a tropical heron that nests at only a few estuaries in Florida (Florida Bay, Tampa Bay and the IRL). Similarly, the roseate spoonbill has a limited range in Florida due to extirpations during the plume hunting era (around the late 1800s). The roseate spoonbill population on KSC has been expanding over the two decades since they have returned to nesting in the IRL. Roseate spoonbills were first documented nesting on KSC in 1987, and their numbers have increased steadily since that time. A study of foraging habitat preference by nesting Great and Snowy Egrets showed some evidence for a slight preference for impounded wetlands over other available wetland types on KSC. Brown pelicans and double-crested cormorants also frequently nest in the wading bird colonies in large numbers.

KSC also supports a large wintering waterfowl population, and hunting takes place each year on the MINWR portion from November through January for 25 days. Twenty-nine species of waterfowl have been documented on KSC, with 23 species regularly occurring, and one, the mottled duck, a year-round resident. Mottled ducks inhabit estuarine edges, impoundments, freshwater wetlands, and occasionally roadside ditches. Important waterfowl species wintering on KSC include: Blue-wing Teal, American Wigeon, Northern Pintail, Lesser Scaup, Redhead, Redbreasted Mergansers and Hooded mergansers. KSC and the adjacent estuarine areas support up to 2/3 of the Lesser Scaup wintering along the Atlantic Flyway (NASA, 2010a, 2015).

Other species of waterbirds which are important components of the KSC avifauna include the numerous shorebirds that migrate through and overwinter on KSC. These birds use the beaches and impounded wetland habitats. It has been estimated that as much as 5% of the Dunlin using the Atlantic flyway overwinter on KSC.

Several species of rails are found in the salt marshes on KSC. The black rail is perhaps the most important as an indicator of ecosystem health. This species is cryptic and little is known about its population status in Florida. It is noteworthy that the black rail inhabits habitat very similar to that which the now extinct dusky seaside sparrow preferred.

Mammals
Common mammals of KSC wetlands include the marsh rabbit, marsh rice rat, round-tailed muskrat and river otter (Table 3.9-13).

Table 3.9-13. Common mammals of KSC wetlands

Scientific Name	Common Name	Frequency
Sylvilagus palustris	Marsh rabbit	occasionally seen
Oryzomys palustris	Marsh rice rat	rarely seen
Neofiber alleni	Round-tailed muskrat	rarely seen
Lutra canadensis	River otter	occasionally seen

Fish
A variety of fish species utilize Merritt Island NWR. Paperno (2001) identified 132 fish species in the lagoon waters of the refuge. Surveys conducted in 1994 (Gilmore 1995) listed 782 fish species for east central Florida, with at least half of these using the Indian River Lagoon at HMP-28 some point during their life history. Fish species within the refuge are important not only to commercial and recreational interests, but also to the ecology of the area. Important fish habitat, such as fish spawning and fish settlement sites in the refuge, must be protected to ensure healthy, sustainable fish populations.

More than 140 species of freshwater and saltwater fish are known to use refuge estuarine areas, impoundments, and freshwater wetlands. Of the species known to occur in refuge waters, only one is a currently federal- or state-listed species, the smalltooth sawfish (E) would be suspected to occur, but rarely and in small numbers. Fish within the refuge are important not only to commercial and recreational interests, but also to the ecology of the area. The refuge protects important fish habitats, such as fish spawning and fish settlement sites, ensuring healthy, sustainable fish populations. The open water estuary habitat of the Indian River Lagoon is one of the most renowned sportfishing sites in the world (Roberts et al., 2001). This system is essential to several interjurisdictional and economically important fish species, including snook, tarpon, red and black drum, spotted seatrout, and striped mullet.

Invertebrates

A wide variety of marine and freshwater invertebrates are found within the Refuge's boundary. While some research has been conducted regarding benthic macro-invertebrates inhabiting the open estuary and select impoundments, no systematic survey has been performed for freshwater invertebrates of the refuge. The mangrove crab is found on the refuge and is listed by the Florida Committee on Rare and Endangered Plants and Animals. Some of the more common invertebrates include conchs, snails, oysters, land crabs, and dragonflies. A keystone species, the horseshoe crab (Limulus polyphemus) which generally inhabits estuarine areas of the refuge, has been in decline (Jane Provancha and Gretchen Ehlinger, Dynamac, Inc., personal communication). The reason for the decline in horseshoe crab abundance is currently unknown.

On KSC the vast majority of the estuarine wetlands have been impounded for mosquito control and isolated from the estuary since the late 1950s and 1960s (Figure 6-3). Salt marsh mosquitoes (*Aedes* sp.) need moist exposed substrate for oviposition sites and then flooding to produce a brood. The intertidal shorelines and tidal wetlands and marshes along the Indian River lagoon system (including the Banana River, and Mosquito Lagoon) are ideal for mosquito production. These conditions are present throughout the year with peak conditions occurring during the summer wet season, May-September (NASA, 2010a, 2015).

To control the salt marsh mosquitoes, managers can use chemical agents (pesticides) or use a biological control to interrupt part of the mosquito's life cycle. The portion of the life cycle easiest to interrupt is the oviposition site. This can be accomplished by either drying out and keeping dry the exposed moist substrate needed for oviposition, or by keeping this substrate flooded. In the 1950-1960s, mosquito control managers set about to control mosquitoes by interrupting the oviposition portion of the life cycle. To achieve this goal, the wetlands and exposed intertidal areas along the coastal and estuarine shorelines were impounded. This was done by digging steep ditches and using the excavated soil to build earthen dikes around the marshes. These areas were then flooded. This worked well for controlling mosquitoes; however, it removed not only tidal access, but any type of water connection between the estuary and the wetlands. These habitats that were once accessible to fish and macro-crustaceans were removed from the ecosystem which was changed dramatically. Beginning in the early 1980's the SJRWMD refocused their efforts into restoring these impounded saltmarshes in an attempt to regain those habitats for both fish and bird use.

The impoundment method of mosquito control had been effective in reducing the mosquito populations but at the same time, radically altered the saltmarsh habitat. Hypersaline and hyposaline conditions eradicated saltmarsh vegetation, freshwater input altered the saltmarsh habitat into a freshwater marsh type. Efforts now are focused on restoring these marshes and introducing normal connections to the Indian River Lagoon, primarily through water control structures. The initial restoration efforts focused on reconnecting impoundments using culverts placed in the dikes. This provided the flexibility to use these culverts to control water levels in the marshes if needed. The culverts had flapgates installed which allowed water to enter and exit the marsh, but could be closed if mosquito breeding increased. This method proved to allow better flushing of the marsh and allowed limited access to the marshes by fish. It became evident that keeping these culverts open did not create the mosquito populations that were expected. And it helped restore a more natural water quality condition in the marsh. However, this limited the access to the marsh to the culvert locations only.

Follow-on restoration efforts involved complete removal of the dikes that were constructed. This was accomplished by placing the fill material that had been dredged from the interior of the marsh, back into the perimeter ditch and leveling the dike areas down to existing marsh elevation. This allowed for natural inundation of the marsh. This method of marsh restoration has shown to be successful in both restoring natural hydrology to the marsh, as well as allowing natural recruitment of native saltmarsh vegetation, fish and wading bird populations. Over the past decade, NASA and the USFWS have reconnected over 1,072 acres of impoundments and restored over 564 acres of impoundments.

3.9.1.2.2.2 Special Status Species

Table 3.9-14 lists wetland wildlife at KSC with Federal and/or State protected status.

Table 3.9-14. Aquatic and transitional Federal and State protected wildlife of KSC

Scientific Name	Common Name	Level of Protection	
Fishes		**FEDERAL**	**STATE**
Acipenser brevirostrum	Shortnose sturgeon	E	E
Pristis pectinata	Smalltooth sawfish	E	E
Amphibians and Reptiles		**FEDERAL**	**STATE**
Alligator mississippiensis	American alligator	T(S/A)	SSC
Caretta caretta	Loggerhead turtle	T	T
Chelonia mydas	Atlantic green turtle	E	E
Dermochelys coriacea	Leatherback sea turtle	E	E
Eretmochelys imbricata	Hawksbill	E	E
Lepidochelys kempii	Kemp's ridley	E	E
Nerodia clarkii taeniata	Atlantic salt marsh snake	T	
Birds		**FEDERAL**	**STATE**
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
Mycteria Americana	Wood stork	T	T
Haliaeetus leucocephalus	Bald eagle	*	
Falco peregrinus	Peregrine falcon		E
Falco sparverius paulus	Southeastern American kestrel		T
Rostrhamus sociabilis plumbeus	Snail kite		E

Scientific Name	Common Name	Level of Protection	
Polyborus plancus audubonii	Crested caracara	T	T
Aramus guarauna	Limpkin		SSC
Grus canadensis pratensis	Florida sandhill crane		T
Charadrius melodus	Piping plover	T	T
Charadrius alexandrinus	Snowy plover		T
Haematopus palliatus	American oystercatcher		SSC
Sterna dougallii	Roseate tern	T	T
Sterna antillarum	Least tern		T
Rynchops niger	Black skimmer		SSC
Calidris canutus rufa	Rufa red knot	T	
Mammals		**FEDERAL**	**STATE**
Peromyscus polionotus niveiventris	Southeastern beach mouse	T	T
Podomys floridanus	Florida mouse		SSC
Trichechus manatus	West Indian manatee	E	E
Key: SSC = Species of Special Concern; T(S/A) = threatened because of similarity of appearance to another protected species; T = threatened; E = endangered. *The bald eagle is federally protected under the MBTA and BGEPRA			

Fish

In the U.S., the federally endangered smalltooth sawfish is found only in Florida, and is common only in the Everglades at the southern tip of the state. It can grow to 770 pounds, reach 20 feet in length, and live to 30 years. Like sharks, skates, and rays, sawfish have skeletons made of cartilage (NOAA, 2014c). The shortnose sturgeon is the smallest of the three sturgeon species found in eastern North America, growing to nearly five feet in length and up to 50 pounds. They are long-lived fish that are found in most major river systems and estuaries along the eastern seaboard of the U.S. Adults primarily feed on mollusks and large crustaceans (NOAA, 2014d).

Amphibians and Reptiles

KSC is home to three species of marine turtles that commonly nest on the beaches: loggerheads, green turtles, and leatherbacks. Kemp's ridley and hawksbill sea turtles also rarely occur and potentially nest here. Two species, loggerheads and green turtles, also occur in the KSC waters of the IRL (NASA, 2010a, 2015).

Sea Turtles

Harvesting of green turtles from the IRL began in about 1878, and early reports describe a turtle fishery that took many green turtles. Fishing for turtles was concentrated more in the south end of the system near Sebastian and Ft. Pierce, rather than in the lagoon near KSC. Green turtles were severely affected by commercial harvesting, and by 1895, captures of turtles from the IRL dropped sharply.

Three different sea turtle species annually nest along the nearly 10-kilometer stretch of refuge beach between March and September. These turtles include the federally threatened loggerhead sea turtle (*Caretta caretta*), federally endangered green turtle (*Chelonia mydas*), and federally endangered leatherback turtle (*Dermochelys coriacea*). The loggerhead (Figure 3.9-13) is the primary nesting turtle on the refuge with over 95 percent of the nesting and with previous annual averages of 1,300 nests (Popotnik and Epstein 2002). Green sea turtle nest numbers oscillate between 50 and 200 every other year. Leatherback sea turtles nest infrequently on the refuge beach, with only one or two nests recorded in a typical year.

Management for these species includes beach protection, NASA coordination efforts, nest monitoring during the nesting season, and predator control. Primary nest predators include raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), and ghost crabs (*Ocypode quadrata*). Nest depredation was greater than 90 percent of nests during the late 1970s before predator control (Llew Ehrhart, personal communication). Today, an active predator control program has reduced the depredation of nests well below an annual rate of 10 percent. In addition, the disorienting effects of artificial nighttime lights from NASA and U.S. Air Force facilities on nesting and hatchling sea turtles are a concern. NASA monitors this turtle disorientation annually. The refuge coordinates efforts with NASA and the Air Force to help reduce or eliminate the adverse effects of nighttime lighting on sea turtle nesting and hatchling disorientation.

Figure 3.9-13. Loggerhead sea turtle hatchlings

Beyond the nesting beaches, MINWR also provides a juvenile sea turtle nursery. Mosquito Lagoon is considered a developmental habitat for sub-adult loggerhead and green sea turtles. The lagoon once supported vast numbers of wintering juvenile sea turtles and an historic sea turtle fishery that extended into the 1960s, which was thought to contribute to the decline in population numbers. Turtles may remain in Mosquito Lagoon until maturity. Turtles wintering in the lagoon are plagued by winter freezes, which can cold-stun the animals and cause mortality. The refuge has developed a plan to coordinate the handling of cold-stunned turtles and prevent moralities. Monitoring of wintering sea turtles in the Mosquito Lagoon in the mid-1970s found higher numbers than presently found and an increase in sea turtle fibropapillomas (FP), a complex and disfiguring disease that causes tumors on the skin and which plagues sea turtles worldwide.

Documented historical evidence for marine turtles' occurrence in Mosquito Lagoon begins with an anecdotal statement that 150 green turtles were exported from Mosquito Lagoon in 1879. Scientific research on marine turtles in Mosquito Lagoon began in 1975. Four species were found in the area: green turtles and loggerheads were most common, but during five years of netting, two Kemp's ridleys and one hawksbill were also captured. Mosquito Lagoon is a nursery habitat for green turtles and loggerheads; the size classes present range from post-yearling to sub-adults. The capture rate for Mosquito Lagoon was 0.67 turtles/day; this rate is an order of magnitude lower than the capture rate near Sebastian Inlet, but greater than the 0.02 turtles/day reported for the northern section of the Indian River.

Information on marine turtles residing in Mosquito Lagoon was gathered opportunistically during cold-stunning events in 1977, 1978, and 1989. When the water temperatures fall below 8oC, marine turtles become lethargic and float to the surface, and can die if not rescued and rehabilitated. During the 1989 freeze, 246 green turtles and ten loggerheads were recovered from Mosquito Lagoon and nearby waters of the northern Indian River, representing the largest recorded cold-stunning event in this region. The relative abundance, distribution and status of the marine turtle population inhabiting Mosquito Lagoon are currently being assessed as part of EMB conservation and stewardship activities. Objectives are to compare the present-day population to baseline data collected in 1976-1979, to determine species ratios, population abundance, and genetic characteristics of marine turtles in the IRL.

Recent data indicate green turtles are more abundant than loggerhead turtles, the inverse of findings observed in the late 1970s. The observed sex ratio is skewed towards females and determined to be 94.4% for greens and 66.6 % for loggerheads. Catch per unit effort (CPUE), a standardized technique to compare sea turtle netting worldwide indicate that green turtles are much more abundant today than in the 1970's. Loggerhead captures indicate a slight decline in their numbers since the 1970's. Several turtles originally tagged in Mosquito Lagoon have been recaptured as far away as Cuba. DNA analyses revealed the presence of sea turtles originating from Florida, Mexico, Aves Island, Surinam and Costa Rica. This indicates the Mosquito Lagoon has a significant role in the sea turtle life cycle.

An additional difference between observations in the 1970s and current observations is the occurrence of fibropapillomatosis (FP). This debilitating disease is transmitted by a retrovirus that manifests itself as tumors. Tumors may grow to a considerable size, usually attached to soft-tissues such as the eyes and flippers. They may occlude the sea turtle's vision, potentially leading to starvation. Occasionally, recaptured individuals showed regression of FP tumors. FP was not observed in any green turtles in the 1970s in Mosquito Lagoon. Unfortunately, today 57 percent of the green turtles have FP tumors. FP is extremely rare in loggerhead sea turtles (NASA, 2010a, 2015).

Birds

Bald eagles are protected under the Bald and Golden Eagle Protection Act of 1940. Bald eagles arrive each year on KSC in the fall, nest during the winter, and leave KSC in early spring after the young have fledged. Records of bald eagle nesting have been kept on KSC continuously since 1978 by MINWR and/or FFWCC. The numbers of nests have increased steadily over the years, in keeping with the general recovery of bald eagle populations in the U.S. since the banning of the pesticide DDT. Between 1998 and 2009, the number of nests was 12, and the average number of known fledglings per year was 12. Eagle nest trees are protected from disturbance within zones of no activity or permitted-only activity. One nest located on KSC is very well known locally as it has been used almost continuously for at least 40 years. The nest measures 0.2 m (7 ft.) in diameter and is 3 m (10 ft.) deep. It is a regular stop for KSC tour buses, and has been equipped with video and still cameras during different time periods, providing an incredible up-close look at life in the nest.

The piping plover, a federally threatened bird is occasionally found using KSC beach habitat during migration. Least terns and black skimmers are two state listed species of beach nesting birds that also nest on gravel rooftops; colonies of these birds exist on KSC. Much of the natural beach and sandbar habitat for these birds is no longer suitable, due to habitat alteration and introduced or natural predators. In recent years most nesting attempts on KSC have occurred on rooftops. However, changing construction materials is causing most gravel rooftops to be replaced with other materials on KSC, thus reducing the available nesting habitat for these species.

The wood stork is federally listed as threatened. Long-term monthly monitoring of feeding sites on KSC began in 1987. Sites surveyed include a sample of mosquito control impoundments, a portion of the edge of the estuary and associated creeks, and a sample of roadside ditches. Results show that wading birds prefer feeding in open water over other available habitats, but will feed in marsh grasses, particularly when the water level is high. More detailed analysis of habitat preference showed that wading birds feeding in impounded salt marsh on KSC preferred areas within 1 m of the boundary between marsh vegetation and unvegetated open water. Wood stork nesting occurred in large numbers prior to 1985, and then again in smaller numbers from 1988 - 1990, but it has not been documented since 1990. However, wood storks do continue to use sites on KSC for feeding and loafing.

The rufa red knot (*Calidris canutus rufa*) is an occasional visitor to the KSC shoreline, mostly during migration. They have not been documented to nest in Florida. Their body shape and size is typical for the sandpipers: they have a small head and eyes, a short neck, a slightly tapering bill that is no longer than its head, and short dark legs. Their winter plumage as observed in Florida is uniformly pale grey, and it is similar between the sexes, in striking contrast to their bright breeding colors. The rufa red knot was federally listed as Threatened in 2014 (NASA, 2015).

The roseate tern (*Sterna dougallii*), listed as a federally protected Threatened species, is similar in size and appearance to several other tern species, although it is shorter-winged and has faster wing beats than other terns. Its thin sharp bill is black, with a red base that develops through the breeding season. Roseate terns do not nest in Florida and are present only during the winter or when they pass through during migration seasons.

Among special status bird species at KSC are wading birds, waterbirds, waterfowl, and shorebirds.

Mammals

The manatee (*Trichechus manatus*) (Figure 3.9-14) is federally listed as endangered. In 1977, KSC supported inventory actions to determine the abundance and distribution of the manatee throughout Florida including the KSC property. The surveys indicated that a large number of manatees were utilizing the same body of water that NASA intended to use for Space operations. As much as 15 percent of the total manatee population of the U.S. is located within the waters immediately surrounding KSC property. Monitoring the distribution and abundance manatees at KSC has been primarily performed through aerial surveys that have been funded by KSC intermittently from 1977- 1983 and almost continuously since 1984. Mean numbers of manatees observed in KSC waters during summer have fluctuated around 160 individuals. Since 1991, KSC aerial surveys have been conducted during cold periods in conjunction with the FFWCC's population census referred to as the Statewide Synoptic Survey.

Figure 3.9-14. The federally-endangered manatee abounds in the waters around KSC

The data collected are immediately shared with the FFWCC. The data have been shared with various agencies and universities, presented at scientific meetings and published in peer-reviewed journals. Data sets have been shared with FFWCC on many occasions over the years and more recent data were submitted (with restricted use) to FFWCC for their evaluation of speed zone regulations which were being developed. Data have also been shared with the public through invited presentations to environmental and educational audiences, marine industry groups, the Brevard County Commission, Marine Mammal Commission, and the USACE.

In 1990, to further protect this endangered species, the USFWS created a sanctuary for manatees covering the majority of the KSC section of the Banana River. The USFWS officially designated the following areas at KSC as Critical Habitat: (1) the entire inland section of water known as the Indian River, from its northernmost point immediately south of the intersection of U.S. Highway 1 and Florida State Road 3 (2) the entire inland section of water known as the Banana River, north of KARS park; (3) and all waterways between the Indian and Banana Rivers (exclusive of those existing manmade structures or settlements which are not necessary to the normal needs of survival of the species). Critical habitat and areas of manatee concentration are shown in Figure 3.9-15. KSC biologists also participate in the manatee-stranding network, for which dead and live standings are reported to FFWCC and USFWS agencies. Those agencies collect the animals, rehabilitate or file necropsy reports. Those data are maintained and archived by FFWCC.

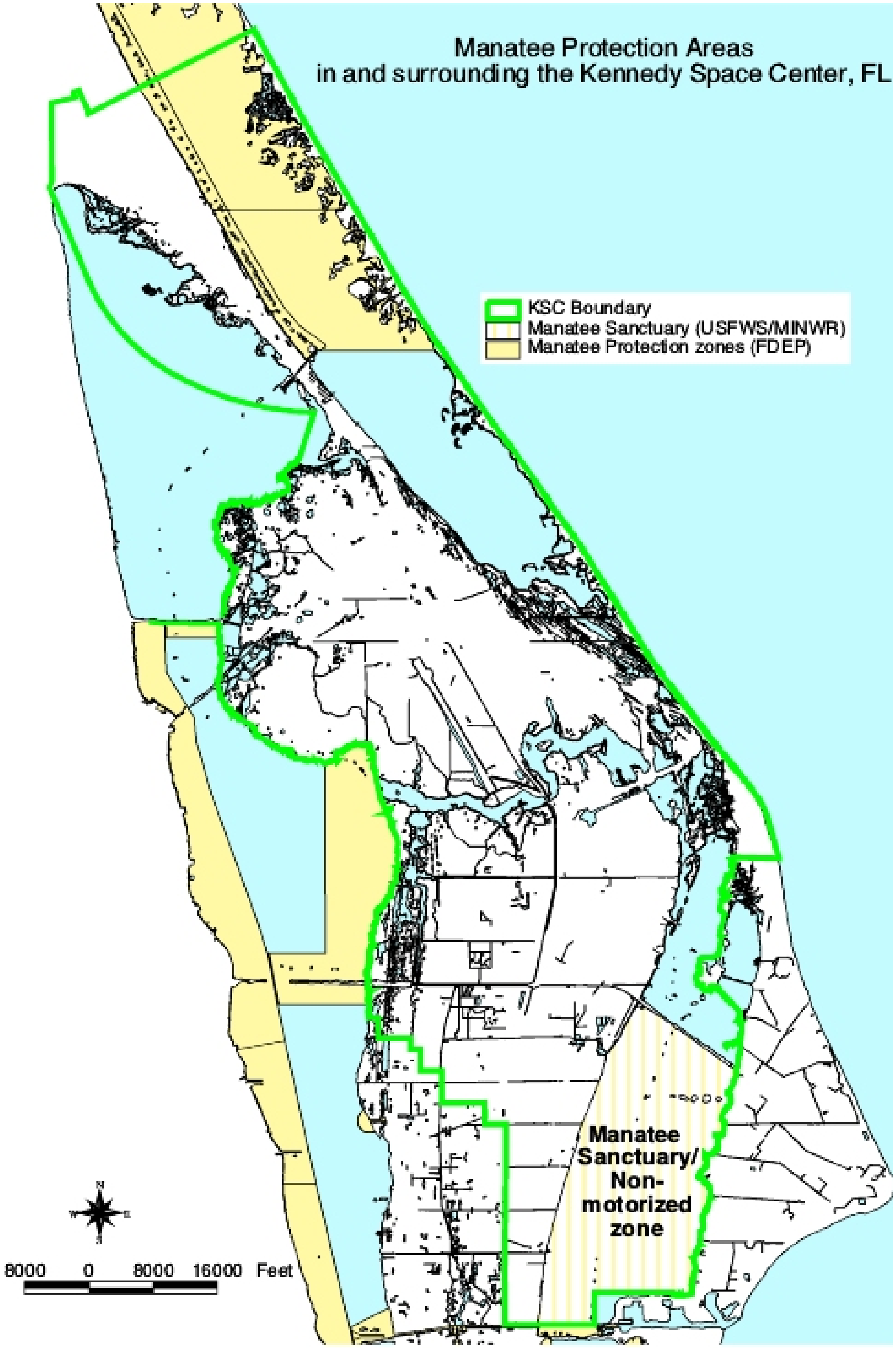


Figure 3.9-15. Manatee protection zones at KSC

3.9.1.2.2.3 Invasive Species

Raccoons are a native species that is common in most habitats on KSC, but particularly abundant near water sources of all kinds. Raccoons have been documented as predators on wildlife and eggs of any kind that are available to them. Although there are no historical data on raccoon densities on KSC, it is thought that populations may have become unnaturally high when mosquito control impoundments were built in the early 1960s. The sudden access to marsh interiors and all of the resources within them may have contributed to a raccoon population expansion. Raccoons are also an animal that coexists well with people and can flourish in situations that might inhibit population growth of other more sensitive species. In the 1970s, raccoons took nearly 100% of the marine turtle eggs that were deposited on the beaches of KSC, CNS, and CCAFS. This trend continued until the responsible agencies implemented various raccoon predation control strategies on their respective beaches. Raccoons have also been implicated in the apparent decline of diamondback terrapin populations on KSC because they have been observed eating adults and destroying nests to obtain eggs (NASA, 2010a, 2015).

3.9.2 Environmental Consequences including Cumulative Impacts

3.9.2.1 Terrestrial Environment – Vegetation

3.9.2.1.1 Proposed Action

3.9.2.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

Impacts of the Land Use Plan, Future Development Plan, and Functional Area Plans on upland vegetation are considered in this section. Actions from these plans that could affect upland vegetation include ground disturbing construction of:

- Vertical launch pads and landing areas
- Horizontal launch and landing areas
- Launch operations and support areas
- Assembly, testing, and processing areas
- Utility systems areas and corridors
- Administration facilities
- Central Campus facilities
- Support Services facilities
- Public Outreach facilities
- Research and Development facilities
- Renewable energy areas

The acreage of some land use areas would increase, while others would decrease (see Table 2.1-1). Overall, the effort to reduce NASA's footprint and consolidate operations into specific functional areas would reduce the total area of existing facilities. However, 6,279 acres that are currently part of the operational buffer, both public use and conservation components, and open space, would be allocated for other land uses. On these sites open space and native vegetation communities (both upland and wetland) would be lost to development (Table 2.1-1). Concentrations of functions and uses would occur in functional areas as listed in Section 2.1.5, which would minimize impacts to native upland vegetation over the long-term.

Native Plants

Ground disturbing construction activities would occur in some areas where vegetation has previously been disturbed, but activities would also occur in areas of relatively undisturbed, natural vegetation communities. In previously disturbed areas, adverse impacts on native upland vegetation would be considered minimal. Where disturbance of intact native plant communities may occur as a result of project activities, the impacts would be greater. The types of impacts are described below.

The use of heavy equipment for construction of facilities would be short-term during project activities, and the degree of vegetation impacts would depend on the community type and the areal extent of the project area. Some native trees, shrubs, and ground cover located in the project footprint may need to be cleared, which would cause long-term adverse impacts on existing vegetation. Loss of an individual or small number of members of a given plant species would not jeopardize the viability of the population in the area. Heavy equipment may also cause temporary disturbance and damage to plants in adjacent areas beyond the footprint of the project site; impacts to surrounding vegetation could be minimized by plainly demarcating site boundaries. The overall impact on vegetation would be reduced by concentrating the area of disturbance to the smallest area necessary to complete the project.

Repeated disturbance of vegetation (i.e., due to vehicle passes) during project activities in areas where plants are not cleared would cause damage to plants and destruction of the vegetation mat. There would also be localized vegetation trampling from foot traffic during project activities. Adverse impacts from trampling would be short-term as vegetation would be expected to recover over time.

Disturbance from construction may allow invasive plant establishment, soil erosion or compaction, a lessened litter layer, decreased soil microbial activity, reduced plant biomass and cover of native species, decreased reproductive success, changes in genetic structure of plant populations, and alteration of wildlife habitats. In order to minimize soil erosion, inhibit the establishment and propagation of invasive exotic plant species, and reestablish the natural vegetation community, disturbed project areas should be revegetated or reseeded with native plant species once construction is complete.

Impacts of proposed project activities on native upland vegetation would be short- term and long-term, direct, adverse, and negligible to moderate depending on whether the site is already disturbed or not, extent of the project area, and type of vegetation occurring onsite. Impacts on native upland vegetation would be less than significant.

Invasive Plants

Invasive plant species are generally found in disturbed soil conditions. Disturbed soil generally attracts infestation by fast-growing invasive weed species; thus any disturbed ground from construction activities would be susceptible to establishment and spread of invasive species. Disturbance events, such as construction activities, can increase weed-seed banks in the soils. Due to the longevity of the seed banks of weed species, any habitat that may be disturbed can promote weed growth.

Exotic plants or seeds could be brought to a project site with fill material, topsoil, or on heavy equipment. Heavy equipment, however, should be cleaned and weed-free before entering a project area. New introductions could allow for exotic plants to become established and spread. Exotic plants currently growing in the area can also become established and spread on newly disturbed substrates. Previously undisturbed habitats are highly susceptible to invasive plant infestations once disturbed. Non-native species could spread and become established, and their proximity to native vegetation communities would represent a threat to native habitats. Best Management Practices (BMPs) to ensure that imported material does not contain exotic plants or seeds should be implemented.

Impacts to native vegetation from introduction, establishment, and spread of invasive species due to project activities would be long-term, direct, adverse, and minor to moderate depending on the whether the site is already disturbed or not, extent of the project area, type of vegetation occurring onsite, and whether invasive plants and seeds can be prevented from introduction and establishment. Impacts of invasive upland plants would be less than significant. To ensure that impacts of invasive species do not surpass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

Special Status Plants

Human activities, development, and construction may affect special status species if the activities occur in habitats which the species utilize. Targeted surveys for presence of special status species should be conducted prior to the start of any project activities. In the event that protected plant species are observed in the project area, populations should be flagged for avoidance. Mitigation measures would be implemented as necessary to avoid impacting listed plants. If they can be avoided, adverse impacts on special status species would not be expected. If they cannot be avoided, similar impacts would occur as described above for native plants.

Where construction activities occur, special status plants many be directly impacted. Construction could alter the amount of habitat available for future colonization by special status plant species. Project actions that decrease the areal extent of habitat or increase cover of invasive species could lower the potential for special status species to colonize in the project area. This would be considered a long-term, adverse effect with the magnitude of impact depending on many site specific factors. Indirect impacts to special status species may occur through dispersal of invasive species from construction activities.

Impacts of proposed project activities on special status species would either not occur if they can be avoided, or would be short-term and long-term, direct and indirect, adverse, and minor to moderate depending on the plant’s state status, how many individuals or populations are impacted, and how much habitat remains intact for a special status species to use. Impacts on upland special status species would be less than significant.

3.9.2.1.1.2 Launch, Landing, Operations and Support

Impacts of Launch, Landing, Operations and Support on upland vegetation are considered in this section. Actions from this program that could affect upland vegetation include:

- Vertical launches and landings

- Horizontal launches and landings

Other activities associated with launches and landings, such as preparation for launch, safing operations, and payload operations would not affect vegetation as they would occur on already developed and hardened surfaces.

Native Plants

Vertical and horizontal launches may result in local adverse impacts on native upland vegetation. Such impacts would result from the deposition of rocket engine emissions (e.g., acids, various metals, and other substances based on the propellant type and characteristics) which would decrease the fitness of an affected local plant population, but would not likely result in the permanent removal or loss of a particular vegetative community (FAA, 2005).

Reduction in the number of plant species present and reduction in total cover may occur as a result of vertical and horizontal launches. Damage to vegetation is to be expected within a small radius of the launch pad due to scorching of vegetation within the path of the flames. Vegetation effects would differ by strata; shrubs and small trees may be eliminated by repeated defoliation more rapidly than forbs and graminoids (NASA, 2010a, 2015). The most severely impacted areas may eventually result in bare ground. However, regrowth is expected in periods without launches.

Due to the location of existing and proposed vertical launch pads, some launches may result in damage to the coastal dune community when the near-field zone extends across the dunes. Thin leafed herbaceous species and shrubs with succulent leaves are more sensitive to launch cloud deposits than are typical dune grasses (NASA, 2010a, 2015). Dune community species exhibiting sensitivity to launch cloud effects include camphorweed (*Heterotheca subaxillaris*), inkberry (*Scaevola plumieri*), beach sunflower (*Helianthus debilis*), and marsh elder (*Iva imbricata*). Dune species exhibiting resistance to launch cloud effects include sea oats (*Uniola paniculata*), beach grass (*Panicum amarum*), and slender cordgrass (*Spartina patens*), and sea grape (*Coccoloba unifera*). During periods without launches, vegetation recovery may be nearly complete within six months (NASA, 2010a, 2015).

Far-field deposition of acids and particulate matter from individual launches can produce damage to foliage of vegetation. Areas receiving 1000 mg/m^2 of chlorides would experience damage from acid etching of the leaves; sensitive species can be damaged by 100 mg/m^2 of chlorides (NASA, 2010a, 2015). No discernible vegetation damage appears to have been caused by particulate deposition in the past, so none is expected in the future. Far-field deposition may be sufficiently dispersed and variable from launch-to-launch that successive launches would seldom affect the same areas.

The deposition of launch vehicle (LV) stages (i.e., booster rockets), the landing of a reentry vehicle (RV), or launch failures in vegetative areas would result in an adverse impact on the localized vegetative community in the event that they are deposited on land rather than water. Plants may be damaged or killed by the impact of LV stages or RVs.

Overall, the effects of vertical and horizontal launches and landings on upland vegetation are expected to be short-term to medium-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of a particular vegetation community to the launch or landing site. Impacts on native upland vegetation would be less than significant.

Invasive Plants

Vertical and horizontal launches and landings would have similar effects on invasive species as described for Native Plants above. However, the reduction in number of plants and cover of invasive species would result in beneficial impacts instead of adverse, at least for the short-term. Previous studies found that the reduction in total species number included both loss of sensitive species and invasion of weedy ones, where losses exceeded new invasion (NASA, 2010a, 2015). This indicates that it is possible over the long-term for invasive species to become re-established, but perhaps at a slower rate.

The effects of vertical and horizontal launches and landings on invasive plants are expected to be direct, beneficial, and negligible to minor in the short-term to medium-term depending on the frequency of launches and landings and the proximity of invasive species to the launch or landing site. Over the long-term, invasive species could become established again. Impacts of invasive upland plants would be less than significant. To ensure that impacts of invasive species do not pass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

Special Status Plants

Vertical and horizontal launches and landings would have similar effects on special status species as described for Native Plants above. Unlike with construction activities, although surveys for special status species can be conducted in areas in close proximity to launch sites, impacts from launches to individuals or populations would not be avoidable. Additionally, the deposition of LV stages or the landing of an RV in areas with special status species would also be unavoidable, resulting in adverse impacts.

Previous studies found that the reduction in total species number as a result of launches included both loss of sensitive species and invasion of more weedy ones, where losses exceeded new invasion (NASA, 2010a, 2015). The loss of sensitive species, such as special status species, would likely occur more readily than their ability to re-establish.

The effects of vertical and horizontal launches and landings on special status species are expected to be long-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of listed populations to the launch or landing site. Impacts on upland special status species would be less than significant.

3.9.2.1.1.3 Future Transportation Plan

Impacts of the Future Transportation Plan on upland vegetation are considered in this section. Actions from this plan that could affect upland vegetation include:

- Road improvements, repair, and resurfacing
- Bridge replacement
- Parking lot repurposing or demolition

- Expansion of the Horizontal Launch and Landing capability with a new runway, facilities, infrastructure, and other airfield systems

Other actions in this plan that would impact upland vegetation would need separate NEPA analysis and would not be covered under this Programmatic EIS. These actions include development of railroads and seaports.

Native Plants
Activities that require construction, renovation, or replacement of facilities would have similar impacts on native upland vegetation as described for ground disturbing construction in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans. It is likely that actions such as road improvements or bridge replacement would impact road shoulders and other areas that have been previously disturbed, thus effects on native plant communities would be minimal. If construction occurs in larger areas of undisturbed native vegetation, such as building new runways, impacts would be much greater. Parking lot demolition would have beneficial effects if the site is then revegetated with native plants.

Impacts of proposed project activities on native upland vegetation would be short- term and long-term, direct, adverse, and negligible to moderate depending on whether the site is already disturbed or not, extent of the project area, and type of vegetation occurring onsite. Impacts on native upland vegetation would be less than significant. To ensure that impacts of invasive species do not pass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

Invasive Plants
Future Transportation Plan actions would have similar effects on invasive plants as described for ground disturbing construction in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans. Many actions would take place in already disturbed areas, such as roadsides, where invasive plants already likely occur. Thus impacts at such sites would not be as great as for the actions that would take place in undisturbed native communities (i.e., where runway construction may occur) where invasive plants could get established due to ground disturbance.

Impacts to native vegetation from introduction, establishment, and spread of invasive species due to project activities would be short-term and long-term, direct, adverse, and negligible to moderate depending on the whether the site is already disturbed or not, extent of the project area, type of vegetation occurring onsite, and whether invasive plants and seeds can be prevented from introduction and establishment. Impacts of invasive upland plants would be less than significant.

Special Status Plants
Surveys for presence of special status species should be conducted prior to the start of any project activities. In the event that protected plant species are observed in the project area, populations should be flagged for avoidance. Mitigation measures would be implemented as necessary to avoid impacting listed plants. If they can be avoided, adverse impacts on special status species would not be expected. If they cannot be avoided, similar impacts on special

status species would occur as described for ground disturbing construction in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans.

Impacts of proposed project activities on special status species would either not occur, or would be short- term and long-term, direct and indirect, adverse, and minor to moderate depending on the plant's state status, how many individuals or populations are impacted, and how much habitat remains intact for a special status species to use. Impacts on upland special status species would be less than significant.

3.9.2.1.1.4 Cumulative Impacts

Upland vegetation at KSC has been, and continues to be, cleared and/or disturbed for such purposes as construction of roads, facility development, launches, recreation, and wildfire, fire suppression, and prescribed fire. These activities involve removal, trampling, or destruction of vegetation; disturbance of ground cover; and introduction of invasive species. Many of these actions also contribute to soil compaction and erosion, making it more difficult for native plant species to re-inhabit an area after disturbance. Additionally, pressure from increasing human presence includes trampling of vegetation due to pedestrian traffic and concentrated areas of foot traffic which removes vegetation and fragments habitat and vegetative populations. Beneficial effects also occur from hazard fuel reduction and habitat improvements achieved by prescribed fire.

Some upland vegetative damage may occur from occasional brush fires and/or heat from launches and wet deposition in the near-field areas. The loss of tree and shrub species and an increase of grass and sedge species may occur. Far-field vegetation should recover between launches since far-field deposition would not occur in the same area after each launch.

Adverse upland vegetation impacts associated with proposed actions would be minor as compared to cumulative past, present, and foreseeable future effects. Cumulative impacts from the Proposed Action alone would vary with the nature and extent of projects, but impacts would be expected to be minor and adverse.

When considered in context of the two other large reasonably foreseeable projects described in Section 3.2, the Shiloh Launch Complex on the northern edge of KSC and the Port Canaveral Rain Extension in the southern portion of it, these conclusions as to cumulative impacts may change. While detailed impacts of both Shiloh and the rail extension are not yet available, both would require the clearing of non-trivial amounts of native upland vegetation and habitat. When all three projects (KSC master plan, Shiloh, rail extension) are considered in combination, cumulative impacts on upland vegetation may shift from minor and adverse to moderate and adverse (noticeable change in a resource occurs, but the integrity of the resource remains intact), but they would still not likely be major or significantly adverse (substantial impact or change in a resource area that is easily defined, noticeable, and measurable, or exceeds a standard).

3.9.2.1.2 Alternative 1

The direct, indirect, and cumulative impacts of Alternative 1 on vegetation would be similar to but less than the Proposed Action, because the two proposed new seaports would not be built. Overall losses of vegetation and habitat would be 1,100 acres less than in the Proposed Action.

3.9.2.1.3 No Action Alternative

Under the No Action Alternative, upland vegetation would not be affected by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Effects on upland vegetation from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. Thus the No Action alternative would not have any additional impacts on upland vegetation.

3.9.2.2 Wetlands Vegetation

3.9.2.2.1 Proposed Action

3.9.2.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

Impacts of the Land Use Plan, Future Development Plan, and Functional Area Plans on wetland vegetation are considered in this section. Actions from these plans that could affect wetland vegetation include ground disturbing construction of:

- Vertical launch pads and landing areas
- Horizontal launch and landing areas
- Launch operations and support areas
- Assembly, testing, and processing areas
- Utility systems areas and corridors
- Administration facilities
- Central Campus facilities
- Support Services facilities
- Public Outreach facilities
- Research and Development facilities
- Renewable energy areas
- Seaport facilities

The acreage of some land use areas would increase, while others would decrease (see Table 2.1-1). Overall, the effort to reduce NASA's footprint and consolidate operations into specific functional areas would reduce the total area of existing facilities. However, 6,279 acres that are currently part of the operational buffer, both public use and conservation components, and open space, would be allocated for other land uses where native vegetation communities (both upland and wetland) would be lost to development (Table 2.1-1). Concentrations of functions and uses would occur in functional areas as listed in Section 2.1.5, which would minimize impacts to native wetland vegetation over the long-term.

However, construction of two new seaports under the Proposed Action – one on Banana Creek (a tributary of the Indian River Lagoon) and one on the Banana River just south of the Exploration Park and Industrial Functional Areas (see Figure 2.1-3 for a more detailed map) –would take place in wetlands and waters of the U.S. (see Figure 2.1-1 and Figure 3.9-2), occupying 286 additional acres, much or most of which is wetlands. Unless mitigated, this would constitute a permanent, adverse, medium-scale, moderate to major, potentially significant impact on wetlands and waters of the U.S. However, under its Section 404 Clean Water Act permitting authority, the U.S. Army Corps of Engineers would require avoidance or compensatory mitigation for construction (dredging and filling) in wetlands on this scale, which would reduce impacts to below the level of significance.

Native Plants

The activities that require ground disturbing construction would have similar impacts on wetland vegetation as described in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans for native upland plants. However, wetlands can be very sensitive to disturbance and have a greater likelihood of slow recovery compared to the adjacent uplands. It is likely that many wetland areas at KSC that would be impacted by project activities have not been previously disturbed. If construction activities affect disturbed wetlands or those with an abundance of invasive species, then the adverse impacts on native wetland vegetation would not be as great.

Permanent wetland loss occurs when wetlands are converted to upland or to developed areas (buildings, launch pads, seaports, etc.). Temporary impacts occur when material is placed in wetlands to create access and storage for construction, and then removed when construction is complete. Vegetation clearing adjacent to wetlands may also be considered a permanent impact. Indirect impacts to wetland vegetation include increased sedimentation and erosion from construction; increased pollution in runoff, which reduces the water quality of wetland habitats; and increased potential for invasive species introduction in areas where native vegetation is disturbed. These indirect effects could result in changes to native wetland species composition, species diversity, and habitat characteristics.

Impacts to wetlands and wetland vegetation would be mitigated by the use of BMPs to reduce erosion and sedimentation during construction activities. These practices include minimizing the length of time bare soil is exposed, along with timely reseeding and mulching. In addition, construction and maintenance of portable and long-term sediment and surface-water retention features would further reduce the potential for erosion and sedimentation. Landscaping within and near wetlands would include the planting of native species.

NASA would try to keep unavoidable wetland impacts within the threshold of the USACE and state-issued required permits. Mitigation would be needed to compensate for unavoidable wetland loss. This could include purchase of credits from a wetland mitigation bank, a monetary compensation for wetland loss, or wetland restoration or preservation.

Except potentially in the case of the two seaports described above, impacts of proposed project activities on native wetland vegetation would be short- term and long-term, direct and indirect, adverse, and minor to moderate depending on the extent of the project area and whether or not the wetland has been previously disturbed. Impacts are likely to become negligible to minor with mitigation. Impacts on native wetland vegetation would be less than significant.

Invasive Plants

The activities that require ground disturbing construction would have similar impacts on wetland invasive species as described in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans for upland invasive plants. It is likely that many wetland areas at

KSC that would be impacted by project activities have not been previously disturbed. Previously undisturbed habitats are highly susceptible to invasive plant infestations once disturbed. Invasive species can outcompete native wetland vegetation, making wetlands less habitable for wildlife and decreasing native plant diversity. If construction activities affect disturbed wetlands or those with an abundance of invasive species, impacts from invasive species would be lower.

Many wetland invaders, including those found at KSC, form monotypes which alter habitat structure, lower biodiversity (both number and "quality" of species), change nutrient cycling and productivity (often increasing it), and modify food webs (Zedler and Kircher, 2004). Wetlands are landscape sinks, which accumulate debris, sediments, water, and nutrients, all of which facilitate invasions by creating canopy gaps or accelerating the growth of opportunistic plant species. These and other disturbances to wetlands create opportunities that wetland invasive plants take advantage of.

Impacts of proposed project activities on invasive wetland vegetation would be long-term, direct, adverse, and minor to moderate depending on whether the site is already disturbed or not, extent of the project area, type of vegetation occurring onsite, and whether invasive plants and seeds can be prevented from introduction and establishment. Impacts on invasive wetland vegetation would be less than significant. To ensure that impacts of invasive species do not pass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

Special Status Plants

Surveys for presence of special status species should be conducted prior to the start of any project activities. In the event that protected plant species are observed in the project area, populations should be flagged for avoidance. Mitigation measures would be implemented as necessary to avoid impacting listed plants. If they can be avoided, adverse impacts on special status species would not be expected. If they cannot be avoided, similar impacts on wetland special status species would occur as described in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans for upland special status species.

Impacts of proposed project activities on special status species would either not occur, or would be short- term and long-term, direct and indirect, adverse, and minor to moderate depending on the plant's state status, how many individuals or populations are impacted, and how much habitat remains intact for a special status species to use. Impacts on wetland special status species would be less than significant.

3.9.2.2.1.2 Launch, Landing, Operations and Support

Impacts of Launch, Landing, Operations and Support on wetland vegetation are considered in this section. Actions from this program that could affect wetland vegetation include:

- Vertical launches and landings
- Horizontal launches and landings

Other activities associated with launches and landings, such as preparation for launch, safing operations, and payload operations would not affect vegetation as they would occur on already developed and hardened surfaces.

Native Plants

Launch and landing activities would have similar impacts on wetland vegetation as described in Section 3.9.2.1.1.1.2 Launch, Landing, Operations and Support for native upland plants. These impacts include decrease in the fitness of affected local wetland plant populations, reduction in the number of plant species and total cover, vegetation damage, and vegetation loss. However, wetlands can be very sensitive to disturbance and have a greater likelihood of slow recovery compared to the adjacent uplands.

In addition, chemical deposition from launch clouds would have adverse impacts on water quality and soils in wetlands, as described in Sections 3.3 and 3.4, which would lead to indirect adverse impacts on wetland vegetation from contamination or water and soil, such as alteration of metabolism and disruption of photosynthesis resulting in loss of vigor and mortality.

Overall, the effects of vertical and horizontal launches and landings on wetland vegetation are expected to be short- to medium-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of a particular wetland community to the launch or landing site. Impacts on native wetland vegetation would be less than significant.

Invasive Plants

Vertical and horizontal launches and landings would have similar effects on invasive species as described in Section 3.9.2.1.1.1.2 Launch, Landing, Operations and Support for invasive plants. However, the reduction in number of plants and cover of invasive species would result in beneficial impacts, at least for the short-term, as invasive plants are eliminated. Additionally, contamination of water and soil from chemical deposition from launch clouds could kill or stunt invasive wetland plants as it would native wetland plants; however, this would also be an indirect beneficial effect.

The effects of vertical and horizontal launches and landings on invasive plants are expected to be direct, beneficial, and negligible to minor in the short-term depending on the frequency of launches and landings and the proximity of invasive species to the launch or landing site. Over the long-term, invasive species could become established again. Impacts of invasive wetland plants would be less than significant. To ensure that impacts of invasive species do not pass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

Special Status Plants

Vertical and horizontal launches and landings would have similar effects on special status species as described in Section 3.9.2.1.1.1.2 Launch, Landing, Operations and Support for special status plants. Unlike with construction activities, although surveys for special status species can be conducted in areas in close proximity to launch sites, impacts from launches to individuals or populations would not be avoidable. Additionally, the deposition of LV stages or the landing of an RV in wetlands with special status species would also be unavoidable, resulting in adverse impacts. Also, as discussed above for Native Plants, chemical contamination of wetland water and soil from launch cloud deposition would also be detrimental to special status species.

The effects of vertical and horizontal launches and landings on special status species are expected to be long-term, direct, adverse, and minor to moderate depending on the frequency of launches and landings and the proximity of listed populations to the launch or landing site. Impacts on wetland special status species would be less than significant.

3.9.2.2.1.3 Future Transportation Plan

Impacts of the Future Transportation Plan on wetland vegetation are considered in this section. Actions from this plan that could affect wetland vegetation include:

- Road improvements, repair, and resurfacing
- Bridge replacement
- Parking lot repurposing or demolition
- Expansion of the Horizontal Launch and Landing capability with a new runway, facilities, infrastructure, and other airfield systems

Other actions in this plan that would impact upland vegetation would need separate NEPA analysis and would not be covered under this Programmatic EIS. These actions include development of railroads and seaports.

Native Plants
The activities that require ground disturbing construction, renovation, or replacement of facilities would have similar impacts on wetland vegetation as described in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans for native upland plants. It is likely that actions such as road improvements or bridge replacement would impact road shoulders and other areas that have been previously disturbed, thus effects on native wetland plant communities would be minimal. If construction occurs in larger areas of undisturbed wetland vegetation, such as building new runways, impacts would be much greater.

Impacts of proposed project activities on native wetland vegetation would be short- term and long-term, direct, adverse, and negligible to moderate depending on the whether the site is already disturbed or not, extent of the project area, and type of vegetation occurring onsite. Impacts on native wetland vegetation would be less than significant.

Invasive Plants
Future Transportation Plan ground disturbing actions would have similar effects on invasive plants as described in Section 3.9.2.1.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans for invasive plants. Some activities would take place in already disturbed areas, such as wetlands around bridges where invasive plants already likely occur. Thus impacts at such sites would not be as great as for the actions that would take place in undisturbed native communities where invasive plants could get established due to ground disturbance.

Impacts to native vegetation from introduction, establishment, and spread of invasive species due to project activities would be long-term, direct, adverse, and minor to moderate depending on the whether the site is already disturbed or not, extent of the project area, type of vegetation occurring onsite, and whether invasive plants and seeds can be prevented from introduction and establishment. Impacts of invasive upland plants would be less than significant. To ensure that impacts of invasive species do not pass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

Special Status Plants

Surveys for presence of special status species should be conducted prior to the start of any project activities. I n the event that protected plant species are observed in the project area, populations should be flagged for avoidance. Mitigation measures would be implemented as necessary to avoid impacting listed plants. If they can be avoided, adverse impacts on special status species would not be expected. If they cannot be avoided, similar impacts on wetland special status species would occur as described in Section 3.9.2.1.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans for special status plants.

Impacts of proposed project activities on wetland special status species would either not occur, or would be short- term and long-term, direct, adverse, and moderate depending on the plant's state status, how many individuals or populations are impacted, and how much habitat remains intact for a special status species to use. Impacts on wetland special status species would be less than significant.

3.9.2.2.1.4 Cumulative Impacts

Wetland vegetation at KSC has been, and continues to be, cleared and/or disturbed for such purposes as construction of roads, facility development, launches, recreation, and prescribed fire. These activities involve removal, trampling, or destruction of vegetation; disturbance of ground cover; and introduction of invasive species. Many of these actions also contribute to soil compaction and erosion, making it more difficult for native plant species to re-inhabit an area after disturbance. Prescribed fire has had beneficial effects as well as it was used along with water management to improve the quality of wetlands. Some vegetative damage may occur from heat from launches and wet deposition in the near-field areas. Far-field vegetation should recover between launches since far-field deposition would not occur in the same area after each launch.

Adverse wetland vegetation impacts associated with proposed actions would be minor as compared to cumulative past, present, and foreseeable future effects. Cumulative impacts from the Proposed Action would vary with the nature and extent of projects, but impacts would be expected to be minor and adverse.

Considered in combination with the other two major projects described in Section 3.2 – the Shiloh Launch Complex the Port Canaveral Rail Extension – the "minor and adverse" determination would not change, because both of these would be constructed predominantly on upland sites, and have at most indirect effects on wetland vegetation.

3.9.2.2.2 Alternative 1

Overall, the direct, indirect, and cumulative impacts of Alternative 1 on wetland vegetation would be similar to but somewhat less than those of the Proposed Action, because the two proposed new seaports would not be built under Alternative 1. Thus, the wetland vegetation at these two proposed seaport sites on Banana Creek and the Banana River would remain unchanged and the impacts associated with the construction and operation of these facilities would be avoided.

The other consequences described above in Section 3.9.2.2.1 under the various actions associated with the Land Use Plan, Future Development Plan, Future Transportation Plan, Functional Area Plans, and Launch, Landing, Operations and Support would be the same.

3.9.2.2.3 No Action Alternative

Under the No Action Alternative, wetland vegetation would not be affected by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Effects on wetland vegetation from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. Thus the No Action alternative would not have any additional impacts on wetland vegetation.

3.9.2.3 Impacts to Upland Wildlife

3.9.2.3.1 Proposed Action

Actions that could affect upland wildlife species under the Proposed Action alternative include:

- Consolidation of administrative facilities at a central campus which would require:
  - Demolition of unused structures and restoration of those sites
  - Site preparation and construction of new facilities at the new site
- Creation or expansion of the site footprints for a broad array of functions including:
  - Assembly, Testing and Processing
  - Central Campus
  - Horizontal Launch
  - Horizontal and Vertical Landing
  - Launch Operations and Support
  - Operational Buffer/Conservation
  - Operational Buffer/Public Use
  - Public Outreach
  - Renewable Energy
  - Research and Development
  - Seaport
  - Utility Systems
  - Vertical Launch

Impacts to terrestrial wildlife under the Proposed Action would be caused by loss or restoration of wildlife habitat, changes in habitat quality caused by fragmentation or human disturbance, injuries and mortalities caused by vehicles and equipment on roads, parking areas and construction sites, and the heat, noise, and chemical launches and landings of spacecraft.

3.9.2.3.1.1 Construction and Transportation Impacts

Habitat losses would be caused by clearing and conversion of currently occupied wildlife habitat to one of the land uses that would not support habitat as listed in Table 3.9-15. For example, any of the 1,419 acres planned to be added to the Assembly, Testing and Processing function, that currently supports habitat for terrestrial wildlife species would be lost to those species when site clearing for construction is undertaken. Overall the largest loss of habitat stemming from the proposed changes in land use would result from conversion of up to 4,406 acres of operational buffer/conservation and 1,874 acres of open space to other land uses. This total of 6,280 acres would constitute some 7.3 percent of the future non-water land uses at KSC, making it a substantive but likely minor, adverse, long-term impact on KSC habitats in general for wildlife species whose populations are currently well-distributed and not stressed by other factors across KSC.

Table 3.9-15. Existing and proposed future land uses at KSC

Land Use	Existing Acreage	Future Acreage	Change in Acreage*
Administration	104.76	40.72	**-64.03**
Assembly, Testing and Processing	475.41	1,894.77	**1,419.36**
Central Campus	NA	138.75	**138.75**
Horizontal Launch and Landing	501.25	2,838.84	**2,336.94**
Launch Operations and Support	398.75	506.14	**107.39**
Open Space	1,873.64	NA	**-1,873.64**
Operational Buffer/Conservation	44,583.14	40,196.94	**-4,386.20**
Operational Buffer/Public Use	34,844.14	34,824.72	**-19.42**
Public Outreach	216.01	522.13	**306.12**
Recreation	161.36	161.36	**0.00**
Renewable Energy	66.54	1,109.85	**1,043.31**
Research and Development	88.36	867.49	**779.13**
Seaport	30.92	317.26	**286.34**
Support Services	723.91	471.40	**-252.51**
Utility Systems	1,327.23	1,329.60	**2.37**
Vertical Launch	360.32	536.42	**176.10**
Vertical Landing	NA	75.73	**75.73****
Water	55,541.81	55,541.81	**0.00**
Total	**141,297.54**	**141,297.54**	**0.00**

*Total difference in size between each existing land use category and future land use category. Numbers in red represent a future land use category that is **SMALLER** than its existing category while numbers in green signify that the future land use category contains a **LARGER** amount of acres than its existing land use category.
**Difference in Total Acreage is due to addition of Vertical Landing category, which lies within same geographical footprint as Horizontal Launch and Landing Category.

Habitat quality changes would result where new facilities are sited in previously unbroken areas of uniform habitat. Fragmentation would be greatest where linear features such as roads or pipeline/cable rights-of-way are cut through larger areas of relatively uniform habitat. These transects change the nature of the habitat so as to introduce human disturbance through a substantial portion of the habitat, reduce the size of the available habitat patches below the preferred patch size of an animal's home range for foraging or reproductive success, and facilitate the introduction of invasive plants and animals. An example of the latter is the invasive cowbird that becomes a more effective brood parasite on songbirds when unbroken forested areas are transected by roads.

Some benefit would be derived in terms of habitat recovery as well as improvements in habitat quality from reducing the footprint of Administration facilities and Support Services facilities which would result in a net gain of 317 acres of unused land that could be restored to wildlife habitat. As noted in Chapter 2 under the Centerwide Strategy, the consolidation of NASA operations into a smaller geographic footprint is a major component of the Future Land Use Plan. Applying the Central Campus concept, for example, will allow NASA to recapitalize, over time, functions and capabilities into more efficient facilities on a smaller footprint and combine once spread-out non-hazardous functions into a smaller, more efficiently secured geographic footprint.

Wildlife habitat not directly affected in clearing for construction or road or other facilities building would be affected to the extent that wildlife species in nearby uncleared habitats would be subject to human disturbances in the short term during construction and in the longer term by continuing disturbance from vehicle noise and exhaust as well as human voices, car alarms, and other related human sounds. Some species are not greatly affected by these types of disturbances and would not diminish in number in those adjacent habitats. Other species might find these locations unacceptable habitats and move off to other areas, competing with the current con-specific occupants. These effects would occur wherever new ground is broken for construction at any location on KSC which is currently not already fully developed.

Protected Species

Special status terrestrial species may be adversely affected by the land use changes under the Proposed Action. Of primary importance in evaluating impacts in KSC upland areas, including scrub habitats and beaches, are the federally protected Eastern indigo snake and Florida scrub-jay, the southeastern beach mouse, piping plover, and Roseate tern. The wood stork, bald eagle and manatee are discussed later under wetlands impacts and protected seas turtles under marine biota impacts.

The southeastern beach mouse, federally listed as a threatened species as well as a State of Florida species of special concern, mainly lives along the primary coastal dunes of the Merritt Island National Wildlife Refuge, Canaveral National Seashore, and CCAFS (USFWS, 1999a). Activities associated with the Proposed Action would occur inland on KSC, away from coastal dunes. Therefore, the Proposed Action would not be expected to affect the southeastern beach mouse.

Non-native and invasive wildlife

Non-native and invasive wildlife species may be adversely affected by loss of some habitat as described above for general wildlife species. Any reduction in non-native or invasive species numbers would likely be a benefit to native species, and in particular, any that have special protected status. Many invasive species may benefit from habitat disturbance and the presence of human development so their numbers may slightly increase due to new construction. Consolidation of administrative facilities may somewhat offset this potential increase.

3.9.2.3.1.2 Launch Impacts

During future spacecraft launches, short-term disturbance would occur in the immediate vicinity of the launch pads, but the disturbance would be short-lived and wildlife fatalities would not be common. Because of the location of the pads and the size of the area (35 miles in length) NASA operations as well as those of private entities would likely have minimal effects on wildlife.

Biologists at MINWR have studied the impacts of rocket launches on wildlife for years. The biological impacts of shuttle launches have been documented since the beginning of the program. Through the 30-year flight history of the Space Shuttle Program there were 135 launches, 82 from Pad 39A and 53 from Pad 39B. The shuttle SRBs were the largest solid rocket motors ever built and flown. Each contained 498,950 kg of propellant. The propellant consisted of an aluminum (Al) powder fuel (16%), ammonium perchlorate as an oxidizer (69.9%), a 100 catalyst of iron oxidizer powder (0.07%), a rubber-based binder of polybutadiene acrylic acid acrylonitrile (12.04%), and an epoxy curing agent (1.96%). Each SRB produced approximately 2,650,000 pounds of thrust at sea level. The exhaust from the SRBs was directed northward from the launch pads by the split flame trench (Anderson and Keller 1983). The exhaust was composed primarily of aluminum, hydrogen, nitrogen, carbon, oxygen, and chloride compounds.

At each launch pad, a sound suppression water system was utilized to protect the shuttle and payloads from damage by acoustical energy reflected from the mobile launch platform during launch. The system consisted of an elevated 2,006,050 l (530,000 gal) tank and associated plumbing that includes a system of six large rain birds and 16 nozzles above the flame deflectors. At approximately 12 seconds prior to launch, the system was activated, initiating a 25 to 30 second dump of the entire water system (NASA, 1978; NASA, 1983). The system also contained an overpressure suppression system consisting of two compartments. A water spray system provided a cushion of water that is routed directly into the flame hole beneath each booster. This was supplemented by a series of water hammocks stretched across each hole in the mobile launch platform. This dual system provided a 26,495 l (7,000 gal) water mass to dampen the pressure pulse resulting from ignition of the SRBs. At launch minus 12 seconds, the sound suppression system was activated, starting flow of water onto the launch pad and structure. At minus nine seconds, the three shuttle main engines were ignited and throttled toward full power. At zero the two SRBs were ignited. The initial blast hit the sound suppression hammocks and water that had been pouring onto the pad, instantly vaporizing and atomizing it.

The resulting mixture of deluge water, debris, and exhaust chemicals exploded from the flame trench at a velocity of approximately 85-100 meters per second. As the shuttle rose from the launch pad, the exit velocity and percent of SRB exhaust exiting the flame trench decayed to zero. At this point, the exhaust ground cloud formation ceased and column cloud formation predominated. Exhaust effluent can follow three paths:

- **Near-field –** wet exhaust deposited north of the flame trench resulting from the SRM ignition and initial blast,
- **Far-field –** wet deposition that “rains out” of the ground cloud as it rises, cools and drifts from the pad on prevailing winds,

- **Column-cloud –** dry particulate and HCl gas that did not entrain water from the deluge and sound suppression system that disperses with prevailing winds.

The near-field deposition consisted primarily of the Al_2O_3 particulates, HCl liquid, H_2O, and sand, shell fragments and other materials such as metals entrained into the exhaust cloud from the pad surface by the SRB blast. HCl deposition was heavy in the near-field zone 101 causing small fish kills in shallow water areas and vegetation damage as a result of the low pH.

Cumulative vegetation damage from repeated launches included loss of woody species, loss of sensitive species, and increased bare ground. During times of no launches recovery of vegetation occurred. Soil surface chemistry was altered by the HCl neutralization process that dissolved calcium and magnesium carbonates. Waters and soils in the area have high buffering capacity and typically returned to pre-launch pH levels within 96 hours. Fish repopulated the area from adjacent areas of no impact and vegetation re-sprouts if the launch frequency was low enough to allow for it. Launch frequencies as high as 40 per year were projected (NASA, 1978, 1979). If these had been achieved, there would have been a reduction in soil buffering capacity, plants would not have time to re-sprout or recolonize the area and impacts would have been more severe. This would result in loss of vegetation cover, exposing bare soil.

Far-field deposition displayed no impacts other than periodic spotting on plant leaves. There is much uncertainty associated with projecting impacts from higher launch rates. Current data and observations indicate the shuttle launch rate that was achieved had no substantial ecosystem impacts. An ongoing ecological risk assessment is being conducted to quantify possible metals impacts to the local food chain. Alligators, sea turtles, gopher tortoises, sport fish, manatees, southeastern beach mice, and other species continue to utilize the area (NASA, 2010a, 2015).

Soils and Upland Habitat Effects
Impacts of future spacecraft launches at KSC would likely be concentrated in the near-field impact zones north of each launch complex. Acute impacts of the acid ground cloud on the terrestrial environment near the launch pads would likely include: alteration of the vegetation community structure and species composition and changes in soil chemical characteristics.

In the Shuttle Program cumulative impacts in the most frequently exposed area north of LC39A through STS-9 included reduction in the number of plant species present and reduction in total cover; the reduction in total species number included both loss of sensitive species and invasion of more weedy ones, but losses exceeded new invasion. Vegetation effects differed by strata; shrubs and small trees were eliminated by repeated defoliation more rapidly than forbs and graminoids. The community level effects consisted of retrogressive changes. These changes continued until launches ceased in 1986 with an increasing amount of bare ground in the most severely impacted area. Considerable regrowth occurred in the period without launches. Resumption of launches in September 1988 initiated another retrogressive sequence. Similar changes have occurred at LC39B (NASA, 2010a, 2015).

Some launches result in damage to the coastal dune community when the near-field zone extends across the dunes. Thin leafed herbaceous species and shrubs with succulent leaves, are more sensitive to launch cloud deposits than are typical dune grasses. Dune community species exhibiting sensitivity to launch cloud effects include camphorweed (*Heterotheca subaxillaris*), inkberry (*Scaevola plumieri*), beach sunflower (*Helianthus debilis*), and marsh elder (*Iva imbricata*). Dune species exhibiting resistance to launch cloud effects include sea oats (*Uniola paniculata*), beach grass (*Panicum amarum*), and slender cordgrass (*Spartina patens*), and sea grape (*Coccoloba unifera*). Within six months vegetation recovery is nearly complete. Impacts to the dunes are infrequent, and cumulative changes in vegetation have not occurred.

Far-field deposition from individual launches can produce damage to foliage of vegetation. Areas receiving 1000 mg/m2 chlorides experience damage from acid etching of the leaves; sensitive species can be damaged by 100 mg/m2 chlorides. Far-field deposition is sufficiently dispersed and variable launch-to- launch that successive launches seldom affect the same areas. No changes in plant community composition or structure due to cumulative effects of far-field deposition have been seen.

Overall, the effects of vertical and horizontal launches and landings on upland wildlife habitat are expected to be direct, adverse, localized, short-term to medium-term, and minor to moderate, depending on the frequency of launches and landings.

Wildlife

Acute impacts of Shuttle launches to wildlife populations at KSC appear minimal with the majority of birds being able to flee the pad area in a fright response to the ignition of the shuttle main engines seven seconds prior to the ignition of the SRBs. On occasion some individuals are caught in the exhaust blast and are killed or injured. Examples of species observed include armadillo, marsh rabbits, snowy egret, killdeer, frogs, and alligators. Because injured animals tend to hide in burrows or dense vegetation, the number may be greater than observed. To date no federally listed threatened or endangered species have been directly identified as being killed as a result of the launch event (NASA, 2010a, 2015).

Based on half a century of observation of impacts from past launches, including the three-decade shuttle program, the program of launches that would take place under the Proposed Action would also not likely incur substantial impacts on upland ecosystems, including wildlife populations. Overall, the effects of vertical and horizontal launches and landings on upland wildlife are expected to be direct and indirect, adverse, localized short-term to medium-term, and minor to moderate depending on the frequency of launches and landings and the proximity of given wildlife species to the launch or landing site.

Terrestrial Plants and Animals

The exhaust heat and atmospheric deposition of emissions associated with the launch and operation of a reusable suborbital rocket has the potential to harm nearby vegetation. Vegetation around launch areas is regularly mowed, and although heat and emissions could result in localized vegetation scorching and spotting, similar effects from other rocket launches have been shown to be temporary and not of sufficient intensity to cause long-term damage to the vegetation (USAF, 1998, 2006; NASA, 2004a). There could be some temporary distress to nearby vegetation from launch emissions, resulting in a minor short-term impact, but no long-term adverse effects would be expected.

The greatest effects on terrestrial wildlife occur from collisions with aircraft and from visual and noise disturbances during launch activities. Although the KSC is considered a low-volume airfield, supporting less than 10,000 aircraft operations annually, its location within the Merritt Island National Wildlife Refuge and its proximity to a variety of upland and wetland habitats poses the potential for a bird strike hazard. However, because the Proposed Action would not vastly increase the number of launches at KSC, an adverse impact on wildlife from potential collisions would not be expected.

During launch activities, birds in the immediate area could be startled and flee the site for a short time; however, the continued presence of sea and shore birds at KSC demonstrates that launches have had little lasting effects on these species. In addition, terrestrial animals might suffer startle responses and be subject to temporary displacement during launch activities. While initially startling to wildlife, animals generally adapt to over-flight activities by changing their behavior and responses, and the overall effects appear to be negligible (USAF, 1998). Furthermore, launch activities would not be expected to significantly affect local wildlife populations.

Special Status Species
In the Shuttle Program environmental reviews, two taxa – the Florida scrub-jay (*Aphelocoma coerulescens*) and the wood stork (*Mycteria americana*) were given special consideration due to possible impacts that may result from the extreme noise levels near the pads at the time of launch. Low frequency noise levels in the 145-160 dB range have been measured near the launch pads. The Florida scrub-jay, a species listed as threatened by the U.S. Fish and Wildlife Service, inhabits scrub vegetation in the vicinity of the two launch pads. After launch, observations were made of the behavior of individuals and their responses to alarm calls. To date no acute effects have been documented. Given this record, the Florida scrub-jay is unlikely to be significantly affected by periodic launches associated with the Proposed Action.

The wood stork nested at the Bluebill Creek Rookery approximately 750-800 m (0.47-0.50 mi) south of Pad 39A. During three nesting seasons, observations of nesting success were conducted at the colony to document possible adverse effects resulting from launch noise or acid deposition. It was speculated that the high noise levels, fright response, or acid deposition on eggs might interfere with some aspect of nesting success. Wood storks were flushed from their nests on several launches with most individuals returning within four minutes. Nests that could be easily seen from boats showed production of two to three young and no evidence that launches reduce nest success. It is plausible that some egg or chick losses were undetected but these are unlikely to have been significant to the species. In December 1989, a severe freeze damaged the black mangroves (*Avicennia germinans*) in which the storks nested. These trees deteriorated in subsequent years and became unsuitable for stork nesting. During the period of observation, success of wood stork nesting at the Bluebill Creek site continually declined, with total failure during the 1992 nesting season. Given the loss of mangroves from the freeze, this decline in nesting could not be associated with launches (Schmalzer et al., 1993).

Essential feeding and nesting habitat for the federally listed threatened wood stork is widespread in the region. Impacts to the wood stork during Space Shuttle launches were examined in 2003 and while a startle response was noted during the launch, within 10 minutes the colony appeared to be functioning normally and no young were observed to be injured or killed from startle effects. Site visits made before and after the launches did not indicate any obvious adverse effects (KSC, 2003). Wood stork colonies could be susceptible to detrimental effects if the flight path of a rocket strayed within 500 feet of the colony. However, the flight path of reusable suborbital rocket launches from the Shuttle Landing Facility would not be expected to stray within 500 feet of a colony.

Overall, given this history of observations, it is unlikely that that future launches associated with the Proposed Action would prevent the reestablishment wood stork nesting in the vicinity or have a detectable adverse effect on the local wood stork population.

Protected Species and Habitat
Two protected bird species, five protected reptiles or amphibians, and two protected mammals have the potential to be affected by future launches and reentries. Although both commercial and NASA launches and reentries under the Proposed Action could cause short-term effects on these species, the launches would not be likely to adversely affect the long-term well-being, reproduction rates, or survival of any of these species. Based on the location of the launch area, the other protected species would not be expected to be affected by the Proposed Action.

In the FAA's regular review of licenses for launch and reentry as well as its review of applications for an experimental permit that proposes to launch from the Shuttle Landing Facility at KSC, the FAA would coordinate with NASA in determining if there is a need to further consult with either USFWS or NMFS based on any new activities proposed by the applicant. The FAA would similarly coordinate with NASA regarding any need to further consult with the appropriate State agency regarding any applicable requirements for State listed protected species and habitat. If potential impacts are identified, the FAA would consult with the appropriate agencies to develop any mitigation measures that may be warranted, as described in Chapter 4 of this PElS. On NASA-initiated launches, NASA will coordinate with USFWS and NMFS.

Bird Species
Essential feeding and nesting habitat for the federally listed threatened Florida scrub-jay is widespread in the region. A noise survey in 1990 assessed the noise levels in Florida scrub-jay habitat during a Titan 34D launch at CCAFS. Although no conclusions were drawn from the field data, ongoing observations of the scrub-jay have not indicated any adverse impact. In addition, there have been studies of reproductive success and survival of Florida scrub-jays in the area surrounding the CCAFS former Titan launch pads. The studies did not identify acute or obvious direct impacts to the scrub-jay from the Titan launches (KSC, 2003).

The state listed least tern has also been known to nest near launch pads at KSC. Individual launches may disturb or startle a few individual terns due to noise and vibration levels associated with the Proposed Action. These impacts would be temporary and would be limited to individual birds close to the launch site during launch activities. Impacts on least terns would be expected to be similar to that of scrub-jays.

Amphibians and Reptiles
The federally listed threatened Atlantic salt marsh snake and eastern indigo snake are present at KSC and the Merritt Island National Wildlife Refuge. The Atlantic salt marsh snake inhabits coastal salt marshes and mangrove swamps, while the eastern indigo snake prefers open undeveloped habitat (USFWS, 1999a). Because the Proposed Action would primarily occur on developed inland areas of KSC, launches would not be expected to affect the Atlantic salt marsh snake, which would not likely be found around operational areas. Since the eastern indigo snake

utilizes a wider range of habitat types than the Atlantic salt marsh snake, it is possible that this species could be present around operational areas at KSC.

3.9.2.3.2 Alternative 1

Overall, the direct, indirect, and cumulative impacts of Alternative 1 on upland wildlife would be very similar to those of the Proposed Action.

3.9.2.3.3 No Action Alternative

Under the No Action Alternative, upland wildlife would not be affected directly or indirectly by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Effects on upland wildlife from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. Thus the No Action alternative would not have any additional impacts on upland wildlife.

3.9.2.4 Impacts to Wetlands and Aquatic Wildlife

3.9.2.4.1 Proposed Action

Construction of facilities, roads or other improvements would not be done within wetlands if at all possible. The exception to this general rule is the construction of the two seaports on Banana Creek and the Banana River discussed above. Up to 286 acres of wetland habitat on KSC could be eliminated permanently if these two seaports were constructed; this would directly and indirectly, adversely affect wildlife dependent on wetland habitat for foraging, resting, cover, nesting, or as a nursery (in the case of some juvenile fish). In any case, there would be no construction in wetlands without first determining that such construction is unavoidable and not until a Section 404 permit is issued by the U.S. Army Corps of Engineers allowing such construction. Any wetland losses would be mitigated as appropriate.

Wetlands would be indirectly affected by soil particles suspended in rainfall runoff from newly developed sites. This would contribute to increased turbidity and loss of productivity for aquatic vegetation. Turbidity could adversely affect the reproduction and foraging success of fishes and other aquatic organisms that rely on relatively clear waters for those purposes.

Protected Wetland Species
The bald eagle, though no longer listed under the endangered species act remains protected under the Bald and Golden Eagle Act as well as the Migratory Bird Treaty Act.

Impacts to estuarine biota in general would occur if changes in land use involving land clearing and construction of new facilities caused an increase in runoff of petroleum products from vehicles and equipment, other chemicals such as herbicides used for site clearing or maintenance, or suspended soil particles thereby causing degradation of water quality that ultimately reaches estuarine organisms in the long term. As noted in Section 3.4 on Water Resources, water quality has been impaired and aquatic vegetation and wildlife in the Indian River Lagoon has suffered mortality in recent years due to that impairment. While no other components of the Proposed Action would likely contribute incrementally toward that impaired condition, the two proposed seaports, in contrast, raise both water quality and lagoon habitat (and related wildlife) concerns. These would have to be addressed in site- and project-specific NEPA compliance documentation and Section 404 permitting analysis with the USACE at such time as a specific proposal were to be put forward.

Protected Marine Species
The federally listed threatened Atlantic loggerhead sea turtle, and the federally listed endangered Atlantic green sea turtle and leatherback sea turtle are found along KSC beaches. Sea turtle activities, including nesting, along KSC, Merritt Island National Wildlife Refuge, and Canaveral National Seashore beaches would not be expected to be affected by daytime launch activities. Facility lighting associated with nighttime launches could disorient sea turtles and hatchlings, and cause them to move in the wrong direction, away from the ocean. Such occurrences could be prevented by implementing a light management plan, as appropriate (USAF, 1998, 2006; NASA, 2004a).

Impacts to protected marine biota would occur if activities under the proposed action affected the eggs of sea turtles that use the beaches at KSC to deposit their eggs. These impacts are highly unlikely to occur because the nesting of endangered sea turtles is monitored and nest predators are controlled.

3.9.2.4.1.1 Launch Impacts

Aquatic Habitat and Fish Impacts
In the Shuttle Program, cumulative impacts in the most frequently exposed area north of LC39A through STS-9 included short-term depression of surface water pH, short-term alteration of water chemistry, and kills of small fish in shallow water areas north of the launch pads (NASA, 2010a, 2015).

For many launches, a fish kill occurred in the shallow surface waters of the lagoon (Pad 39A) or impoundment (Pad 39B) immediately north of each launch complex in line with the SRB flame trench. This fish kill is the direct result of the surface water acidification that often exceeds 5 pH units. The rapid drop in pH produced severe damage to the gill lamella of fish exposed to the near-field launch deposition. Field surveys conducted after each launch have indicated that this event is generally limited to the shallow shoreline closest to the pad and the stormwater ditches leading away from the north side of the pad surface. At Pad 39A the fish kill appears limited to a band of shallow water approximately 10 m wide (the 0.5 m depth contour). In deeper, open water, fish apparently dive below the area of acidification avoiding the rapid drop in pH. At Pad 39B, the fish kill may cover a larger area and involve a larger number of individuals, because the impoundment water depth is generally less than 0.5 m year round, and the fish are not able to avoid the rapid drop in pH. In every event, the fish kill occurs in direct relation to the spatial pattern of the near-field deposition footprint.

Species observed after almost every launch included the rainwater killifish (*Lucania parva*), mosquito fish (*Gambusia holbrooki*), sheepshead minnow (*Cyprinodon variegatus*), and sailfin molly (*Poecilia latipinna*). The numbers of individuals observed after each launch were highly variable, depending on such factors as deposition pattern, seasonal water depths, and seasonal reproductive activity (presence of large numbers of juveniles). These species are aggressive invaders of open habitats and begin to recolonize the area within several days after each launch. This rapid immigration is possible because only a small portion of the larger contiguous population is actually impacted. Also, these species are tolerant of a wide range of environmental conditions and are extremely prolific, making them ideally suited for life in the shallow brackish waters around the pads. Other taxa that have been observed less frequently have included mullet (*Mugil cephalus*), sheepshead (*Archosargus probatocephalus*), black drum (*Pogonias cromis*), needle fish (*Strongylura* spp.) lady fish (*Elops saurus*) and red drum (*Sciaenops ocellatus*) (NASA, 2010a, 2015).

Most suborbital rockets would use propellants that emit H_20, HCl and CO. Surface-water monitoring conducted for large launch systems at KSC and other launch facilities has shown that the emissions from rocket engines have not had a long -term effect on basic water chemistry or resulted in alterations of the aquatic vegetation (NASA, 2004a; USAF, 2006). The continued classification of the Indian River Lagoon system as one of the richest and most productive estuarine faunas in the continental United States demonstrates that launches from KSC have had little lasting effects on aquatic plants and wildlife. Acidification and impacts to marine aquatic wildlife would not be expected in the nearby Atlantic Ocean because emissions and fluids would be neutralized by sea salt and quickly diluted in the open ocean (NASA, 2004a; USAF, 1998). Therefore, the impacts of atmospheric deposition from launch emissions on aquatic vegetation and wildlife would be expected to be negligible.

The risk of operations at KSC affecting or taking a marine mammal would be extremely low. A take would only occur if a reusable suborbital rocket failed or a projectile fell on a marine mammal. Such events would be very unlikely. In addition, no notable adverse impacts to fish or essential fish habitat surrounding KSC would be expected, because ocean currents would rapidly dilute any emission deposition that entered the water.

Overall, launches at KSC under the Proposed Action would likely continue to have recurring, short-term, localized to medium, minor to moderate adverse impacts to aquatic habitats and fish for the duration of the Center Master Plan. These impacts would not be significant because aquatic habitats and wildlife have proved resilient in the face of these environmental stresses over the past 50 years.

3.9.2.4.2 Alternative 1

Overall, the direct, indirect, and cumulative impacts of Alternative 1 on wetland and aquatic wildlife would be similar to but somewhat less than those of the Proposed Action. Because the two new seaports on Banana Creek and the Banana River would not be constructed and operated under Alternative 1, those particular impacts associated with the Proposed Action would be avoided.

3.9.2.4.3 No Action

Wildlife and aquatic species would continue to be affected to a negligible to minor degree from continuation of activities at KSC under the No Action Alternative, but the impacts discussed above under the Proposed Action would not occur. Activities that would continue under the No

Action alternative that constitute a background contributor to the current status of wildlife and aquatic species at KSC are noted here.

Under the No Action Alternative, the total land and water area under jurisdiction of KSC would remain at approximately 140,000 acres. Of this total area, about 85,000 acres would continue to be owned by NASA and the remaining 55,000 acres by the State of Florida and dedicated for the exclusive use of the U. S. Government under Deeds of Dedication. The acreage remaining under permit to the Merritt Island National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service, would not change. This entire 140,000-acre area, in association with adjacent water bodies, would continue to serve as buffer zones to afford adequate safety to the surrounding civilian communities for vehicle launches and other KSC activities. A portion of the seashore on the eastern edge of the Center would continue to be available for public recreation purposes on a non-interference basis. It is further assumed that the KSC workforce would remain a total of 13,100, of which approximately 2,100 are employees of the federal government, and the remainder employees of companies working under contract to NASA or other federal agencies.

The environmental, social, and economic conditions described as the affected environment would not be affected by construction or operations as described under the proposed action alternative. Existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Individual actions proposed from the Proposed Action or any of the alternatives may proceed but would have to do so after environmental assessment under separate environmental documentation.

Land Use

Under the No Action Alternative, current land uses and their configuration at KSC would remain unchanged for the duration of the 20-year planning horizon (2012-2032). Existing land uses are shown in Figure 2-3. The same land use classifications are used to describe the primary activity of all existing facilities and associated land areas as are used in the Proposed Action above.

Transportation

Under the No Action Alternative, the existing KSC transportation system would remain essentially unchanged except for routine maintenance.

Environmental Remediation

Under the No Action Alternative, the numerous sites known to have been environmentally contaminated by past practices would continue to be monitored and remediated proportional to available funding. Development in environmental remediation areas would be avoided in favor of unencumbered sites. Environmental baseline studies documenting existing conditions and identification of any past contamination would be carried out by NASA prior to allowing any new uses to develop or redevelop KSC property and facility sites. Any new users would accept liability for their future activities, outlined in a corresponding commercial agreement.

Launch, Landing, Operations and Support

Under the No Action Alternative, KSC would continue to use a variety of areas around the Center for the vertical launch and landing of vehicles. In general, vertical launch and landing of NASA missions and non-NASA commercial missions under the No Action Alternative would take place at a reduced rate or frequency (launches/landings per year) from that anticipated under the Proposed Action.

Under the No Action Alternative, in contrast to the Proposed Action, no new construction would occur at both the south-field and mid-field sites along the SLF.

All existing vehicles that currently launch and/or land at KSC (and are listed and described under the Proposed Action) would continue to do so under the No Action Alternative, and at current levels of activity.

KSC would continue to use a variety of areas around the Center for assembly, testing and processing (described above in Section 2.1.4.4) under the No Action Alternative.

Other Actions
As discussed under Water Resources (Section 3.4), cumulative impacts have already harmed the IRL, with sudden die-offs of submerged aquatic vegetation and even prominent mammals and birds in recent years, reversing a period of gradual improvement. As overall human population, infrastructure, development, and activity in the surrounding watershed and adjacent areas all increase in the coming decades, to which the No Action Alternative at KSC and other actions such as the Shiloh Launch Complex and Port Canaveral Rail Extension would materially contribute, Federal and State agencies, along with local jurisdictions and communities, recreationists, and the public are going to have to cooperate and implement costlier measures and restrictions to avoid further impairment of this valuable natural resource and the aquatic wildlife it supports.

These cumulative impacts on the IRL would be expected with or without implementation of the Proposed Action. That is, the No Action Alternative would neither significantly increase or decrease their magnitude.

Climate Change and Sea Level Rise
Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, widespread or large extent, and possibly significant, even under the No Action Alternative.

3.9.2.5 Cumulative Impacts to Upland Wildlife, Wetlands and Aquatic Biota

The Proposed Action, Alternative 1, and No Action Alternative would add incrementally to the impacts of other factors affecting the wildlife and aquatic species of KSC as discussed in the Merritt Island NWR Comprehensive Conservation Plan (USFWS, 2008).

Human impacts and underlying threats to biological diversity on and off the refuge include:

- Direct loss of habitat due to development and other human activities;
- Simplification and degradation of remaining habitats, including habitat alteration;
- Fragmentation;
- Loss and decline of species and biological diversity;
- Effects of constructing navigation and water diversion facilities;
- Introduction and spread of exotic, nuisance, and invasive species;

- Lack of environmental regulation and enforcement;
- Cumulative effects of land and water resource development projects;
- Ongoing wildlife disturbance due to development and other human activities;
- Impacts of nonpoint sources of pollution and water quality degradation; and
- Impacts of sea level rise and global warming.

As a result of these threats, some species endemic to the northern Indian River Lagoon have become extinct, endangered, or threatened. MINWR provides habitat to support 15 federally listed species, among them, the Florida scrub-jay, eastern indigo snake, piping plover, roseate tern, southeastern beach mouse, Atlantic salt marsh snake, loggerhead sea turtle, green sea turtle, and leatherback sea turtle. Further, the refuge also supports an additional 47 species listed by the State of Florida as either threatened, endangered, of special concern, or commercially exploited. Of those species that have a state or federal designation, 46 are listed by the Florida Committee on Rare and Endangered Plants and Animals; 53 are listed by the Florida Natural Areas Inventory; and 26 are on the Audubon Society's Watch List (see Appendix D for a complete listing of these species).

MINWR serves to protect, maintain, and enhance the high productivity and biological diversity within this system. Increasing human population growth and impact have altered many ecological characteristics of Indian River Lagoon. The refuge faces ongoing threats from contaminated air, soil, and water; from erosion and sedimentation; and from cumulative habitat impacts from land and water resource development activities adjacent to and on the refuge (e.g., NASA's operations facilities). The MINWR Comprehensive Conservation Plan outlines ecological threats and problems facing the MINWR, including: the direct loss of habitat due to development and other human activities; the simplification and degradation of remaining habitats, including habitat alteration and fragmentation; the loss and decline of species and biological diversity; the effects of constructing navigation and water diversion facilities; the introduction and spread of exotic, nuisance, and invasive species; the lack of environmental regulation and enforcement; the cumulative effects of land and water resource development projects; the ongoing wildlife disturbance due to development and other human activities; the impacts of nonpoint sources of pollution and water quality degradation; and the impacts of sea level rise and global warming (USFWS, 2008).

Rapid population growth and development in the region have resulted in long-term negative impacts to the refuge, including increased boat traffic in the shallow waters of the lagoon, increased use and development of natural resources in the area, local habitat fragmentation, and the introduction and spread of exotic species.

Native terrestrial habitats that once dominated uplands include hardwood hammocks, which are very important for mammals and migratory birds. Urbanization and agricultural operations (e.g., large citrus groves) now dominate land uses in the upland areas along the entire Indian River Lagoon. Historically, citrus and other agricultural operations, such as cattle pastures, dominated the area's landscape, but these are quickly being replaced by urban and suburban sprawl. Stormwater inputs, saltwater exchange through fortified ocean inlets, pollution, habitat destruction, and continual land and water use practices are constant threats to fish and wildlife resources in this area. By the year 2015, Florida is expected to reach 20 million residents, and by 2040, Brevard County is projected to have 668,020 residents (an increase of more than 100,000 from the population at present), and Volusia County 591,980, an increase of nearly 100,000 (EDR, 2015).

The reduction of ecological function and connection are major concerns, especially in areas where the modification of inland waterways has caused declines in fisheries and aquatic resource productivity. Beaches, seagrass beds, salt marshes, mangrove islands, and hammocks are subject to further loss or elimination. Some known environmental modification includes the construction of causeways (e.g., impacting seagrasses); the construction and maintenance of the Intracoastal Waterway (e.g., changing hydrological functions and salinity); the development of beaches and shorelines (e.g., impoundments, impacting fragile coastal habitats for migratory birds, small mammals, and nesting sea turtles); and fishing activities (e.g., increasing recreational and commercial uses) in transitional and aquatic communities and habitats. Causeway construction, canal dredging, and commercial agricultural operations have contributed to the long-term loss and elimination of aquatic resources and habitats. In addition, declining water quality due to increased sediment and nutrient runoff is likely to adversely impact seagrass communities, resulting in declines in fish and mollusk (fisheries and aquatic resource) production.

Estuarine wetlands (native salt marsh and mangrove swamps) on the refuge were impounded to meet mosquito control needs. Refuge wetland management objectives include reconnecting impoundments and restoring natural-like flow and biological interchange, while maintaining mosquito control and migratory bird habitats.

Construction of the two large reasonably foreseeable projects listed in Section 3.2, Shiloh and the rail extension, would add to the cumulative stresses that local wildlife populations face in the future, primarily by eliminating and fragmenting additional habitat. If KSC and Shiloh launches were both conducted at capacity in the future, local ecosystems in MINWR could be subjected to discontinuous, recurring perturbations from general disturbance, noise, and the chemicals discussed above. These would be transient or short-lived, but recurring on a regular basis, and local ecosystems and their wildlife species would have to adapt, but some species and communities would be more adaptable than others. Overall cumulative impacts on wildlife would be long-term, of medium extent and moderate magnitude, but not significant.

3.9.2.5.1 Invasive Species

Invasive exotic plants have displaced many native species in upland and wetland communities. Brazilian pepper and Australian pine, for example, are two invasive species that are widespread throughout the refuge, and melaleuca, cogongrass, and other invasive plants are locally abundant. Citrus trees for agricultural harvest cover other large areas. As adjacent urbanization and suburbanization continue to increase, KSC, MINWR, and CNS are all likely to experience an increased threat from feral animals, free-roaming pets, recreational boating, elevated nutrient loading, and pollution, as well as from the increased demand for public use activities that are not directly linked to fish and wildlife goals. Overall cumulative impacts on invasive species would be minor to moderate, but not significantly adverse.

3.9.2.5.2 Recreational Use

This section briefly discusses general impacts of growing outdoor recreation in the area on biological resources in the KSC region. See Section 3.15 on Recreation in this PEIS for more detailed discussion of cumulative impacts of the Proposed Action, Alternative 1, and the No Action Alternative on recreation at MINWR and CNS.

Year-round recreation at the Canaveral National Seashore includes fishing, boating, canoeing, surfing, sunbathing, swimming, hiking, camping, enjoying nature and historic trails, and exploring cultural resources. From 2010 to 2014, the seashore hosted between about 970,000 and 1.4 million recreation visits annually. Visitation has fluctuated by as much as about 300,000 visitors from year to year. Visitation at the South District (Playalinda Beach) has increased more than 75 percent from 2010 to 2014, with over 875,000 visitors in 2014 (NPS, 2010-2014). More detailed visitation figures for the CNS are included in Section 3.15.1.2 of this PEIS.

Popular with anglers, kayakers, birders, wildlife enthusiasts, and photographers, MINWR has the distinction of being one of the most visited refuges in the National Wildlife Refuge System with almost 1.2 million visitors in 2011. Non-consumptive recreation accounted for 1.0 million visits with residents comprising 42 percent of total visitation. Fishing, crabbing, clamming, oystering, and shrimping are permitted in the Indian River Lagoon, Mosquito Lagoon, Banana River Lagoon, Mosquito Control Impoundments and Interior Freshwater Lakes except for the restricted areas of the KSC (USFWS, 2015b). More detailed figures for non- consumptive activities are included in Section 3.15.1.1.1 of this PDEIS.

Increased disturbance of fish spawning areas and nesting and roosting birds, and impacts to water quality and habitat are likely to lower MINWR's biological integrity. Management overlap of refuge lands and waters is shared by multiple agencies and a continual challenge is to coordinate conservation management with the more than 100 agencies and organizations which share the responsibility of managing the Indian River Lagoon watershed (Indian River Lagoon National Estuary Program, 1996).

Saltwater fishing is the fastest growing public use activity. Twenty years ago, about 25,000 anglers a year used the IRL (Lenze, 2002). By 2011 saltwater fishing in MINWR had increased to almost 167,000. This estimate is even considered low as access from Parrish Park, Titusville Marina, Jones Landing, Scottsmoor Landing, and River Breeze boat ramps is not captured; nor is fishing visitation in the Banana River (USFWS, 2013). While in general, more residents (or those from Brevard and Volusia counties) than non-residents participated in freshwater fishing, residents and non-residents participated equally in saltwater fishing. As shown in Table 3.14-1, the populations of Brevard and Volusia counties have increased my more than 1 million from 2000 to 2013, or by about 14 percent. The population of the six surrounding counties increased almost 20 percent from 2005 to 2015, reaching 3.3 million residents (EDR, 2015).

With this rapid population growth the Service anticipates fishing pressure to escalate at similar rates. The increase in fishing pressure has resulted in habitat impacts to Mosquito Lagoon. Prop scarring on the flats is increasing. Prop scarring occurs when power boats operating in shallow water cut into the bottom and destroy linear strips of rooted sea grass and dredge cuts into the bottom. This impacts sea grasses and stirs up bottom sediment which increases turbidity. Studies show increasing levels of boating activity also negatively impact populations of waterfowl and other waterbirds. A study completed at Merritt Island in 2002 showed that lesser scaup were changing their feeding habits from daytime to nighttime. Bird nesting on historic nesting islands has also declined.

With the lack of fresh water, the refuge has limited opportunities for freshwater fishing. Most freshwater fishing occurs in several man-made borrow pits which were dug for road construction material. These borrow pits provide easy access to bank fishing opportunities for anglers who do not have a boat. However, they can become overfished and need management to sustain a quality freshwater fishery.

As discussed under Water Resources (Section 3.4), cumulative impacts have already harmed the IRL, with abrupt die-offs of submerged aquatic vegetation (seagrass beds) and even prominent mammals (manatees and bottlenose dolphins) and birds (brown pelicans) in recent years, reversing a period of gradual improvement. As overall human population, infrastructure, development, and activity in the surrounding watershed and adjacent areas all increase in the coming decades, to which the Proposed Action and Alternative 1 at KSC and other actions in the region would materially contribute, Federal and State agencies, along with local jurisdictions and communities, recreationists, and the public are going to have to cooperate and implement costlier measures and restrictions to avoid further impairment of this valuable natural resource and the aquatic wildlife it supports.

3.9.2.5.3 Climate Change and Sea Level Rise

As discussed in Section 3.7, impacts on the KSC and MINWR stemming from global warming and climate change may manifest themselves through rising sea level and increased tropical cyclones, due to elevation, topographic relief, and proximity of the Refuge to the ocean. Rising sea level could result in wetter hydrologic regimes and saltwater intrusion. The extent and nature of the Refuge's impoundments and marshes could be altered. More frequent and more intense tropical cyclones could cause alteration to the beach profiles and affect the flora and fauna that presently use these habitats.

State and federal assessments of coastal zone vulnerability from current and future sea level rise reflect coastal changes, particularly to coastal barrier island systems (see Section 3.7 Climate Change). Impacts to the refuge could include beach and dune habitat changes that would pose threats to several federally listed sea turtles and the southeastern beach mouse. Loss of dune systems and lowered dune profile could increase sea turtle disorientation from lighting at NASA's and the U.S. Air Force's launch facilities. The refuge's beach has been changing with a mix of points of accretion and erosion since the 1800s with no observed long-term trend (Ron Schaub, Dynamac, Inc., personal communication). However, increased sea level would exacerbate beach erosion and may reconfigure the beach and shoreline contour (e.g., the beach could experience increased overwash and the formation of an inlet in Mosquito Lagoon). Additional impacts could include inundation of low-lying areas along the Mosquito Lagoon, Indian River Lagoon, and the Banana River, including marshes, impoundment dikes, marsh islands, and spoil islands. The changes could include habitat transitions from upland to coastal wetlands. Saltwater intrusion into aquifers and increased flooding potential (increasing the potential for impacts from disasters) are also important considerations, particularly in beach areas that have been developed (Leatherman and Kershaw, 2001).

Coastal wetland ecologists have suggested that the coastal marshes may be impacted if they cannot maintain the detrital-building process and the marsh elevation due to sea level rise (accretion deficit; Reed and Cahoon, 1993). They suggest that some marsh management practices (e. g., burning or migratory bird management) would inhibit marsh accretion in a system that has a narrow tidal range, low sediment accretion rate, and a low tolerance for accelerated sea level rise (Cahoon et al., 2004). The rise in sea level could effectively cause the transition of high marsh systems to lower marshes and the migration of high marshes into the fringing upland ecotones. Marsh expansion may have beneficial impacts; however, the increase in salt marsh may also increase the production potential of the salt marsh mosquito.

Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, widespread or large extent, and possibly significant.

3.10 Cultural Resources

3.10.1 Affected Environment

Cultural resources are historic properties as defined by the National Historic Preservation Act of 1966 (NHPA), cultural items as defined by the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), archaeological resources as defined by the Archaeological Resources Protection Act of 1979 (ARPA), sacred sites as defined by EO 13007, and collections and associated records as defined by 36 CFR 79. Cultural resources are associated with human use of an area. They may include archaeological sites, historic properties, or ethnographic locations associated with past and present use of an area. A cultural resource can be physical remains, intangible traditional use areas, or entire landscape, encompassing past cultures or present, modern-day cultures. Physical remains of cultural resources are usually referred to as archaeological sites or historic properties.

3.10.1.1 Regulatory Framework

The principal federal statutes governing the management of cultural resources or historic properties on federal and tribal lands include the Antiquities Act of 1906; Historic Sites Act of 1935; National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969; Archaeological and Historic Preservation Act of 1974; American Indian Religious Freedom Act of 1978; Archaeological Resources Protection Act of 1979; and the Native American Graves Protection and Repatriation Act of 1990.

Relevant executive agency directives for the federal government include Executive Order (EO) 13287, Preserve America (2003); EO 11593, Protection and Enhancement of the Cultural Environment (1971); EO 13007, Indian Sacred Sites (1996); and EO 13175, Consultation and Coordination with Indian Tribal Governments (2000). Chapter 267 of the Florida Statutes (F.S.) contains legislation which parallels the federal requirements on the state level.

The following rules in the Code of Federal Regulations (CFR) also address cultural resources: 36 CFR 60, National Register of Historic Places (NRHP); 36 CFR 61, Procedural for Approved State and Local Government Historic Preservation Program; 36 CFR 63, Determinations of Eligibility for Inclusion in the NRHP; 36 CFR 65, National Historic Landmarks (NHLs) Program; 36 CFR 68, The Secretary of the Interior's Standards for Treatment of Historic Properties; 36 CFR 79, Curation of Federally-Owned and Administered Archeological Collections; 36 CFR 800, Protection of Historic Properties; 43 CFR 3, Preservation of American Antiquities; 43 CFR 7, Subpart A, Protection of Archaeological Resources, Uniform Regulations; and 43 CFR 10, Native American Graves Protection and Repatriation Act Regulations, Final Rule.

Under Section 106 of NHPA, and its amendments, important cultural resources must be given consideration in the environmental planning and permitting process. Implementing regulations for Section 106 are at 36 CFR 800 (Protection of Historic Properties), which requires the responsible federal agency, in consultation with the State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Officer (THPO), to determine the level of effort to identify historically significant cultural resources in the area of potential effects (APE) of the undertaking. This usually requires a review of existing records to determine the presence of properties that are listed on the National Register of Historic Places (NRHP) within the area of potential effects and archaeological survey of the APE to identify potential historic properties that have not been previously identified and evaluate their potential for inclusion on the NRHP (NPS, 2015). The responsible federal agency must then give consideration to the effects of the undertaking upon properties listed on the NRHP or potentially eligible for listing on the register, in consultation with the appropriate SHPO and/or THPO.

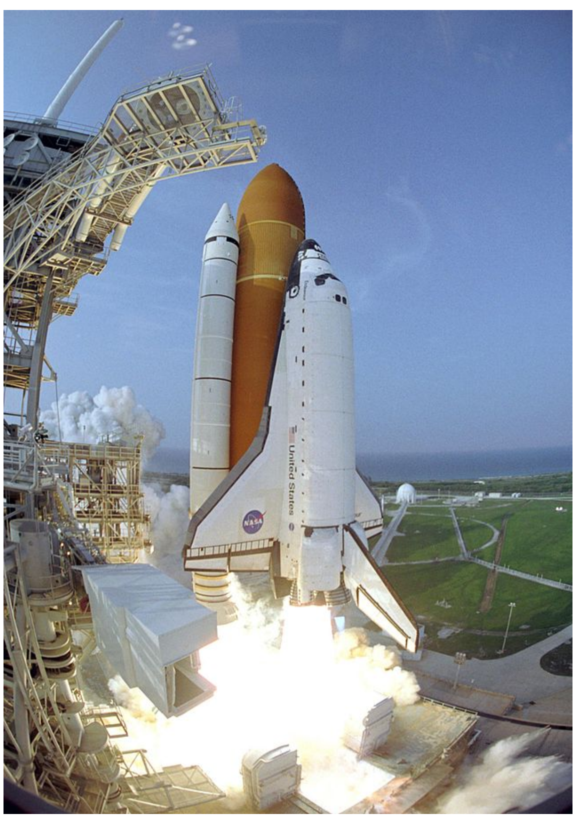


Figure 3.10-1. LC-39 – Pad A is one of several facilities at KSC listed on the NRHP

National Historic Landmarks (NHLs) are nationally significant districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, or culture. NHLs are automatically listed in the NRHP and designated by the Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States. Today, fewer than 2,500 historic places bear this national distinction.

In accordance with 36 CFR Part 800, federal agencies are encouraged to coordinate studies and documents prepared under Section 106 with those done under NEPA. Section 800.8(a) of the regulations provides guidance on how NEPA and Section 106 process can be coordinated. KSC also will conform to the consultation, identification and documentation standards set forth in 36 CFR Part 800.8(c), and will notify in advance, the SHPO and Advisory Council on Historic Preservation (ACHP), where it intends to use the NEPA process to comply with Section 106.

Section 110 of the NHPA (as amended in 1992) obligates federal agencies to establish a historic preservation program for the identification, evaluation and nomination to the NRHP of historic properties under their jurisdiction and to ensure that such properties are managed and maintained in a way that considers their historic, archaeological, architectural, and cultural values. Section 110(a) requires federal agencies to give priority to the use of historic properties for agency purposes. Section 110(a)(2)(D) requires that the federal agency's preservation-related activities are carried out in consultation with other federal, state, and local agencies, Indian tribes, and other stakeholders, including the private sector. Section 110(b) mandates that federal agencies document historic properties that may be destroyed or altered as a result of federal actions or assistance. It also calls for such records to be deposited in the Library of Congress or other designated repository for "future use and reference." Section 110(d) calls for agencies to integrate historic preservation concerns into their plans and programs and Section 110(f) addresses impacts to NHLs.

Section 111 of the NHPA addresses the lease or exchange of historic properties owned by federal agencies, provided such actions "will adequately ensure the preservation of the historic property" Section 111(a)). Under Section 111(b) the proceeds of the lease may be used by the agency to defray the costs of administering and maintaining its historic properties.

Section 112 of the NHPA addresses both professional standards for agency personnel and contractors responsible for historic resources (Section 112(a)(1)(A)), as well as records and data management (Section 112(a)(2)).

Section 304 of the NHPA discusses confidentiality regarding the locations of historic resources which stipulates that disclosure shall be withheld from the public if it has the potential to cause "significant invasion of privacy," harm to the historic resources, or "impede the use of a traditional religious site by practitioners."

The Antiquities Act of 1906 and the Archaeological Resources Protection Act of 1979 (ARPA) prohibit the unauthorized excavation, removal, damage, alteration, defacement, or the attempt of such acts on federal lands. ARPA provides legal penalties and establishes a permitting system to authorize excavation or removal of archaeological resources by qualified applicants.

The American Indian Religious Freedom Act (AIRFA) of 1978 applies the First Amendment guarantee of religious freedom to Native Americans whose religious practices may involve requirements to access sacred sites on federal property. Under AIRFA Native Americans must be provided with access and ceremonial use of Native American sacred sites on federal property, and the federal agency must avoid adversely impacting those sites and maintain the confidentiality of sacred site locations.

The Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 was intended to ensure the protection and the rightful disposition of Native American cultural items (which, under NAGPRA, include human remains, associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony) located on federal or Native American lands and in the federal government's possession or control. NAGPRA requires agencies to determine what Native American cultural items are within its possession or located at its facilities and then notify potentially effected tribes concerning possible repatriation. Upon inadvertent discovery and intentional excavation of potential cultural items, it is necessary for the federal agency to identify proper ownership and to ensure the rightful disposition of cultural items (NASA, 2010a, 2015).

3.10.1.2 Integrated Cultural Resources Management Plan

The KSC has a stewardship responsibility for managing the cultural resources on NASA-owned lands, as well as the NASA-owned facilities located within the Cape Canaveral Air Force Station (CCAFS). To this end, KSC has developed an Integrated Cultural Resource Management Plan (ICRMP) that reflects the Agency's commitments to the protection of its significant cultural resources. The most recent version of the ICRMP covers the 2014-2018 time period (InoMedic, 2014). The Center has a designated Historic Preservation Officer (HPO) under the Environmental Management Branch to manage the ICRMP and to report to NASA Headquarters, Federal Preservation Officer, as required. It is the goal of KSC to balance historic preservation considerations with NASA's missions and mandates and to avoid conflict with ongoing operational requirements.

Historic preservation is an integral part of KSC's environmental mission and is part of the decision-making process for activities at KSC. The ICRMP provides an inventory of significant cultural resources and a plan of action to identify, assess, manage, preserve and protect these resources. It also includes a guide for impact analysis review and a set of Standard Operating Procedures (SOPs) for ongoing cultural resource management activities. The ICRMP is also consistent with KSC's Environmental Policy which promulgates compliance, "through a proactive, systematic approach that integrates environmental management system elements into KSC's operations and practices to comply with all environmental laws, regulations, policies, EO's and with NASA environmental directives, procedures, and requirements" (NASA, 2010a, 2015).

3.10.1.2.1 Prehistoric and Historic Archaeological Resources

The general KSC area has been the focus of archaeological investigations for over 100 years. The area has been studied by many investigators conducting a number of archaeological surveys. Most of the studies and surveys focused upon small parcels of lands proposed for facility development. Details of the surveys can be found in the ICRMP. The 104 known archaeological sites at KSC contain a total of 120 identified temporal/cultural components of which 92 (77 percent) are precontact and 28 (23 percent) are historic.

Between 1990 and 1996, a KSC-wide archaeological survey was conducted to establish differential Zones of Archaeological Potential (ZAPs) within all areas of the KSC. Based on background research and archaeological surveys, the ZAPs were defined as low, medium, and high probability zones based upon the anticipated potential for containing significant or potentially significant archaeological sites. The determination of these ZAPs resulted in a KSC-specific archaeological site location predictive model. A set of U.S. Geological Survey (USGS) quadrangle maps were prepared showing the ZAPs defined by this effort, as well as the locations of known archaeological sites. These baseline maps are used to create layers in the KSC Geographic Information System (GIS). 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.

From 2007 to 2008, 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, circa 1700 to 1958. Work included field reconnaissance (e.g., limited shovel testing) to validate the predictive model. A total of 126 historic ZAPs were identified within KSC. These ZAPs were incorporated into the KSC GIS. As funds become available, potential historic period archaeological sites will be surveyed, evaluated, and recorded in the Florida Master Site File (FMSF).

All recorded archaeological sites within KSC are classified into one of five evaluation categories:

A. National Register Site - Site is listed in the NRHP;

B. National Register Eligible - Site is considered significant based on existing information, and thus is deemed eligible for listing in the NRHP;

C. Potentially Significant - Site appears potentially significant but additional archaeological data is needed before a final determination can be made;

D. Not Determined - Not enough information currently exists to make an informed assessment of significance; and

E. Not Significant/Not Eligible - Site is considered not regionally significant because of limited data, potential or site destruction, and therefore, is not deemed eligible for listing in the NRHP.

Currently, 2.2% of the sites are presently listed (Category A) in the National Register; 13.5% are considered eligible for listing (Category B); 11.9% appear to be potentially eligible (Category C) but require additional information before a final determination can be made; 39.5% have not been adequately investigated to make a determination (Category D); and 33%.0 have been adjudged not significant, and thus, not National Register eligible (Category E) (InoMedic, 2014).

3.10.1.2.2 Historic Buildings, Structures, Objects, and Districts

As of November 2008, a total of 89 historic properties had been identified within KSC, including six historic districts, 29 individually listed or eligible properties, and 54 resources that are contributing to a historic district, but not individually eligible. The individually eligible properties include multiple resources such as two crawler transporters, three mobile launcher platforms, and two payload canisters. The ICRMP includes descriptions and summary statements of the 29 individually eligible properties (including 14 buildings, 14 structures, and one object), as well as the six historic districts.

In September 1983, a revised NHL Federal Agency Nomination was prepared by the NPS History Division at the direction of the Secretary of the Interior's Advisory Board to reflect an agreement between the NPS, the U.S. Air Force, and the Board. The nomination highlighted the national significance of those principal facilities associated with the manned and unmanned space program of the United States, included Launch Pads 5, 6, 13, 14, 19, 26, 34, and the original Mission Control Center (MCC). Of these, LC 5/6, 19, 34, and the MCC are NASA-owned properties. At the direction of the Secretary of the Interior's Advisory Board, the boundary of the NHL District included only the area immediately surrounding the seven launch pads and the MCC. The Cape Canaveral Air Force Station Historic District was listed as a NHL on April 16, 1984 (NASA, 2010a, 2015).

3.10.2 Environmental Consequences including Cumulative Effects

3.10.2.1 Proposed Action

All activities under the Proposed Action that may have adverse effects on cultural resources at KSC would be managed in accordance with the KSC Integrated Cultural Resources Management Plan. The ICRMP provides an inventory of significant cultural resources and a plan of action to identify, assess, manage, preserve and protect these resources. It also includes a guide for impact analysis review and a set of SOPs for ongoing cultural resource management activities.

At the programmatic level of analysis, such as this PEIS, specific project impacts cannot be determined, since specific actions have not been defined. Although specific project locations are not currently known, it is possible that some project locations may occur in or adjacent to areas with a high potential for the presence of archaeological sites. As the project locations are defined, the NHPA Section 106 process would be initiated and determinations would be made for the APE and potentially impacted cultural resources. Appropriate surveys and studies would be conducted so that the effect of the undertaking upon the cultural resources can be determined. Consultations would be undertaken on a project-by-project basis with the respective SHPO or THPO and interested or affected Native American tribes.

Should previously undiscovered artifacts or features be unearthed during any of the proposed projects, in accordance with SOP #5 (InoMedic, 2014; p. 6-11), work would be stopped in the immediate vicinity of the find, a determination of significance made by the KSC HPO, and if significant; a mitigation plan would be formulated in consultation with the respective THPO or SPHO and with American Indian entities that may have interests in the project area. If not significant, the HPO would provide approval for the project to proceed.

When implementing the Proposed Action, NASA will continue to follow stipulations identified in the ICRMP, existing Memoranda of Agreements (MOAs), and an existing Programmatic Agreement (PA). If a specific project of detailed dimensions and scale is proposed at a specific location, this PEIS will serve as a master NEPA document off which future NEPA compliance documents may be “tiered”. That is, having already been addressed at a programmatic level, an agency can subsequently tier to this analysis, and analyze narrower, site-or proposal-specific issues (CEQ, 2014). If existing KSC cultural resource management practices do not address potential affects to cultural resources, a Section 106 consultation may need to be initiated and new agreements, such as a project-specific MOA or project PA, may need to developed and implemented. KSC will conform to the consultation, identification and documentation standards set forth in 36 CFR Part 800.8(c), and will notify in advance, the SHPO and ACHP where it intends to use the NEPA process to comply with Section 106.

The remainder of this subsection describes how MOAs and PAs are used to manage cultural resources, and identifies the existing NASA KSC MOAs and PA that are in place. If the need arises, NASA will develop new MOAs or modify the existing PA to address proposed activities that are not currently addressed in the existing agreements.

NASA has implemented MOAs with Florida SHPO, ACHP, and other organizations to record agreed upon resolutions for specific undertakings with a defined beginning and conclusion, where adverse effects are understood. Below are the MOAs that NASA has executed (NASA, 2010a, 2015).

1. MOA for the LC-39 Site among KSC, the ACHP, and the Florida SHPO permits KSC to proceed with the design and development of Space Shuttle facilities including modifications to existing facilities and new construction (1974);

2. MOA between NASA and the Smithsonian Institution concerning the Transfer and Management of NASA Historical Artifacts. NASA must offer all personal property including historic artifacts to the Smithsonian after NASA Programs/Projects and other federal agencies have screened the property for government use. The Smithsonian Institute is responsible for preserving the artifacts that represent aviation and space flight (1998);

3. MOA for the Launch Control Center (LCC) between KSC and the SHPO addresses the removal of the Sun Louvers and Replacement of the Window Framing Unit from the LCC (2008);

4. MOA for the Demolition of Launch Complex (LC)-34 Environmental Support Building between KSC and the SHPO (2006);

5. A Non-Reimbursable Space Act Agreement Regarding the Clifton Schoolhouse for the removal of the remaining schoolhouse structure (2006); and

6. MOA for the Demolition of the Mission Control Center between KSC, the SHPO and the ACHP (2009).

In contrast to MOAs, PAs are appropriate for multiple or complex federal undertakings where: 1) effects to historic properties cannot be fully determined in advance, 2) for federal agency programs, 3) for routine management activities by an agency, or 4) to tailor the standard Section 106 process to better fit in with agency management or decision making. PAs generally fall into two types: project PAs or program PA.

Project PAs are typically developed for occasions where completing the Section 106 process prior to making a final decision on a particular undertaking is not practical. The regulations allow an agency to pursue a project PA (36 CFR § 800.14(b)(3)), rather than an MOA under certain circumstances. The most common situation where a project PA may be appropriate is when, prior to approving the undertaking, the federal agency cannot fully determine how a particular undertaking may affect historic properties or the location of historic properties and their significance and character. For instance, the agency may be required by law to make a final decision on an undertaking within a timeframe that simply cannot accommodate the standard Section 106 process, particularly when the undertaking's area of potential effects encompasses large areas of land or when the undertaking may consist of multiple activities that could adversely affect historic properties.

A federal agency may pursue a program PA (36 CFR § 800.14(b)(2)) when it wants to create a Section 106 process that differs from the standard review process and that will apply to all undertakings under a particular program. Reasons justifying program PAs include having a program that has undertakings with similar or repetitive effects on historic properties to avoid the need for a separate Section 106 review for each project, or that relies on delegating major decision making responsibilities to non-federal parties. The ACHP has helped develop numerous program PAs for routine management of real property, land, and historic properties at federal facilities like military installations, national forests, national energy laboratories, and NASA centers.

KSC has executed a PA called the Programmatic Agreement for the Management of Historic Properties. This agreement streamlines the Section 106 process and documentation for “like” multiple assets (e.g., launch pads, mobile launcher platforms, crawler transporters). It also allows KSC to do normal maintenance and minor modifications, as well as reuse facilities and property. Moreover, it ensures that historic, engineering, and architectural values are recognized and considered in the course of ongoing KSC programs (InoMedic, 2014).

In conclusion, since the Proposed Action would be implemented in accordance with the KSC Cultural Resources Management Plan and associated MOAs and PAs, direct and indirect impacts on cultural resources at KSC, while long term, would not be significant.

3.10.2.1.1 Cumulative Effects

KSC works in partnership with the USFWS and NPS to manage MINWR) and CNS – both of which are located within the boundaries of KSC. KSC is also bordered on the east by the CCAFS, where NASA operates several facilities.

The boundaries of KSC include cultural resources from CNS and MINWR, although these cultural resources are managed by NPS and USFWS separately. Cultural resources in areas where the MINWR and CNS overlap are managed by the NPS. One cultural site, known as the Elliot Plantation, is a large, multicomponent archaeological complex consisting of approximately 2,585 acres. The Elliot Plantation proper and lies within MINWR and a KSC designated buffer zone, west of SR 3 (though the larger cultural landscape spans east and west of SR 3). Built during the British Period of Florida, it is comprised of a former sugar works factory, rum distillery, slave village, overseer's house, canals and other agricultural remnants. It is listed on the Florida Master Site File and the NPS Southeast Archeological Center has determined it to be eligible for inclusion in the NRHP and for consideration of NHL designation (NPS, 2014).

Dating to the 1760s, this site is the southernmost and earliest British period sugar plantation in North America. It is unusually well preserved, and contains one of the most significant African-American landscapes known (NPS 2011; Schwadron 2013). As noted in the NPS submission, "It is our opinion that this property represents one of the most significant properties in North America." The nearly 250-year-old site is of special interest "because it is one of the most significant and well-preserved African-American landscapes known."

The Proposed Action would not directly impact the Elliot Plantation. As part of the Proposed Action, NASA activities in operational buffer zones would limit development to include infrastructure, operations of low impact, or small footprint facilities that may be required for support of space launch or landing operations. That said, the Elliot Plantation is part of the larger cultural landscape that extends beyond the Elliot Plantation proper and the MINWR. Space Florida proposes to develop the Shiloh Launch Complex, a state-controlled and state-managed launch site, in the vicinity of the Elliot Plantation. A separate EIS is being prepared by the Federal Aviation Administration (FAA) for the Shiloh project. The Canaveral Port Authority proposes to develop the Port Rail Extension, which would also occur in the vicinity of the Elliot Plantation. A separate EIS is being prepared by the State Transportation Authority (STA). Potential impacts to cultural resources from the proposed Shiloh Launch Complex and/or from the proposed Port Rail Extension have not yet been analyzed. As such, cumulative impacts from the Proposed Action cannot be analyzed in relation to these two projects at this time.

Overall, the Proposed Action would not have additional adverse cumulative impacts over and above those of its direct and indirect effects.

3.10.2.2 Alternative 1

The direct, indirect, and cumulative impacts of Alternative 1 on cultural resources would be essentially the same as those of the Proposed Action.

3.10.2.3 No Action Alternative

Under the No Action Alternative, cultural resources would not be affected by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws, regulations, and policies. Existing uses would continue at current levels. Effects on cultural resources from existing activities, such as maintenance of roads and facilities, vertical and horizontal launches, and recreation would remain unchanged from current levels. Thus the No Action alternative would not have any additional impacts on cultural resources.

3.11 Land Use

3.11.1 Affected Environment

KSC is located on the east coast of Florida approximately 242 kilometers (km) (150 miles [mi]) south of Jacksonville and 40 miles (64 km) east of Orlando on the north end of Merritt Island, which forms a barrier island complex adjacent to Cape Canaveral. The total KSC land and water area jurisdiction is approximately 140,000 acres in Brevard and Volusia counties. It is 34 miles (55 km) long and roughly 6 miles (10 km) wide, covering 219 square miles (570 km^2). All KSC facilities are located on Merritt Island and Cape Canaveral.

KSC is bordered on the west by the Indian River and on the east by the Atlantic Ocean and Cape Canaveral Air Force Station (CCAFS) (see Figure 1.2-1). The northernmost end of the Banana River (another brackish-water lagoon) lies between Merritt Island and CCAFS and is included as part of KSC submerged lands. The southern boundary of KSC runs east west along the Merritt Island Barge Canal, which connects the Indian River with the Banana River and Port Canaveral at the southern tip of Cape Canaveral. The northern border lies in Volusia County near Oak Hill across Mosquito Lagoon. The Indian River, Banana River and the Mosquito Lagoon collectively make up the Indian River Lagoon system.

Undisturbed areas, including uplands, wetlands, mosquito control impoundments, and open water areas, comprise approximately 95 percent of the total KSC area. Nearly 40 percent of KSC consists of open water areas. NASA maintains operational control of approximately 4,463 acres (1,806 hectares [ha]) of KSC. NASA’s operational area contains developed facility sites, roads, lawns, and maintained right-of-ways. The remaining undeveloped portions of the operational area are dedicated as safety zones around existing facilities or held in reserve for future expansion. Developed facilities within the NASA operational area are dominated by the Space Shuttle Landing Facility, the Industrial Area, and the Vehicle Assembly Building (VAB) area. All launch operations are conducted from Pads A and B at Launch Complex 39 (LC-39). Both pads are close to the ocean, three miles (five km) east of the VAB. The varying administrative areas at KSC are shown in Figures 3.11-1 and 3.11-2.

The KSC Industrial Area (Figure 2.1-4), where many of the Center's support facilities are located, is five miles (eight km) south of LC-39. It includes the Headquarters Building, the Operations and Checkout Building and the Central Instrumentation Facility. KSC was also home to the Merritt Island Spaceflight Tracking and Data Network station (MILA), a key radio communications and spacecraft tracking complex. The Center operates its own short-line railroad.

KSC is a major central Florida tourist destination and is approximately one hour's drive from the Orlando area. The Visitor Complex offers public tours of the center and CCAFS. Because much of the installation is a restricted area and only nine percent of the land is developed, the site also serves as an important wildlife sanctuary.

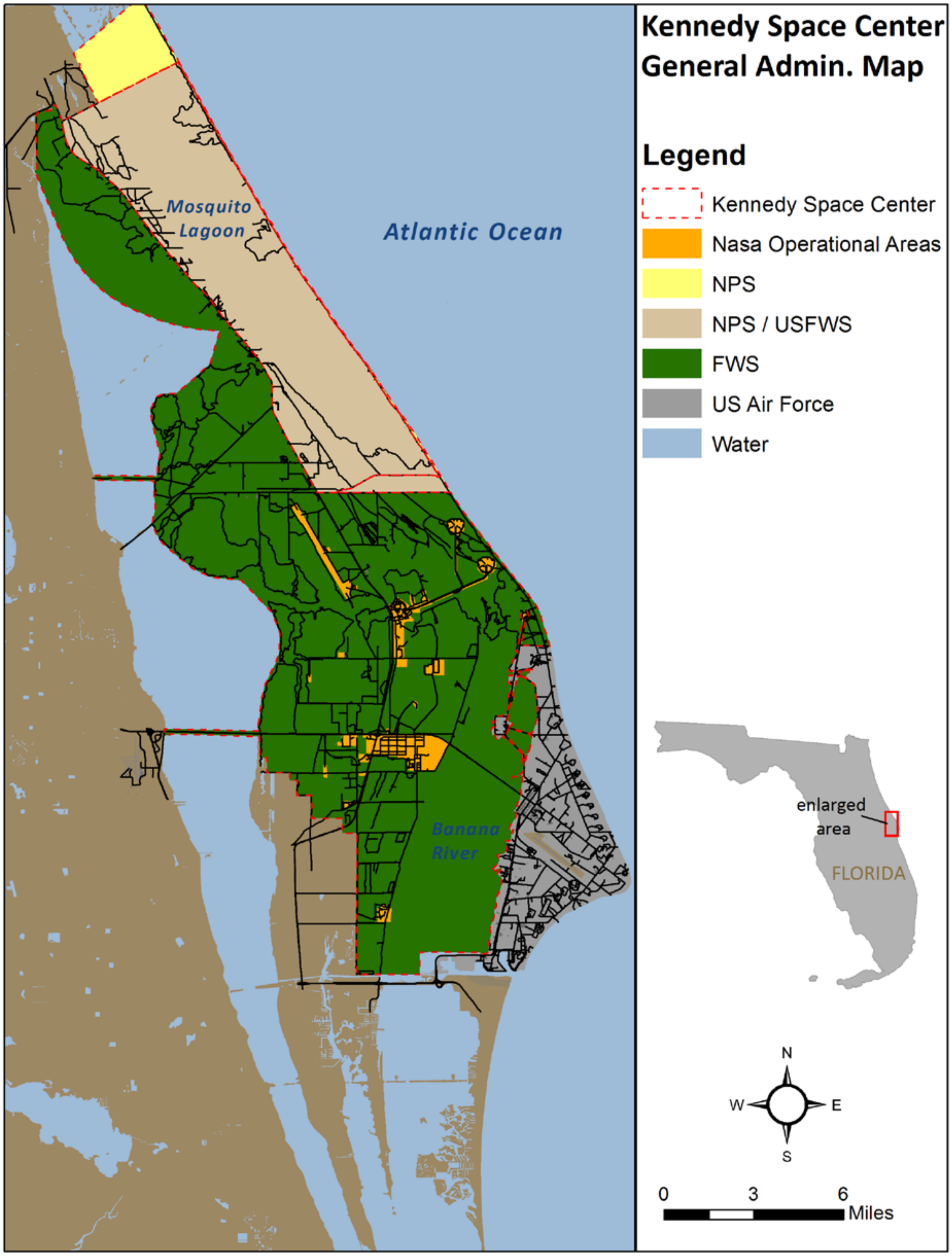


Figure 3.11-1. General land use and administration at KSC

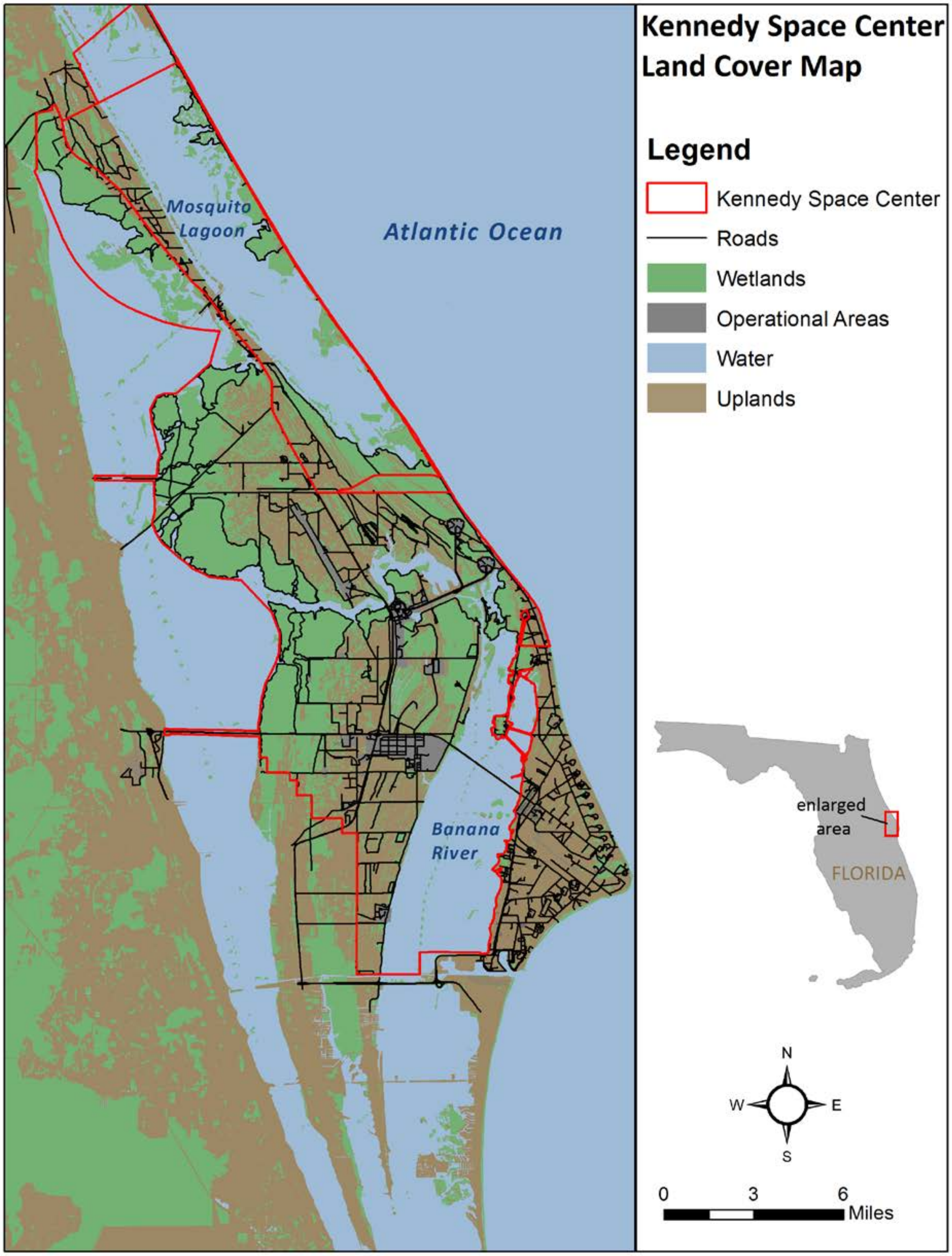


Figure 3.11-2. General land cover at KSC

The areas outside the NASA operational control area, including the Canaveral National Seashore and Merritt Island National Wildlife Refuge (MINWR), are managed by the National Park Service and U.S. Fish and Wildlife Service (USFWS) (KSC 2003).

3.11.1.1 NASA Zoning and Land Use Planning

All zoning and land use planning is under NASA directive for implementation of the nation's space program. Land use at KSC is carefully planned and managed to provide required support for missions and to maximize protection of the environment. Essential safety zones, clearance areas, lines-of-sight, and other such elements have been developed as guides to master planning and, where applicable, as mandatory operational requirements. For areas not directly utilized for NASA operations, land planning and management responsibilities have been delegated to the USFWS at MINWR and the National Park Service (NPS). These agencies exercise management control over agricultural, recreational, and environmental programs at KSC (NASA, 2012b).

Land use surrounding KSC includes an active seaport; recreation and wildlife management areas; and agricultural uses that include citrus and other crops and pasturage. Major municipalities outside of, but near, KSC include the city of Titusville, which is approximately 9.5 miles (15.2 km) from the KSC Industrial Area and the city of Cape Canaveral, which is approximately 8.5 miles (13.6 km) from the KSC Industrial Area.

A new Central Master Plan (CMP) is currently being developed by the Center Planning and Development Office at NASA. The CMP will include, among other plans, a Future Land Use Plan, Facility Development Plan, and Area Development Plans. KSC’s last major revision to its CMP was performed in 2002, with an update to define Area Development Plans (ADPs) in 2008 (Rivera, 2008).

3.11.1.2 Land Cover at KSC

The most recent land cover map for KSC is based on high-resolution imagery acquired during December 2003 with additional source data including land cover from the St. Johns River Water Management District (SJRWMD) (as KSC is located in the watershed area administered by the SJRWMD), planimetrics from KSC Master Planning, and light detection and ranging data for height profiles. The classification scheme is partly derived from the Florida Land Use, Cover and Forms Classification System (FLUCCS) with site-specific descriptions of class composition from Schmalzer and Hinkle (1990). The total land cover area defined in Figure 3.11-2 is 2,226 acres (901 ha) larger than the area inside the KSC boundary. This difference is comprised of contiguous brackish and estuarine aquatic habitats that are under management jurisdiction of the USFWS at MINWR.

The 2003 land cover map in Section 3.9.1.1.1 (Table 3.9-2) (NASA, 2010a, 2015) identifies 31 cover types on KSC (Figure 3.9-2 and Table 3.9-2). Types 1 through 19 are found in upland areas. Types 20 through 31 are wetlands and open waters.

The varying types of land cover shown in the table and figure above are discussed in greater detail in Section 3.4, Water Resources; and Section 3.9, Biological Resources.

3.11.1.3 Existing Land Uses at KSC

3.11.1.3.1 Vertical Launch

Vertical launch includes all facilities and land area directly related to vertical launch operations, including launch pads 39A, 39B and 41, as well as future vertical launch facilities. It also includes immediately adjacent launch support facilities and countdown facilities required to be operational at the time of launch. Quantity Distance (QD) arcs and other related safety setback and exposure limits are considered restrictions on the use of land adjacent to vertical launch complexes. Land within these QD arcs limits is not designated part of the vertical launch use.

3.11.1.3.2 Vertical Landing

Accommodating vertical landing capability, both powered and unpowered, will promote reusability of space flight hardware and significantly lower the price point for access to space. In anticipation of these advances, KSC has designated areas along its northeastern secure boundary as lands that could accommodate such activity. These areas could accommodate the return of first stage boosters or possibly vehicles returning from orbit.

3.11.1.3.3 Horizontal Launch and Landing

Horizontal launch and landing includes pavements, infrastructure, facilities and land area directly related to horizontal launch and landing operations. Horizontal Launch and Landing includes all paved runway surfaces, aprons, or similar runway features primarily associated with the Shuttle Landing Facility (SLF). Imaginary surfaces related to airfield safety clearances consistent with FAA clearance criteria and requirements, as well as QD arcs and related safety setback criteria, are considered restrictions on the use of land in and adjacent to Horizontal Launch and Landing areas. Land within those surface areas, setback, and limits is not designated as part of Horizontal Launch and land use classification.

3.11.1.3.4 Launch Operations and Support

Launch operations and support includes facilities and associated land areas essential to supporting a mission during launch and flight, including command, control and compilation, evaluation and communication of the data associated with launch vehicle activities. Storage of propellants and munitions is also included in this classification.

3.11.1.3.5 Assembly, Testing and Processing

Assembly, testing and processing includes facilities, operations and land areas that are essential to space vehicle component assembly, integration and processing prior to launch. Laboratories, material support and interface testing to achieve final assembly, test and closeout to prepare and test payloads, space systems and systems components for flight and integration, which may include hazardous commodities, are also included in this clarification. Primary uses and facilities support both government and commercial capabilities for payload assembly, integration, and processing; the development and testing of launch vehicle or spacecraft equipment at the component or system level; post-flight servicing and refurbishment activities; and spaceport infrastructure and operations. Secondary uses and facilities include associated and compatible manufacturing, logistics, or technical support functions.

3.11.1.3.6 Utility Systems

Utilities systems land use classification includes land and facilities associated with KSC utilities infrastructure and systems (i.e., water, wastewater, gas, electrical, chilled water, medium temperature hot water, communications and sewer systems). Utility easements help to define patterns and impacts associated with the development of utility systems and the overall land use pattern. Communications lines for line-of sight are identified visual corridors associated with communications components.

3.11.1.3.7 Administration

Administration includes facilities supporting operations management and oversight activities. Administrative functions/uses associated with management are more focused in the Industrial Area. A subset of administration applies to administrative functions that are adjacent to and in support of assembly, integration and processing operations.

3.11.1.3.8 Central Campus

The area identified as Central Campus would be utilized as a means to consolidate NASA operations into a smaller more cost-effective operational footprint. The Central Campus land use includes all non-hazardous NASA operations that occur in support of NASA missions and programs. Ideal land uses for consolidation include: Administration, Research and Development, and non-hazardous Support Services.

3.11.1.3.9 Support Services

Support services includes all functions other than administration that provide management and oversight of KSC operations and services provided for overall KSC benefit, including operations and maintenance. Operations and maintenance land uses include supply, storage, facilities maintenance, motor pool, service stations, railroad, reclamation areas, roads and grounds maintenance and sanitary landfill facilities. Service land uses include: access control and entry gates; fire protection facilities and training areas; security facilities and related training areas; child development and care; training and conference; dispensary; data processing; environmental and occupational health; food service and photo operations facilities.

3.11.1.3.10 Public Outreach

The public outreach land use classification includes facilities and associated land areas that promote an educational, research or informational connection between the community and KSC. Examples of Public Outreach use include public reception/welcome centers, tour facilities, display and education areas, museums, memorials, launch viewing areas, recreation areas and conference centers.

3.11.1.3.11 Recreation

Recreation areas include parks, outdoor fitness, athletic fields, recreation buildings, centers and clubs. Examples of recreation land uses include KARS Park North and KARS Park South complexes. Coastal beaches and supporting facilities are part of the Canaveral National Seashore and are classified as Operational Buffer/Public Use. Hunting, fishing, wildlife observation and photography, and environmental education and interpretation associated with the Merritt Island National Wildlife Refuge are also classified as Operational Buffer/Public Use.

3.11.1.3.12 Research and Development

The research and development (R&D) land use classification includes non-program specific laboratories, related facilities and associated land areas that perform research, experimentation and testing in support of developing new technologies, procedures and products to enhance existing and future programs at KSC.

Light industrial and manufacturing functions, as well as commercial uses may also be accommodated within R&D land use areas. Integration of educational institutions offering advanced degrees in disciplines supporting space-related research and development activities provide added enhancement and support reinforcing R&D collaboration between KSC, private industry and the educational community. Examples of R&D land uses include chemical and physical standards and laser testing laboratories; missile research and testing facilities; centers for experimentation; innovative science and technology; and life science activities accommodated in Exploration Park.

3.11.1.3.13 Seaport

The Seaport land use classification includes: port, harbor, wharves, docks and associated land areas to accommodate authorized delivery or embarkation of materials, equipment or people via access to the mainland through means of seagoing vessels. Land areas contiguous to wharves and docks that are used for the staging, off-loading, transfer and storage/processing of materials, equipment or people are also classified as Seaport land use.

3.11.1.3.14 Renewable Energy

Land areas designated to accommodate varying forms of renewable energy are designated Renewable Energy land use. Corresponding to fallow agricultural land and other underutilized property, land areas designated as Renewable Energy also includes research and production facilitating KSC's goal for achieving increased on-site generation of its power from renewable sources. This includes current and future accommodation of solar array fields, as well as other emerging renewable energy technologies that may be developed in the future.

3.11.1.3.15 Operational Buffer

The buffer land and water area includes the beach; hunting and fishing areas; trails; submerged areas; areas vulnerable to inundation by rising waters under storm events and climate change impacts; and areas of high value for species of critical concern such as Florida scrub-jay, red knot, West Indian manatees, and sea turtles. The two sub-categories of Operational Buffer are: Public Use and Conservation. Operational Buffer/Public Use areas correspond to publically accessible areas of Merritt Island NWR and the Canaveral National Seashore for recreational use in the northern portion of KSC, as a conditional use subject to the operational activities associated with KSC's mission. Operational Buffer/Conservation areas correspond to land areas in the southern portion of KSC that may never have been developed, or sites that may have reverted to a natural environment over the years.

3.11.1.3.16 Open Space

Open space at KSC currently consists of 1,873 acres of land.

3.11.1.3.17 Roads and Bridges

KSC is serviced by over 211 miles (340 km) of roadway with 163 miles (263 km) of paved roads and 48 miles (77 km) of unpaved roads. Of the five access roads onto KSC, NASA Parkway West serves as the primary access road for cargo, tourists, and personnel entering and leaving. This four-lane road originates in Titusville as State Road 405 and crosses the Indian River Lagoon onto KSC. Once passing through the Industrial Area, the road reduces to two lanes of traffic. It then crosses the Banana River and enters the CCAFS. The third point of entry onto KSC is from the south via South Kennedy Parkway, which originates on north Merritt Island as State Road 3. This road is the major north-south artery for KSC and is also a four-lane highway. The fourth entry point is accessible from Titusville along Beach Road, which connects to North Kennedy Parkway. The final access point is south of Oak Hill at the intersection of U.S.1 and North Kennedy Parkway.

A railroad spur runs from the Florida East Coast rail line to KSC. The spur spans the Indian River and Intracoastal Waterway via a causeway and bascule bridge from Wilson, on the mainland, to Merritt Island. Approximately 40 miles (65 km) of rail track provide heavy freight transport to KSC. Transportation infrastructure and systems are covered in greater detail in Section 3.12, Transportation.

3.11.1.4 Land Use Controls

By separate Memorandum of Agreement (MOA), effective February 23, 2001, with the EPA and Florida Department of Environmental Protection (FDEP), KSC, on behalf of NASA, agreed to implement Center-wide, certain periodic site inspection, condition certification and agency notification procedures designed to ensure the maintenance by Center personnel of any site-specific land use controls (LUCs) deemed necessary for future protection of human health and the environment. Although the terms and conditions of the MOA are not specifically incorporated or made enforceable within each LUC Implementation Plan (LUCIP) by reference, it is understood and agreed by NASA KSC, EPA, and FDEP that the permanence each LUCIP's proposed measures shall be dependent upon the Center's substantial good faith compliance with the specific LUC maintenance commitments. Should such compliance not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy may be reconsidered and that additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment. LUCIPs are generally prepared for sites undergoing some type of corrective action and will remain in place until the site conditions requiring land use controls are eliminated (NASA, 2010a, 2015).

3.11.1.5 Land Use Permits

Special land use permits are considered during review of facility siting requests. Both duration of the permit and assignment of the permit vary. Three examples of current special land use permits are KARS Park, COE spoil site, and LC-39 press site. A permit has been obtained for a recreation area (KARS Park I and II) located on Center property. KSC personnel and their families use these parks. The Corps of Engineers has a permit for a spoil area located on the north bank of the Barge Canal at the southern boundary of KSC. Many of the news media lease areas in the Press Site for news gathering and broadcasting facilities. Major media leaseholders include Associated Press, American Broadcasting Company, Columbia Broadcasting System, National Broadcasting Company, Cable News Network, Spaceflight Now, and Nikon. Several newspaper organizations including Orlando Sentinel and Florida Today also use Press Site property.

The Center formed a partnership with the State of Florida to develop a 400-acre (161 ha), campus-like and ecologically friendly research park with a balanced mix of academic and commercial tenants. In order to take advantage of this established partnership, the Center constructed a 100,000 ft^2 (9,290 m^2) facility, the Space Life Sciences Lab containing state-of-the-art laboratories. Enhanced Use Leasing allows NASA to recover asset values, reduce operating costs, improved facility conditions, and therefore improve mission effectiveness. NASA encourages the use of its property and facilities by other agencies, industries, and universities.

NASA-KSC and Florida Power and Light (FPL) have entered into an Enhanced Use Lease (EUL) for the purpose of developing and operating a photovoltaic facility to generate renewable energy for use and distribution by both parties. Phase 1 is a 30-year lease of 60 acres (24 ha) for construction of a 10 MW facility. A second phase would be a lease option for additional 48 acres (19 ha) contingent upon an FPL proposal being accepted by NASA-KSC. Space Florida plans to continue to develop Exploration Park on KSC property for space-related business, transportation and educational activities.

3.11.1.6 Land Use Agreements

KSC has entered into agreements with the USFWS and NPS regarding property management concerning MINWR and CNS. KSC has an agreement with the USFWS and NPS to:

- Manage KSC property that is not used specifically for Space Program activities
- Manage KSC property that is not assigned to the NPS to manage as part of the CNS

KSC has an agreement with the U.S. Department of the Interior for management of a part of the CNS by the NPS and a part by the FWS. The NPS administers a 6,655-acre area of the CNS including a 24-mile long beachfront. The NPS has developed a General Management Plan (GMP) which summarizes the Service's immediate and long-term resource management objectives.

3.11.2 Environmental Consequences Including Cumulative Impacts

3.11.2.1 Proposed Action

The Proposed Action involves actions to be taken in conjunction with an updated CMP that proposes and describes Center-wide operations and activities for a 20-year planning horizon from 2012–2032. This includes a range of future scenarios from repurposing existing facilities and recapitalizing infrastructure, to reorganizing KSC management of its land resources with various types of commercial partnerships.

3.11.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

The goal of the future land use plan (Figure 2.1-1) is to promote the most efficient use of land area resources balanced with an understanding of development suitability and development capacity. An understanding of existing land use characteristics forms the basis of an overall development framework to support continuing NASA programs and encourage future non-NASA opportunities (NASA, 2013e). This includes promoting compatible relationships between adjacent land uses, encouraging infill development and preserving environmentally sensitive areas. The future land use plan also aims to support expansion of the site's quint-modal capabilities to provide multi-use spaceport users increased support. The plan outlines where development can occur, how land can be used, and how strategic capabilities can be expanded to support KSC's evolution to a multi-user spaceport. Through this approach, KSC aims to better separate potentially hazardous operations from less-hazardous operational areas and non-NASA operations from NASA operations.

Table 2.1-1 identifies existing and proposed future land uses at KSC and their proposed acreages under the 2013 KSC Master Plan. Proposed future land use at KSC is shown in Figure 2.1-1.

The consolidation of NASA operations into a smaller geographic footprint is a major component of the Future Land Use Plan. Applying the Central Campus concept, for example, would allow NASA to recapitalize, over time, functions and capabilities into more efficient facilities on a smaller footprint and combine once spread-out non-hazardous functions into a smaller, more efficiently secured geographic footprint.

Future development and potential land use changes that may occur as a result of implementation of the proposed CMP Update are described below.

3.11.2.1.1.1 Utility Systems

Utility corridors will be established as needed, and are anticipated to increase by approximately two acres under the Proposed Action.

3.11.2.1.1.2 Administration

Facilities supporting Administration functions are planned to be recapitalized into the Central Campus area over the near, medium, long-term and beyond. Consolidation of non-hazardous facilities, such as administration facilities, is a necessary precursor to the consolidation of NASA operational areas to support a multi-user spaceport. Under the Proposed Action, land use supporting Administration would decrease by 64 acres.

3.11.2.1.1.3 Central Campus

The Central Campus area would be populated over the planning horizon and beyond to support any non-hazardous new NASA development in support of NASA programming and as part of the KSC's recapitalization process. Facilities that are meant to be relocated to Central Campus through recapitalization efforts are NASA facilities being utilized for Administration, Research and Development, and non-hazardous Support Services functions that have aging-related operational inefficiencies and excessive maintenance requirements whose relocation would support decreased CRV and O&M costs. Underutilized and deteriorated vacated buildings would be demolished to reduce operation and maintenance costs. Under the Proposed Action, 138.75 acres of land would be assigned to the Central Campus. This represents an increase in land acreage in this category.

3.11.2.1.1.4 Support Services

Future development of non-hazardous support services facilities and recapitalization of inefficient existing facilities are intended to occur in the Central Campus area to support right-sizing efforts and the consolidation of NASA operational areas. Land associated with Support Services would increase by 252.5 acres under the Proposed Action.

3.11.2.1.1.5 Public Outreach

Existing public outreach areas are retained and designated in the Future Land Plan. Current venues would be renovated and new venues would be added. This includes public reception/welcome centers, tour facilities, display and education areas, museums, memorials, launch viewing areas, and recreation areas. An educational complex would be developed. The Press Site would be relocated from LC-39 due to impending safety concerns. Deteriorated maintenance support facilities would be renovated or replaced, a new administration building would be constructed, and infrastructure would be constructed to support new facilities.

3.11.2.1.1.6 Recreation

Additional recreational land use areas are not planned, so future development or expansion of recreational functions, if necessary, would occur within the already established recreational land areas. Existing acreage devoted to recreation would not change under the Proposed Action.

3.11.2.1.1.7 Research and Development

Additional R&D development would be directed to the Industrial Area with non-NASA development designated for west of C Avenue or within Exploration Park in order to provide separation from NASA operational areas. New NASA R&D facilities and recapitalization of existing NASA R&D facilities would be directed to Central Campus in the designated area east of C Avenue. The first phase proposed is 60 acres adjacent to the Space Life Sciences Laboratory (SLSL) to provide office, flex space and processing/light manufacturing facilities for industry, academia, and Government users. Additional phases would be developed as the need for facilities is identified. Land designated for Research and Development under the Proposed Action would increase by 779 acres.

3.11.2.1.1.8 Seaport

Additional land areas (for an increase of 286 acres under the Proposed Action) are designated as Seaport to support future development of the sea-based transportation capability to further leverage quinti-modal functionality and to also capitalize on surrounding area water accessibility and linkage to Port Canaveral. A future Seaport is designated to the west of the SLF to provide water access in support of horizontal launch and landing operations via the Indian River. An additional Seaport is designated to the south of the Assembly, Integration and Processing Area on the east side of the Industrial Area. This Seaport would provide water access to support all operations and functional areas within the Industrial Area.

3.11.2.1.1.9 Renewable Energy

Former citrus groves that have now become fallow are designated as future land areas to accommodate Renewable Energy uses. Additional land for renewable energy use is also designated in the Industrial Area and can be accommodated as secondary uses in parking lots. Land designated for Renewable Energy purposes would increase under the Proposed Action by 1,043.3 acres.

3.11.2.1.1.10 Operational Buffer

Development in Operational Buffer areas may include infrastructure, operations of low impact, or small footprint facilities that may be required for support of space launch or landing operations. Under the Proposed Action, land associated with the conservation component of the Operational Buffer would be decreased by 4,386.2 acres. Land associated with the public use component of the Operational Buffer would be decreased by 19.4 acres.

3.11.2.1.1.11 Open Space

As shown in Table 2.1-1, under the Proposed Action, open space would be decreased by approximately 1,874 acres. The Open Space land use classification includes undeveloped open land within developed activity centers identified as likely for future development. The criteria for open space include existing land that is primarily cleared of natural vegetation, level, and located in or immediately adjacent to developed activity centers where future expansion of existing facilities may be anticipated.

3.11.2.1.2 Launch, Landing, Operations and Support

3.11.2.1.2.1 Vertical Launch

In keeping with previous recommendations from the 1966, ‘72 and ‘77 KSC Master Plans, when the market demands an expansion of vertical launch capacity this Plan recommends additional vertical launch pads to be sited to the north of existing 39B, as pads 39C and 39D respectively. In addition, a 2007 Vertical Launch Site Evaluation Study also concluded that a vertical pad could also be sited to the south of 39A and to the north of pad 41. Structures in poor condition or considered surplus would be eliminated. Land use associated with Vertical Launch purposes would increase by 176 acres under the Proposed Action.

3.11.2.1.2.2 Vertical Landing

Land use associated with Vertical Landing at KSC would increase by 76 acres under the Proposed Action.

3.11.2.1.2.3 Horizontal Launch and Landing

Apron areas supporting the SLF are intended to be expanded to accommodate future horizontal launch and landing activities and customers along with associated support facilities. Expansion of these capabilities is expected to be consistent with the recommendations outlined in the 21st Century Launch Complex ADP (April 2012). Initial development will be focused on the east side of the runway and future development, if required, will be accommodated on the west side. Over the long term, as the market and emerging technology may demand, additional horizontal launch infrastructure may be constructed in an area identified just south of Beach Road that will support an east-west horizontal launch capability. Under the Proposed Action, land use associated with Horizontal Launch and Landing would increase by 2,337 acres.

3.11.2.1.2.4 Launch Operations and Support

Launch Operations and Support areas will be expanded, if needed, to accommodate future launch activities and the requirements of NASA and non-NASA operations. It is anticipated that, under the Proposed Action, land use associated with Launch Operations and Support would increase by 107.4 acres.

3.11.2.1.2.5 Assembly, Testing and Processing

Assembly, Testing and Processing areas may be expanded to the north of the existing developed areas in the VAB Area to accommodate future Assembly, Testing and Processing functions. Development in the expanded areas would require seawall construction to comply with sea level rise criteria. Land areas in the vicinity of Contractors Row previously designed as Support Services are designated as Assembly, Integration and Processing in support of future needs and requirements. In the Industrial Area, Assembly, Testing, and Processing payload functions may be expanded to the north and east of their current concentration to accommodate increased payload processing and testing. Under the Proposed Action, land use supporting Assembly, Testing, and Processing would be increased by approximately 1,419 acres.

3.11.2.1.3 Future Transportation Plan

3.11.2.1.3.1 Roads and Bridges

Over the next five years, repair and resurfacing of over 29 miles of Kennedy Parkway is anticipated. Repair and resurfacing is also planned for over three miles of NASA Parkway east of Kennedy Parkway. The two and four-lane sections east of the Industrial Area toward the Banana River Bridge will also be repaired.

In support of the Central Campus concept, the near term would see the elimination of D Avenue access between NASA Parkway and 2nd Street SE to clear the way for construction on Central Campus Phase 1. The north segment of this road would be used for access to parking to the new facility. Development of a new facility and supporting roadway and other infrastructure would require a separate NEPA analysis. As the Central Campus concept develops over the medium and long term, additional infrastructure changes may be required to support the consolidation and security of NASA operations in the area.

A road easement should be recognized that would make it possible, if future demand requires, having access to new development capabilities contributing to non-NASA vertical launch support operations. This easement would support access to new development and serve as a barrier to further development east.

To further promote KSC's multi-user concept, a commercial entity may require the development of new vertical launch capabilities that meet their specific needs. Should the market necessitate this expansion, the development would be directed to areas north of LC39B along Beach Road. To support this added capability, a road easement is proposed that will support access from Beach Road to the pad location with such a road expansion being funded by a Non-NASA entity.

3.11.2.1.3.2 Water

To support the expansion of this transportation capability, the Master Plan has identified areas with potential future rail spurs that would be ideal for the development of additional seaports to support future non-NASA spaceport operations: an area adjacent to the Industrial Area provides water access to future manufacturing and research and development areas on the east side of the Center; and an expansion of the Turn Basin capability could provide increased access from the Banana River Channel to the VAB area. There would be no change to the acreage of water bodies present at KSC under the Proposed Action.

3.11.2.1.4 Summary of Impacts

Under the Proposed Action, acreage at KSC currently used for administration, open space, an operational buffer (for both conservation and public use), and support services would decrease. There would be no change to acreage associated with water or recreation. Acreage currently used for Assembly, Testing, and Processing; Central Campus; Horizontal Launch and Landing; Launch Operations and Support; Public Outreach; Renewable Energy; Research and Development; Seaport; Utility Systems; Vertical Launch; and Vertical Landing would increase. Though Table 2.1-1 shows an increase in total area of approximately 76 acres, this is attributable to the addition of the Vertical Landing category, which lies within the same geographical footprint as the Horizontal Launch and Landing category.

The consolidation of NASA operations into a smaller geographic footprint is a major component of the Future Land Use Plan. Applying the Central Campus concept would, over time, allow NASA to recapitalize functions and capabilities into more efficient facilities on a smaller footprint and combine once spread-out non-hazardous functions into a smaller, more efficiently secured geographic footprint. Ideal Land Uses for consolidation include: Administration, Research and Development, and non-hazardous Support Services. Underutilized parking facilities that are unable to be repurposed would, ideally, be demolished to increase permeable land on Center as a suitable alternative to being abandoned in place. Former citrus groves that have now become fallow are designated as future land areas to accommodate Renewable Energy uses. These possible land use and land cover changes would be minor to moderate in magnitude, of small extent, long-term, and beneficial.

However, road easements and expansions would also occur. Operational buffer areas would experience development that would include the construction of infrastructure, operations of low impact, or small footprint facilities that may be required for support of space launch or landing operations. Assembly, Testing and Processing areas may be expanded to the north of the existing developed areas in the VAB Area to accommodate future Assembly, Testing and Processing functions. Development in the expanded areas would require seawall construction to comply with sea level rise criteria. The near term would also see the elimination of D Avenue access between NASA Parkway and 2nd Street SE to clear the way for construction on Central Campus Phase 1.

Apron areas supporting the SLF are intended to be expanded to accommodate future horizontal launch and landing activities and customers along with associated support facilities. Initial development would be focused on the east side of the runway and future development, if required, would be accommodated on the west side.

Over the long term, as the market and emerging technology may demand, additional horizontal launch infrastructure may be constructed in an area identified just south of Beach Road that will support an east-west horizontal launch capability.

NASA-KSC and FPL's EUL, though it would bring about greater renewable energy use at the site, would entail construction of a 10 MW facility. The possibility of leasing land to commercial entities to develop and operate a Commercial Vertical Launch Complex (CVLC) on KSC property is under consideration. In addition, Space Florida will continue developing Exploration Park on KSC property for space-related business, transportation and educational activities.

As implementation of the CMP Update occurs, NASA would work closely with USFWS and NPS to determine the appropriate methods for, locations of, and mitigations pertaining to projects within KSC, MINWR, and CNS. Expansion of SLF-related capabilities is expected to be consistent with the recommendations outlined in the 21st Century Launch Complex ADP (April 2012). Environmental impacts related to land use would also be minimized or mitigated through consistency with the environmental stewardship objectives described in the CMP. Development in environmental remediation areas would be avoided in favor of unencumbered sites.

Due to the proposed changes, construction, and demolition activities that would occur, and BMPs that would be followed, in conjunction with the implementation of all projects, impacts to land use are anticipated to minor to moderate, depending on the acreage impacted, the land cover to be changed, and the number or type of projects to be carried out in that area. Impacts are anticipated to be of small to medium extent, long-term, and possible.

3.11.2.1.5 Cumulative Impacts

The proposed land use changes would occur within the existing KSC site, and would thus have a small cumulative impact on land use when viewed from a site-wide or local perspective. Any decisions regarding changes to land use would be made in conjunction, where relevant, with neighboring/partnering administrative entities.

Development at and near the site by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS may spur further land use change in the local or regional area. This could spur further development to support the housing and other needs of those that may relocate to the area as a result of that development. This subject is covered in greater detail in Section 3.15, Socioeconomics.

When considered in combination with all other reasonably foreseeable actions (including municipal development induced by the need to accommodate a larger workforce), overall cumulative impacts to land use over the coming several decades would likely be moderate in magnitude.

3.11.2.2 Alternative 1

The direct, indirect, and cumulative impacts of Alternative 1 on existing land use would be very similar to those of the Proposed Action, with three important exceptions. First, the proposed new seaports would not be built. Second, the horizontal launch and landing area north of Beach Road might not be built, and third, new vertical launch sites north of LC-39 become “notional” rather than definite.

3.11.2.3 No Action Alternative

Under the No Action Alternative, current land uses and their configuration at KSC would remain unchanged for the duration of the 20-year planning horizon (2012-2032). Existing land uses are shown in Figure 2-3. The same land use classifications are used to describe the primary activity of all existing facilities and associated land areas as are used in the Proposed Action above.

Under the No Action Alternative, the total land and water area under jurisdiction of KSC would remain at approximately 140,000 acres. Of this total area, about 85,000 acres would continue to be owned by NASA and the remaining 55,000 acres by the State of Florida and dedicated for the exclusive use of the U. S. Government under Deeds of Dedication. The entire 140,000-acre land total would remain under USFWS management. This entire area, in association with adjacent water bodies, would continue to serve as buffer zones. A portion of the seashore on the eastern edge of the Center would continue to be available for public recreation purposes on a non-interference basis. Under the No Action Alternative, the existing KSC transportation system would remain essentially unchanged except for routine maintenance.

The affected environment as described in this resource section would not be affected by construction or operations as described under the Proposed Action. Any existing activities or operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Individual actions proposed from the Proposed Action impacting land use may proceed but would have to do so after environmental assessment under separate environmental documentation.

Because there would be no change to land use under the No Action Alternative, there would be no additional impacts on this resource.

3.12 Transportation

This section addresses existing regional transportation involving the roadway network, average daily traffic; KSC transportation systems involving the roadway network and traffic; as well and other transportation modes to include rail, water, aviation, and transit.

3.12.1 Affected Environment

Transportation near KSC is achieved mainly via road and street networks and pedestrian walkways. KSC is serviced by over 211 miles of roadways, with 163 miles of paved roads and 48 miles of unpaved roads. NASA Parkway West (Route 405) is the primary entrance and exit for cargo, tourists, and personnel (NASA, 2007). Regional access is provided by Interstate (I)-95. State routes that provide access to the area include South Washington Avenue (U.S. Route 1), Max Brewer Memorial Parkway (Route 402), and NASA Parkway West, while Kennedy Parkway North provides direct access at the north side of KSC. The annual average daily traffic counts (AADT) for these roadways are compiled in Table 3.12-1.

Table 3.12-1. Annual average daily traffic counts for nearby off-Center roadways

Roadway	Number of Lanes	Posted Speed Limit	AADT
I-95	6	70	26,000
Max Brewer Memorial Parkway	2	55	450
NASA Parkway West	4	45	11,500
Kennedy Parkway North	2	45	900
South Washington Avenue	4	45	26,500
Space Commerce Way	2	35	2,800

Source: FDOT, 2014

NASA Parkway West is a four-lane road and originates in Titusville as Route 405 and crosses the Indian River Lagoon onto KSC. Once passing through the industrial area, the road crosses the Banana River and enters the Cape Canaveral Air Force Station (CCAFS). Design standards for primary roads and highways mandate 24-feet widths and for two-lane roads, a 40-feet wide median strip. All paved roads conform to the American Association of State Highway and Transportation specification H20-S16. This specification establishes a load bearing capacity of 20 tons for a tractor truck and a gross single axle weight of 16 tons (NASA 2010). All roads to KSC have access control points and are manned 24 hours per day, seven days per week. Entry from the south is Kennedy Parkway, which originates on north Merritt Island as State Road 3. This road is the major north-south artery for KSC and is a four-lane highway. The entry point from Titusville is along Beach Road, which connects to Kennedy Parkway. The final access point is south of Oak Hill at the intersection of South Washington Avenue and Kennedy Parkway (NASA 2010).

The average annual daily traffic (AADT) is the average number of vehicles traveling along a roadway each day. Level of Service (LOS) is a measure of the operational conditions on a roadway or at an intersection. LOS range from A to F, with “A” representing the best operating conditions (free flow, little delay) and “F” the worst (congestion, long delays). LOS A, B, or C are typically considered good operating conditions. Table 3.12-2 outlines the routes near the proposed sites and in the area, their AADT, and their estimated existing LOS. Notably, some of the nearby roadways are already congested during peak traffic periods (i.e. LOS D, E, or F).

Table 3.12-2. Traffic volumes and estimated LOS – existing

Roadway	One-way peak hr. volume (V) [vph]	Volume to capacity ratio (V/C)	Estimated existing level of service (LOS)
I-95	936	0.55	D

Roadway	One-way peak hr. volume (V) [vph]	Volume to capacity ratio (V/C)	Estimated existing level of service (LOS)
Max Brewer Memorial Parkway	49	0.03	A
NASA Parkway West	621	0.37	C
Kennedy Parkway	97	0.06	A
South Washington Avenue	1,431	0.84	E
Space Commerce Way	302	0.18	B

Source: FDOT 2014 and ITE 2003

3.12.1.1 Rail

The closest Amtrak station is 45 miles away in Winter Park (Amtrak 2014). A railroad spur runs from the Florida East Coast rail line to KSC. Construction of the KSC Railroad was completed in 1965. Approximately 40 miles of rail track provide heavy freight transport to KSC (NASA 2010). 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. The NASA Railroad crosses the Indian River via the Jay Jay Bridge. The west branch of the railroad, with a length of 11 miles, extends from Wilson's Corner to the KSC Industrial Area (NASA 2013).

Figure 3.12-1. Railroad tracks at KSC and MINWR

3.12.1.2 Public Transportation

Public transportation is provided by Space Coast Area Transit (SCAT). SCAT operates fixed route service Monday - Saturday from 7:45 a.m. to 6:00 p.m. The closest stop to KSC Visitor Center is in Merritt Island Route (SCAT 2014).

3.12.1.3 Airports

The closest airport is NASA Shuttle Landing Facility (SLF) which has an average of 66 operations per week (AirNav 2014).The closest international airport is Orlando Sanford International (SFB) which is 35 miles away and has 221 operations per day (AirNav 2014). Other nearby airports include Arthur Dunn Airpark, Space Coast Regional Airport, Cape Canaveral Air Force Strip, Merritt Island Airport, and Patrick Air Force Base.

3.12.1.4 Launch Facilities

Facilities include space vehicle launch and landing facilities, numerous vehicle and payload processing facilities, fuel handling systems, and several industrial, laboratory, clean rooms, and office complexes. Through the 30 year flight history of the Space Shuttle Program there were 135 launches, 82 from Pad 39A and 53 from Pad 39B (NASA, 2014).

3.12.1.5 Waterways

Port Canaveral is the nearest navigable oceanic connection to KSC. Navigable access from Port Canaveral to KSC docking facilities at Hangar AF (CCAFS) and the Barge Turning Basin is provided by 19.3 miles of maintained channels. The docking facilities at Hangar AF Wharf are used primarily for the retrieval of the solid rocket booster motors following launches. The Turning Basin Wharf is used to unload the external fuel tanks of the space transportation system and other heavy equipment suited to waterway transport. A total of 1,578 feet of dockage is available at the existing wharf facilities (NASA 2010).

Port Canaveral provides water access to KSC facilities through a canal that links the port with the Intracoastal Waterway in the Indian River.

3.12.2 Environmental Consequences Including Cumulative Impacts

This section provides a discussion of the environmental impacts to transportation resources that would result from the Proposed Action and No Action Alternatives. Impacts were primarily assessed by reviewing existing conditions at KSC, and determining the potential effects the Proposed Action would have on traffic and other transportation resources. The extent of the impacts would depend on the size and nature of the project; however, in general impacts would be considered significant if the Proposed Action was expected to have appreciable changes in the overall traffic volume or LOS on affected intersections or roadways.

3.12.2.1 Proposed Action

Short- and long-term minor adverse effects would be expected. The Proposed Action would result in the continuation of many of the modes of transportation presently occurring at KSC but potentially in greater amounts. Short-term increases in traffic would result from construction worker commutes during construction and demolition activities. Long-term effects would be primarily due to additional worker commutes and changes in traffic patterns near more centralized activities at KSC. Increased traffic volumes and changes in traffic patterns, and changes in both vertical and horizontal launch activities would have minor effects, and there would be some long-term beneficial effects from upgrades in transportation infrastructure. The Proposed Action is not expected to have appreciable changes in the overall traffic volume at KSC; however, some components could affect the LOS at intersections or roadways both on and off the facility.

3.12.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

The implementation of the land use plan, future development plan, and functional area plans would have short- and long-term minor adverse effects on traffic and transportation resources. Short-term effects would be from worker commutes and some truck traffic during demolition of aging or outdated facilities and construction of new facilities. Long-term effects would be from worker commutes to and from the KSC and changes in launch activities. This section outlines effects from planning activities, and demolition and construction activities. Effects from proposed changes in launch, landing, operations, and support activities are addressed in Section 3.12.2.1.2. Effect from proposed changes in non-space-based transportation activities and infrastructure upgrades are addressed in Section 3.12.2.1.4.

3.12.2.1.1.1 Planning Activities

The planning activities associated with the updated land use plan, future development plan, and functional area plans in-and-of themselves would not generate any traffic or changes to transportation infrastructure. Therefore, planning activities and updating the land use designations would have no effect on traffic and transportation resources.

3.12.2.1.1.2 Construction and Demolition Activities

Any construction or demolition activities that occurred as result of the future activities at KSC would have short-term minor adverse effects on transportation and traffic. These effects would be primarily due to construction worker commutes and delivery of equipment and materials to and from the construction and demolition sites. The roadway infrastructure would be sufficient to support the increases from construction vehicle traffic. Congestion may increase in the immediate area of construction and demolition sites because of additional vehicles and traffic delays near sites. In addition, road closures or detours to accommodate utility system work may occur. Although effects would likely be minor, there is a wide range of possible demolition and construction scenarios. *Future or tiered NEPA would require assessment of effects to traffic and transportation resources for actions that include more than 1,000,000 gsf/yr of demolition or construction, the addition of new roadways, or the closure of existing roadways,*

Although the effects would be minor, during any construction or demolition activities, contractors would route and schedule vehicles to minimize conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts. All on-and off-road trucks and heavy equipment would be equipped with backing alarms, two-way radios, and Slow Moving Vehicle signs when appropriate.

3.12.2.1.2 Launch, Landing, Operations and Support

Launch, landing, operations and support would have short- and long-term minor adverse effects on transportation resources. Short-term effects would be from worker commutes and delivery of heavy equipment and materials during construction and modification of launch and support facilities. Long-term effects would be from worker commutes to and from the KSC and increases in launch activities. This section outlines effects from:

- Site modifications and pre-launch preparations;
- Vertical launch activities; and
- Horizontal launch activities.

Traffic and transportation effects from planning activities and associated demolition and construction activities are addressed in Section 3.12.2.1.1. Effect from proposed changes in non-space-based transportation activities and infrastructure upgrades are addressed in Section 3.12.2.1.4.

3.12.2.1.2.1 Site Modifications and Pre-Launch Preparations.

For most launch programs, site modifications would normally be minor and limited to launch pads and facilities directly related to individual launches and test programs. Modifications to existing facilities may include clearing, grading, and limited construction. Traffic from worker commutes during site modifications and pre-test preparations are expected to be minimal and temporary. Effects on traffic and transportation would be similar in nature and overall level as demolition and construction traffic in Section 3.12.2.1.1. Because these activities would take place on KSC, the public in the surrounding areas would not normally detect an increase in traffic; therefore, site modification and pre-launch preparations would not cause significant traffic impacts. However, as with other construction activities, *future or tiered NEPA would require assessment of effects to traffic and transportation resources for actions that include more than 1,000,000 gsf/yr of demolition or construction, the addition of new roadways, or the permanent closure of existing roadways,*

Prelaunch operations and assembly would likely introduce minor local roadway traffic and a small increase in aircraft operations for component delivery. These activities would be minute when compared to current KSC activities, and would not appreciably change the existing transportation environment. As a result, prelaunch processing and assembly of launch vehicle components would not cause significant impacts to transportation resources.

3.12.2.1.2.2 Vertical Launch and Landing

Under the Proposed Action, vertical launches and landings would be ongoing at KSC. In the hours before launches, remote sensors and helicopters may be used to verify that the hazard areas would be clear of non-mission-essential aircraft, vessels, and personnel. If helicopters were used to verify that beach areas and near shore waters are clear of non-participants, then they would generally limit their flights to the areas around the base, thus also limiting the effects on local communities. These individual helicopter overflights would be a small fraction of the overall air operations at KSC and would have insignificant effects to air traffic or transportation resources.

Although the exact nature of future vertical launch activities is unknown, the Proposed Action would result in the continuation of vertical launches comparable to that presently occurring at KSC. No appreciable changes in ground-based traffic or transportation would be expected with the launches. Visitation and launch viewing would be comparable to historical conditions. As a result, no significant impacts on traffic and transportation resources are expected from vertical launch activities.

In the hours and days following vertical launches, a general safety check and cleanup of the launch sites would occur. There would be some small amount of traffic from worker commuting, the removal of equipment from the launch site, and general refurbishment of the launch facilities. As with site modifications and pre-launch preparations, post-launch refurbishment activities would not cause significant transportation impacts.

3.12.2.1.2.3 Horizontal Launch and Landing

Under the Proposed Action, horizontal launches and landings could become commonplace at KSC. Launch vehicles would likely consist of traditional commercial aircraft comparable to a 747 and designed to carry an additional launch vehicle that would be released in the upper atmosphere. Although the exact nature of future horizontal launch activities is unknown, the Proposed Action would result in the continuation of aircraft activities comparable to that presently occurring at KSC. As a result, no significant impacts on traffic and transportation resources are expected. Although effects would likely be minor, there are a wide range of possible horizontal launch and landing vehicle types and operating scenarios. Increases in horizontal launch and landing activities are not expected to have appreciable changes in the overall traffic volume at KSC. Because of these uncertainties, *future or tiered NEPA would require a transportation assessment for the action that includes an appreciable change in the number of aircraft operations at KSC.*

3.12.2.1.3 Climate Change

Implementation of the climate change and sea-level rise requirements would have short-term minor adverse effects on the transportation environment. Short-term effects due to increases in traffic would result from construction and demolition activities. Effects from the demolition and construction are addressed in Section 3.12.2.1.1.

Modifications of existing facilities to meet climate change and sea-level rise requirements may include everything from minor hardening efforts to complete on-site demolition and reconstruction. Any demolition or construction required to meet climate change and sea-level rise requirements would be similar in nature and overall level as that outlined in Section 3.12.2.1.1 with the implementation of the land use planning efforts. The roadway infrastructure would be sufficient to support the increase in construction vehicle traffic. Congestion may increase in the immediate area because of additional vehicles and traffic delays near sites. In addition, road closures or detours to accommodate utility system work might occur. Although effects would likely be minor, there is a wide range of possible demolition and construction scenarios. A detailed list of locations is not available at this time; therefore, *future or tiered NEPA would require assessment of effects to traffic and transportation resources for actions that include more than 1,000,000 gsf/yr of demolition or construction, the addition of new roadways, or the permanent closure of existing roadways.*

3.12.2.1.4 Future Transportation Plan

Implementing the transportation plan would have short-term minor and long-term beneficial effects. Short-term effects would be from traffic increases due to construction activities, where long-term effects would be from changes in roadway configurations, traffic patterns, and changes in other modes of transportation throughout KSC. Effects from the demolition and construction are addressed in Section 3.12.2.1.1. The change in ownership of transportation infrastructure associated with the transportation plan in-and-of itself would not generate any traffic or changes to transportation infrastructure; therefore, would have no direct effect on traffic and transportation resources.

3.12.2.1.4.1 Road, Bridges and Parking

Road, bridges and parking improvement and replacement projects would be specifically designed to relieve roadway congestion on and near KSC while accessing new commercial facilities, parking, and operational areas. There would be some construction and resurfacing of roadways with the implementation of the transportation plan; however, most of the activities would take place on KSC, the public in the surrounding areas would not normally detect an increase in traffic. Road, bridge and parking construction would not cause significant traffic impacts.

Long-term effects of the Proposed Action could be due to additional personnel and potentially increased traffic both on and off KSC. The additional vehicles would constitute an incremental change in traffic volumes along roadways near KSC; however, increases would only be a small fraction of the current traffic. Road and bridge divestiture would eliminate the vehicle traffic on and the maintenance of the divested infrastructure and any associated congestion. Rerouted vehicles may cause increases in traffic in centralized areas of KSC; however, these small changes in traffic patterns would have minor effects. Although effects would likely be less than significant, there is a wide range of possible roadway, bridge and parking configurations and potential personnel changes throughout KSC. Because of these uncertainties, *future or tiered NEPA would require transportation assessment for actions that include the addition of new roadways, bridges or access control points, or permanent closure of existing roadways, bridges or access control points.*

3.12.2.1.4.2 Rail and Water

Construction and operation of new rail spurs and seaports would have short-and long-term impacts. Short-term effects would be from traffic increases due to construction activities, where long-term effect would be from changes in rail and port configurations, traffic patterns, and changes in other modes of transportation throughout KSC. Although effects would likely be minor, there is a wide range of possible seaport operating scenarios. *Future or tiered NEPA would require transportation assessment for the establishment, or closure of any seaports or rail spur at KSC.*

3.12.2.1.4.3 Air

Modifications to SLF facilities, infrastructure, the runway, and other airfield systems would have short- and long-term effects. Short-term effects would be from traffic increases due to construction activities, where long-term effect would be from changes in airfield systems configurations, traffic patterns, and changes in other modes of transportation throughout KSC. Although effects would likely be minor, there is a wide range of possible airport operating scenarios. *Future or tiered NEPA would require transportation assessment for the establishment, expansion or closure of any runway at KSC*.

3.12.2.1.5 Programmatic Determinations

A programmatic approach to assess the effect of the Proposed Action on traffic and transportation was performed for this EIS. In general, the overall effects of the action and its components would be less than significant. Site-specific and project-level details are not available at this time; however, based on existing information no additional evaluation under future or tiered NEPA would be required for transportation unless the project:

- Included more than 1,000,000 gsf/yr of demolition or construction;
- Included the addition of new roadways, bridges, or access control points;
- Included the permanent closure of any existing roadways, bridges, or access control points;
- Included the closure of existing or the establishment of any new rail spurs or facilities at KSC;
- Included the closure of existing or the establishment of any new seaports at KSC; or
- Included the establishment, expansion or closure of any runway at KSC.

Without these components, future or tiered NEPA could include this programmatic analysis by reference and eliminate transportation as a resource area carried forward for detailed evaluation.

3.12.2.1.6 Cumulative Impacts

Minor short- and long-term cumulative effects would be expected. Traffic and transportation effects would be primarily due to demolition and construction activities, the introduction of new launches, traffic patterns, and automotive traffic. These activities would constitute incremental increases in traffic and transportation. Increased traffic generated by activities would be concentrated on KSC and are expected to be less than significant. Implementation of the Proposed Action would not contribute appreciably to adverse cumulative effects to traffic and transportation. There are no projects identified that when combined with the Proposed Action that would have greater than significant effects.

3.12.2.2 Alternative 1

With one important exception, the direct, indirect, and cumulative impacts of Alternative 1 would be like those of the Proposed Action. The exception is that under Alternative 1, the two proposed new seaports that are part of the Proposed Action would not be constructed and operated. Thus, under Alternative 1, KSC would not develop these two new facilities to support additional development sea-based transportation capability and capitalize on surrounding area water accessibility and its linkage to Port Canaveral. In this respect, Alternative 1 would be like the No Action Alternative.

3.12.2.3 No Action Alternative

Selecting the No Action Alternative would result in no changes in the impact to traffic and transportation. KSC operations and the current levels of activities would continue without changes, and traffic and transportation would remain unchanged when compared to existing conditions as described in Section 3.12.1.

3.13 Utilities

3.13.1 Affected Environment

3.13.1.1 Major Energy Sources at KSC

KSC is a retail electricity, natural gas, and fuel oil customer. The Institutional Services Contractor (ISC) provides a monthly energy utilization/cost report that feeds NASA's accounting process to "direct charge" facility energy costs to the appropriate KSC program or tenant according to facility use. Each major program has its own facility engineering and operations and maintenance (O&M) contractor. The ISC report also informs the NASA Environmental Tracking System for energy metrics reporting to Department of Energy, Office of Management and Budget, and Congress. Table 3.13-1 summarizes KSC's main facility energy sources and their costs. Table 3.13-2 summarizes how KSC obtains electricity and natural gas.

Table 3.13-1. Major energy sources at KSC

	Electricity	Natural Gas
Contact	• 45 Space Wing (SW) w/Florida Power & Light (FPL)	• Local Delivery: NASA with City Gas Company of Florida • Commodity: Defense Energy Support Center with Interconn Resources, Inc. marketer
System Ownership	• FPL: 115 kiloVolt (kV) transmission • NASA: 13.8 & 13.2kV distribution	• Florida City Gas owns distribution
Billing	• FPL bills KSC for 2 main substations & 9 small loads; rates by size • NASA reimburses 45 SW for Cape Canaveral Air Force Station (CCAFS) facilities	• City Gas bills KSC for 43 small and 4 large accounts • Interconn bills KSC for commodity; rate same for all buildings and fluctuates with monthly price index

Table 3.13-2 summarizes FY 2013 energy consumption and cost for NASA-owned facilities at KSC and CCAFS and reimbursable NASA-leased facilities such as the KSC Visitor Complex, Air Force Facilities located at KSC, etc.

Table 3.13-2. FY 2013 consumption and cost

FY 2013 Consumption & Cost								
	NASA Owned Facilities			NASA Leased Facilities			KSC Totals	
Source	**(MMBtu)**	**(%)**	**Cost($M)**	**(MMBtu)**	**(%)**	**Cost($M)**	**(MMBtu)**	**Cost ($M)**
Electricity	539,313.01	58.82	12.22	146,108.89	15.94	3.31	685,421.91	15.52
Natural Gas	181,005.90	19.74	4.10	50,472.90	5.50	1.14	231,478.80	5.24
#2 Fuel Oil	1,340.58	89.52	0.03	157.00	10.48	0.00	1,497.57	0.03
						KSC Totals (Cost $M)	20.80	

3.13.1.2 Regulatory Overview

The following regulations, policies, and statutes govern the management and utilization of energy systems at NASA-KSC.

Federal

- EO 13514, Federal Leadership in Environmental, Energy and Economic Performance
- 42 U.S.C. 8251, et seq., the National Energy Conservation Policy Act (NECPA), as amended
- EO 13423, Strengthening Federal Environmental, Energy and Transportation Management
- EO 13221, Energy Efficiency Standby Power Devices
- 10 CFR 433, Energy Efficiency Standards for the Design and Construction of New
- Federal Commercial and Multifamily High Rise Residential Buildings
- 10 CFR 434, Energy Code for New Federal Commercial and Multi-Family High Rise Residential Buildings
- 10 CFR 435, Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings
- 10 CFR 436, Federal Energy Management and Planning Programs (includes Life Cycle Costing)

NASA

- NPD 8500.1B, NASA Environmental Management
- NPR 8570.1, Energy Efficiency and Water Conservation
- NPR 8820.2F, Facility Project Requirements

KSC

- CD COMM #2005-08, Energy Conservation at Kennedy Space Center, September 8, 2005
- KNPD 8500.1, KSC Environmental Management
- KNPR 8500.1, KSC Environmental Requirements
- KSC-PLN-1906 Rev B, Energy Management Five-Year Plan

NASA Energy Efficiency Panel
Per EO 13123, Greening the Government through Efficient Energy Management, NASA established the NASA Energy Efficiency Panel to:

- Expedite and encourage use of appropriations and alternative financing to meet the President's energy efficiency requirements and goals
- Provide a forum to guide planning and implementation of energy efficiency activities, including energy and water conservation, greenhouse gas reduction, and use of renewable energy sources

KSC Energy Working Group (EWG)
The EWG was formed in July 1991 to ensure that KSC makes continual progress towards compliance with Federal energy efficiency mandates and reducing energy costs. Regarding energy matters, the EWG provides a forum to develop policies and plans, report progress and

accomplishments, increase awareness, advocate/pursue initiatives and technology applications, forecast consumption/cost, and foster consistency across all Center elements.

The following regulations and policies govern the management and utilization of other utility systems at NASA-KSC:

Safe Drinking Water Act (SDWA)
The SDWA was established to protect the quality of drinking water and its sources (both surface and ground water). The SDWA authorizes the Environmental Protection Agency (EPA) to establish standards and require all owners and operators of public water systems to comply with these health-related standards. In August 1996, amendments to the SDWA were passed to tighten drinking water standards and provide funding to the states to improve water treatment systems. The objectives of the 1996 Amendments focused on:

- Identification, monitoring, and control of drinking water contaminants as identified by EPA and the SDWA
- Enforcement of the regulations
- Collection of treated water data and distribution to the public
- Providing consumer right-to-know information
- Providing funding to the states for necessary treatment system upgrades

The legislature of Florida has enacted the Florida Safe Drinking Water Act (Florida SDWA), sections 403.850- 403.864, F.S. This chapter and chapters 62-550, 62-555, and 62-560, F.A.C., are promulgated to implement the requirements of the Florida Safe Drinking Water Act and to acquire and maintain primacy for Florida under the Federal Act. Under these laws, the State of Florida has delegated the Florida Department of Environmental Protection (FDEP) to promulgate regulations and administer programs for the enforcement of the State and Federal laws concerning our drinking water. FDEP has developed standards and operating practices to protect the health and safety of the public and is responsible for enforcing these regulations and permitting treatment and distribution systems.

The SDWA gives EPA the responsibility for setting national drinking water standards. Since 1974, EPA has set national safety standards for over 80 contaminants that may occur in drinking water. While EPA and state governments set and enforce standards, local governments and private water suppliers have direct responsibility for the quality of the water that is delivered to the tap. The KSC water distribution system is maintained, tested, and treated to ensure that the quality of water delivered measures up to Federal and State standards. These actions are continuously documented due to permitting and reported to the regulatory agencies governing the KSC Potable Water System.

Domestic Wastewater
State regulatory authority over wastewater treatment facilities was established by the Florida Air and Water Pollution Control Act (FAWPCA) Chapter 403 F.S., of 1967. The directives of the FAWPCA were implemented through Chapter 62-3, 62-4, and 62-6 of the F.A.C. Chapters 62-3 F.A.C. and 62-4 F.A.C. deal with effluent quality standards and with permitting requirements, respectively. Chapter 62-600 F.A.C. addresses wastewater facility design and construction criteria. Under these laws, the State of Florida has delegated the FDEP to promulgate regulations and administer programs for the enforcement of the State and Federal laws concerning the

disposal of domestic wastewater. FDEP has developed the Domestic Wastewater Program to set treatment standards and operating practices to protect the health and safety of the public, to protect aquifers, lakes and rivers from harm, and to promote reuse of reclaimed water. FDEP and State Health Departments are responsible for enforcing these regulations and permitting treatment systems.

Industrial Wastewater
In an effort to restore and maintain the chemical, physical, and biological integrity of the nation's waters, the Federal Government enacted the Federal Water Pollution Control Act (FWPCA), commonly known as the Clean Water Act (CWA) amended in 1977. The CWA gives the EPA responsibility for regulating point source discharges of pollutants. The CWA also has provisions for states to administer the Federal legislation after approval from the EPA. Under these provisions, the State of Florida has enacted The Florida SDWA, Chapter 403, Florida Statute and Water Resources, Chapter 373, F.S., to promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of the State's water resources.

The FEDP promulgates regulations and administer programs for the enforcement of the State and Federal laws concerning the disposal of industrial wastewater. FDEP is responsible for issuing permits that authorize the discharge of properly treated wastewater to the land or to waters of the State. Due to the variability of waste streams, industrial waste treatment requirements must be developed on a case-by-case or industry-by-industry basis rather than under a uniform treatment standard. Most industrial wastewater discharges are regulated by specific federal requirements at a minimum. However, if additional treatment is necessary to protect Florida's water quality standards, the industries must provide it.

Stormwater
To manage the issues of flooding and water contamination, the State of Florida created a program that requires the construction of surface water management systems to control stormwater runoff. The Environmental Resource Permit (ERP) program was developed with two main goals. The first is to ensure that any type of new development or changes in land use will not cause flooding by adversely affecting the natural flow and storage of water. The second purpose is to prevent stormwater pollution in lakes and streams and to protect wetland environments. This program is administered by the St. Johns River Water Management District (SJRWMD), and by the FDEP. These two agencies are responsible for reviewing stormwater system designs and issuing permits for their construction and operation.

In October 2000, the EPA authorized the FDEP to implement the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program in the State of Florida (in all areas except Indian country lands). FDEP's authority to assume delegation of the NPDES program is set forth in Section 403.0885, F.S. and is undertaken pursuant to a Memorandum of Agreement with EPA. The NPDES stormwater program regulates point source discharges of stormwater into surface waters of the U.S. and the State. Regulated sources must obtain an NPDES stormwater permit and implement a stormwater management plan that includes pollution prevention techniques to reduce contamination of stormwater runoff.

The NPDES stormwater permitting program is separate from the State's stormwater ERP programs and local stormwater/water quality programs, which have their own regulations and permitting requirements.

3.13.1.3 Utility Systems at KSC

The Utilities Systems land use classification at KSC includes land and facilities associated with KSC utilities infrastructure and systems (i.e., water, wastewater, gas, electrical, chilled water, medium temperature hot water, communications and sewer systems). Utility systems currently occupy 1,327.23 acres of land at KSC. Utility easements help to define patterns and impacts associated with the development of utility systems and the overall land use pattern. Communications lines for line-of sight are identified visual corridors associated with communications components (NASA 2010).

3.13.1.3.1 Drinking Water

KSC uses tap water for a wide variety of purposes such as lawn irrigation, fire fighting, air conditioning, and construction. Commercial and industrial operations also place heavy demands on the public water supply. These include launch operations such as sound suppression and deluge/wash operations, and shuttle and launch vehicle processing operations. KSC uses an average of 1.2 million gpd with a maximum daily average usage of 2.2 million gallons.

KSC is subject to regulation under the SDWA as a supplier since it operates a Non-Transient, Non-Community “Public Water System” as defined by State and Federal regulations. The source of KSC’s drinking water supply is surface water from the Taylor Creek Reservoir and groundwater from wells located in east Orange County. The City of Cocoa operates the Claude H. Dyal Water Treatment Plant that treats the raw water from these sources. Water from this plant is transmitted to KSC via a 24” water main to KSC’s south boundary. At this interface point, the flowrate of water is maintained by booster pumps at the Water Pump Station (N6-1007), while chlorine and a corrosion inhibitor are added to maintain the proper chlorine residual and to maintain the integrity of the distribution system. Water flows through a 24” primary distribution system from the South Gate to the Vehicle Assembly Building (VAB) area. At the intersection of Schwartz Road and S.R. 3, the water can be chlorinated again to maintain the residual concentration. Throughout KSC there are various storage systems and secondary pump systems to supply water needs for fire suppression, launch activities, and potable water.

3.13.1.3.2 Domestic Wastewater

Two domestic wastewater collection/transmission systems, one located in the Industrial Area and one in the VAB Area, provide service for approximately 80 percent of NASA and contractor personnel at KSC. These systems transport raw wastewater to the CCAFS Regional Plant located on the CCAFS. There are a number of septic tank systems throughout KSC that typically support small offices or temporary facilities. Of the existing septic tanks, only a few are permitted under Chapter 64E-6, F.A.C. The remaining septic tanks were constructed prior to the implementation of permitting regulations and are therefore either grandfathered in under these rules or it was determined that a permit was not required for use.

3.13.1.3.3 Industrial Wastewater

KSC currently maintains operating permits for one facility treating industrial wastewater:

- Seawater Immersion Facility at Beach Corrosion Test Laboratory - The Beach Corrosion Test Laboratory is located near Complex 40 along the Atlantic Ocean. The facility is used for testing the resistance of materials and coatings to the natural elements. The industrial wastewater is generated when seawater is withdrawn from the ocean and passed over test materials before being discharged back to the ocean.

Launch Complexes 39A and 39B utilize holding tanks to treat industrial wastewater waste streams generated by sound suppression water, Firex water, SRB exhaust and post-launch washdown. The industrial wastewater generated during launch is collected in deluge tanks and is neutralized with Sodium Hydroxide or Phosphoric Acid. The effluent is discharged to a percolation pond using supplementary sprayfield disposal. The system is operated on a "per launch" basis. Diversion gates direct stormwater runoff to stormwater swales in non-launch configuration. The industrial wastewater permits for Launch Complexes 39A and 39B were surrendered in 2012 and are no longer carried by KSC. The permit for Pad 39B must be re-established prior to the occurrence of a launch.

3.13.1.3.4 Stormwater

KSC has over 100 surface water management systems to control stormwater runoff. The four largest stormwater systems at KSC are the Region I system that serves the Industrial Area, the Sub-basin 11 system that serves the western VAB Area, the VAB South system that serves the south VAB area, and the SLF system.

In addition to those stormwater management systems permitted by the SJRWMD, KSC manages an NPDES Stormwater permit for industrial activities. This permit covers six industrial operations at KSC, which include the Contractors Road Locomotive Yard, the SLF, the Ransom Road Reclamation Yard, the Transportation, Storage and Disposal Facility (TSDF), and the Fleet Maintenance Facility. KSC does not meet the criteria established by FDEP that would categorize it as an urban area and is therefore not required to obtain a permit as a MS4.

3.13.1.3.5 Easements and Rights-of-Way

Easements are provided to utility suppliers such as FPL for power lines, and the right-of-way for AT&T communication cables. Others include the easement used until 1983 by Florida East Coast Railroad and easements for high pressure and natural gas lines. KSC has also granted easements for cellular communication towers to improve cell phone service.

3.13.1.4 NASA KSC Energy Management Goals and Five-Year Plan

NASA energy goals are listed in NPR 8570.1, Energy Efficiency and Water Conservation Technologies and Practices. Since the effective date of the NPR 8570.1, Executive Order (EO) 13123 was superseded by EO 13423, *Strengthening Federal Environmental, Energy and Transportation Management*, and EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*. In addition to EO 13423 and EO13514, two Federal Energy Laws were also passed by Congress; the Energy Policy Act of 2005 (EPAct) and the Energy Independence and Security Act (EISA) of 2007. KSC addresses the Center's intent of meeting these requirements in Table 3.13-3.

Table 3.13-3. KSC energy management and efficiency goals

Energy Issue	Goal
Energy Intensity or Energy Use Index	3% per year or 30% by the end of FY 2015 relative to a FY 2003 baseline
Products	Energy Star or Federal Energy Management Program (FEMP)-designated products that use less than 1 Watt of standby power
Energy Use Measurement & Accounting	Electric metering required in federal buildings by FY 2012, where practicable. Natural gas metering required by FY 2016 where practicable
Federal Building Standard	Buildings to be designed to consume 30% less energy than ASHRAE 90.1-2004 standard where life cycle cost effective (10CFR433)
Major building renovations & expansions	Employ the most energy efficient designs, systems, equipment and controls that are life cycle cost effective
Renewable energy use	3% in FY 2007-2009; 5% in FY 2010-2012; 7.5% in FY 2013 and beyond
Renewable energy sources	At least half of the statutorily required renewable energy consumed in a fiscal year comes from new sources
Solar hot water	Provide 30% of hot water demand with solar hot water heaters where life cycle cost effective
Electronic Products and Services	Ensure 95% of new contract actions, task orders, and delivery orders for products and services are energy efficient (ENERGY STAR® or FEMP-designated), water efficient, bio-based, and are environmentally preferable
Sustainable Facilities	Ensure at least 15% of existing agency buildings and leases (above 5,000 gross square feet) meet the Guiding Principles by FY 2015
Comprehensive Evaluations	Conduct comprehensive evaluations on 25% of covered facilities every year
Projects	Implement energy efficiency projects within two years after completing comprehensive evaluations / appropriated funds can be combined with Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs)
Life-cycle cost analysis	Use in investment decisions for purchases, design, construction, and O&M
Utility costs	Reduce utility costs.
Reduction in Water	Reducing potable water consumption intensity 2% annually

Energy Issue	Goal
Consumption	through fiscal year 2020, or 26% by the end of fiscal year 2020, relative to a fiscal year 2007 baseline.
Agricultural Water Reduction	Reducing agency industrial, landscaping, and agricultural water consumption 2% annually, or 20% by the end of fiscal year 2020, relative to a fiscal year 2010 baseline.
Water Reuse Strategies	Identifying, promoting, and implementing water reuse strategies consistent with state law that reduce potable water consumption.

The EWG updated the KSC Energy Management Five-Year Plan in 2009. The plan divides energy goals among the major programs at KSC, and contains sections where each program identifies how it will meet its share of the goals. The plan serves as a framework for managing the Center's energy program by:

- Summarizing how KSC deploys an energy program that buys and uses energy wisely
- Defining Agency energy goals at the Center and Subdivided levels
- Documenting strategies to meet the goals
- Describing planned contributions of initiatives and projects required to meet the goals
- Identifying gaps where additional effort and resources are required to meet the goals

KSC tracks progress towards energy efficiency goals using energy metrics for all Goal Subject facilities. Previous energy reduction initiatives include lighting retrofits, heating, ventilation, and air conditioning (HVAC) control conversions from pneumatic to digital, conversion to variable speed motor drives, decentralization of an inefficient high temperature hot water distribution system, and minimal renewable energy technology applications as warranted by life cycle cost effectiveness (NASA, 2014).

Figure 3.13-1. Solar photovoltaic panels at the Kennedy Space Center

3.13.2 Environmental Consequences Including Cumulative Impacts

3.13.2.1 Proposed Action

Under the Proposed Action, KSC would continue to be a retail electricity, natural gas, and fuel oil customer. Energy would continue to be delivered as described in Table 3.13-1. Although one of the goals of the Proposed Action is the efficient spacing and right-sizing of buildings at KSC, changes to infrastructure, facilities, and operations would necessitate an increase in land acreage of utility corridors of approximately two acres (from 1,327.2 to 1,329.6). Though this is partly due to newly constructed buildings requiring hookups to power and water systems, the increase in acreage would also be due in part to anticipated movements towards KSC's goal of greater on-site generation of its power from renewable sources.

Utilization of energy sources and other utilities would be managed according to the federal, state, local, and private regulations and policies described under the Affected Environment section. The EWG would focus on the continual progress of KSC towards compliance with relevant mandates, reduction of energy and water costs, and meeting conservation goals. As the individual actions comprising the overall Proposed Action were implemented, utilization of energy and water sources should become more efficient as well, reducing demands on local and regional systems.

3.13.2.1.1 Summary of Impacts

The construction of new facilities or sites within KSC would require the construction of new utilities rights-of-way and installation of new utility lines or extensions for power, water, and telecommunications. Depending on the location and size of the systems to be installed or expanded, the land clearing, trenching, excavation, and other activities associated with the preparation of ROWs and installation of utility lines could have direct and indirect environmental impacts.

Wildlife and vegetation that exist at the KSC site could be impacted by land clearing, excavation of soils, changes to habitat, and the temporary generation of noise. Potential impacts to natural habitat are described further in Section 3.9, Biological Resources. Noise impacts are discussed in Section 3.8, Acoustic Environment (Noise).

Activities such as excavation and trenching associated with the addition and expansion of utility corridors and systems would degrade soil quality and require stockpiling of removed soils. Though most soils would be replaced on top of the buried utility lines, not all existing soils would be needed. Installation activities would increase the runoff of erosion and sedimentation at the site, which may contaminate ground and surface water at the perimeter of the site. Erosion and sedimentation may also be increased were the fallow citrus groves at KSC to be converted as anticipated to increase the land base for solar arrays and other renewable technologies. Soil resources are analyzed in depth in Section 3.3, Soils and Geology.

Because a large portion of the KSC site is already developed, impacts from new and utility systems would not be as substantial as they may be if the site were still pristine, undeveloped land. Additionally, over time, the site as a whole may actually consume less energy and water due to the achievement of greater efficiency and right-sizing under the proposed Central Master Plan. Therefore, it is not anticipated that the capacity of existing utility service providers linked to the KSC site would be exceeded. Any decisions pertaining to the expansion or creation of utility corridors would be made in accordance with the goals of KSC's Energy Management Five-Year Plan.

With consideration of all temporary and permanent impacts described, impacts from the installation and expansion of utility systems at KSC under the Proposed Action are anticipated to be minor to moderate and of small to medium extent. The magnitude and extent of the impacts would depend on the specific land area chosen as a utility corridor, and the size of the pipeline or system extension required. Impacts would be short-term (those that would occur during construction and installation) and long-term (those that would occur throughout the life of the proposed CMP activities), and probable.

3.13.2.1.2 Cumulative Impacts

The proposed utility changes would occur within the existing NASA KSC site, and would thus have a relatively small cumulative impact on land and utility service providers when viewed from a site-wide or local perspective (with an increase of two acres of land devoted to utility corridors of a total of 140,000 acres at KSC). Any decisions regarding changes to utilities would be made in conjunction, where relevant, with neighboring/partnering administrative entities, would prioritize already developed land, and would aim to further the comprehensive goals of the Energy Management Five-Year Plan and any other similar plans held by agencies or companies planning to develop facilities or operations in the area.

Development at and near the site by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS may spur further utility needs in the local or regional area. This could create further impacts to soils, water resources, biological resources, and to the local community as a result of noise or visual disturbances during installation of utility corridors/systems. The capacity of regional utility service providers could potentially be exceeded. Impacts could be moderate, of medium extent, possible, and long-term.

3.13.2.2 Alternative 1

Direct, indirect and cumulative impacts of Alternative 1 would be very similar to those of the Proposed Action, but on a somewhat smaller scale, because the two proposed new seaports associated with the Proposed Action would not be built and operated. Also, additional launching and landing facilities might not be built.

3.13.2.3 No Action Alternative

Under the No Action Alternative, utility systems would continue to age and would require upgrades or replacements as they become less efficient or fail. However, current utility systems and their configuration at KSC would remain relatively unchanged aside from regular maintenance for the duration of the 20-year planning horizon (2012-2032).
The affected environment as described in this resource section would not be affected by the construction or operations described under the Proposed Action. Any existing activities or

operations would occur in accordance with existing laws and permits. Existing uses would continue at current levels. Individual actions conducted as part of the Proposed Action impacting utilities may proceed, but would have to do so after environmental assessment under separate environmental documentation.

3.14 Socioeconomics

3.14.1 Affected Environment

The analysis of socioeconomic resources identifies aspects of the social and economic environment that are sensitive to changes and that may be affected by the proposal for KSC to transition over a 20-year period (2012-2032) to a multi-user spaceport. The analysis specifically considers how the proposed and alternative actions might affect the individuals, communities, and the larger social and economic systems of Brevard and Volusia counties; the surrounding region; and the State of Florida.

This section evaluates socioeconomic characteristics, including population, employment, housing, community services, and economic systems. Social impacts would be felt most by individuals, communities, residents, and workers in Brevard and Volusia counties. Businesses, community services, and economic systems in these counties would likely change the most in response to the implementation of the proposed action. Since potential impacts with the greatest magnitude, duration, extent, and likelihood would occur in Brevard and Volusia counties, they are therefore defined as the Region of Influence (ROI) for the analysis of socioeconomic impacts. Impacts that extend outside of the ROI are discussed where applicable throughout the section.

The data supporting this analysis are collected from standard sources, including the U.S. Census Bureau (Census), Bureau of Labor Statistics (BLS), other Federal, State, and local agencies, or other research institutes. Demographic and economic data are presented for Brevard and Volusia counties and compared to demographic and economic data for the State of Florida.

3.14.1.1 Population and Housing

3.14.1.1.1 Population

The 2013 estimated population of Brevard County is 550,823, representing a 15.7 percent increase from the 2000 estimated population. Volusia County's population increased at a somewhat slower rate – 13.0 percent from 2000 to 2013. As shown in Table 3.14-1, the state population grew faster than both counties by about 22.3 percent from 2000-2013.

In general, children comprise a smaller portion of the population in Brevard and Volusia counties (respectively) than in the state overall. The percentage of children in the ROI, including those under five years of age, between 5 and 18 years, or all children under 18 years, is lower than percentages for those same age groups in the State of Florida. Table 3.14-2 shows population estimates and the percent of children by age group in Brevard and Volusia counties as well as for Florida.

Table 3.14-1. Population change, 2000-2013

Location	2000	2013	Percent Change 2000-2013
Brevard County	476,230	550,823	15.7
Volusia County	443,343	500,800	13.0
Florida	15,982,378	19,552,860	22.3

Source: U.S. Census Bureau 2000 and 2013

Table 3.14-2. Summary of children by age group (2013)

Location	Total Population	Children Under 5 Years		Children 5 to 18 Years		All Children Under 18 Years	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Brevard County	550,823	25,769	4.7	77,666	14.1	103,558	18.8
Volusia County	500,800	23,563	4.7	67,608	13.5	91,146	18.2
Florida	19,552,860	1,074,049	5.5	295,248,186	15.1	4,027,889	20.6

Source: American Community Survey, 2013

Table 3.14-3 summarizes the distribution of population by age in the Brevard and Volusia counties compared to the State of Florida. The percent of the population 45 years and older is higher in the ROI is about two to three higher than in the state overall.

Table 3.14-3. Distribution of population by age (2013)

Location	Percent Under 18 Years	Percent 18-44 Years	Percent 45-64 Years	Percent 65 and Older
Brevard County	18.8	29.0	30.1	22.1
Volusia County	18.2	30.2	28.7	22.9
Florida	20.6	33.9	26.9	18.6

Source: American Community Survey, 2013

Table 3.14-4 summarizes the components of population change between 2010 and 2013. Births and deaths are estimated using reports from the National Center for Health Statistics (NCHS) and the Federal-State Cooperative for Population Estimates (FSCPE). Between 2010 and 2013, the number of deaths exceeded the number of births in the ROI, and experienced a natural decrease in population. However, with a net positive domestic and international migration into the ROI, the population increased overall. In Florida, births exceeded deaths during this period, but migration accounted for the majority of the total population increase. Given the age distribution of the population, decreases in population due to "natural events" can be expected to continue in the ROI. Generally speaking, the birth and death estimates are the most reliable parts of the population estimates program, as all states require birth and death certificates (USCB, 2013c).

Table 3.14-4. Components of population change, 2010-2013

Location	Component				
	Births	Deaths	Domestic Migration	International Migration	Total Population Change
Brevard County	16,553	20,190	7,449	3,173	7,451
Volusia County	15,265	20,190	8,321	2,756	6,203
Florida	697,507	576,432	308,152	310,822	750,170

Source: U.S. Census Bureau, 2013
Note: The total population change includes a residual, or the change in population that cannot be attributed to any specific demographic component.

Domestic in- and out-migration includes all changes of residence including moving into, out of, or within a given area (i.e., Brevard and Volusia counties) in the United States. International migration refers to movement of people across the borders of the United States. Domestic migration estimates are based on Internal Revenue Service (IRS) tax exemptions, change in Medicare enrollment, and change in the group quarters population and are therefore less reliable than birth and death estimates. The total population change includes a residual, or the change in population that cannot be attributed to any specific demographic component (USCB, 2015).

3.14.1.1.2 Housing

A housing unit refers to a house, an apartment, a mobile home or trailer, a group of rooms, or a single room occupied as separate living quarters, or if vacant, intended for occupancy as separate living quarters. An owner-occupied housing unit indicates that the owner or co-owner lives in the unit even if it is mortgaged or not fully paid for. The median value(s) of housing units reflects housing units with and without a mortgage. A household includes all the people who occupy a housing unit as their usual place of residence.

The housing units in Brevard County, Volusia County, and the State of Florida are all about 80 percent occupied (Table 3.14-5). About 70 percent of homeowners in the ROI occupy their housing unit, about 5 percent higher than for the state overall. The homeownership rate, which is computed by dividing the number of owner-occupied housing units by the number of occupied housing units, is highest in Volusia County. The median value of owner-occupied housing units in Florida is about $20,000-30,000 more expensive than in the ROI.

Housing is important to a state's economy because the sale of every new single-family home supports more than four jobs, not just in construction and manufacturing, but also financial services and retail as new homeowners splurge on appliances and furnishings. During the housing bubble, housing was overvalued and many people borrowed money for homes they couldn't afford. When housing prices fell, home building and home purchases likewise fell. Many people were stuck with mortgages they could no longer pay, forcing a wave of foreclosures. In 2013, Florida had the highest rate of foreclosures in the nation: 1 in every 328 properties (WP, 2013).

Table 3.14-5. Housing characteristics (2013)

Location	Total Housing Units	Occupied Housing Units (%)	Owner-Occupied Housing Units (%)	Home-ownership Rate (%)	Median Value of Owner-Occupied Housing Units
Brevard County	270,641	80.7%	68.8%	85.3%	$135,900
Volusia County	254,238	78.8%	71.6%	90.9%	$123,400
State of Florida	9,047,973	79.7%	64.8%	81.3%	$153,300

Source: American Community Survey, 2013

3.14.1.2 Labor

3.14.1.2.1 Civilian Labor Force

The size of a county's civilian labor force is measured as the sum of those currently employed and unemployed. As shown in Table 3.14-6, from 2000 to 2013 Volusia County's (and the State's) labor force grew about six percent faster than Brevard's. Notably, the labor forces of the ROI actually decreased from 2008 to 2013. The state labor force also decreased from 2008 to 2010; but increased from 2010 to 2013 (BLS, 2000; BLS, 2008; BLS, 2010; BLS, 2010).

Table 3.14-6. Civilian labor force, 2000-2010

Location	Number in Labor Force				Percent Change 2000-2013
	2000	2008	2010	2013	
Brevard County	232,007	268,551	267,779	264,024	13.8
Volusia County	209,694	254,290	252,093	251,813	20.0
Florida	7,869,695	9,216,383	8,130,853	9,432,295	19.9

Source: Bureau of Labor Statistics, 2010

3.14.1.2.2 Employment

Table 3.14-7 exhibits the annual employment levels in the ROI for the years 2000, 2008, 2010, and 2013. From 2000 to 2010, employment increased 8.7 percent in Brevard County and 9.7 percent in Volusia County. The number employed in Florida increased by over a million persons, or 15.6 percent, over the same 13-year period.

Table 3.14-7. Annual employment, 2000-2013

Location	Number in Employment				Percent Change 2000-2013
	2000	2008	2010	2013	
Brevard County	223,587	251,053	237,905	243,123	8.7
Volusia County	202,623	237,596	222,886	233,371	9.7
Florida	7,569,406	8,637,206	9,167,314	8,749,590	15.6

Source: Bureau of Labor Statistics, 2013

The top 10 private employers in Brevard County provide health care and manufacturing jobs, and are included in Table 3.14-8 below (not including retail). Health First, Inc. and Harris

Corporation, the top two employers, employ about two to three percent of the labor force in Brevard County each assuming those employed also live in Brevard County.

Table 3.14-8. Top 10 private employers in Brevard County (2013)

Organization	Industry	# of Employees
Health First, Inc.	Healthcare	7,800
Harris Corporation	Manufacturing	6,005
Wuesthoff Medical Center	Healthcare	1,610
Rockwell Collins, Inc.	Manufacturing	1,445
Florida Institute of Technology	Education	1,340
Northrup Grumman Corp.	Search, Detection and Navigation Instruments	1,330
Adecco USA, Inc.	Provider of Recruitment and Workforce Solutions	1,150
Parrish Medical Center	Healthcare	1,065
Lockheed Martin Corporation	Manufacturing	1,030
Ebay Call Center	Telemarketing Bureaus	

The top 10 private employers in Volusia County provide healthcare and education jobs, and are included in Table 3.14-9 below. Boston Whaler and Cividen, two manufacturing firms, employ 450 and 500 (respectively). Volusia County, Schools, Embry-Riddle Aeronautical University, Daytona State College, Stetson University, and Bethune-Cookman University employ about 4.5 percent of the county's workforce (assuming those employed also live in Volusia County).

Table 3.14-9. Top 10 private employers in Volusia County (2014)

Organization	Industry	# of Employees
Volusia County Schools	Education	7,503
Florida Hospital Volusia-Flagler Market	Healthcare	4,810
Halifax Health*	Healthcare	3,197
Frontier Communications	Customer Service	1,200
Embry-Riddle Aeronautical University	Education	1,072
Daytona State College	Education	980
Florida Health Care Plans, Inc.	Healthcare	916
Stetson University	Education	886
Bethune-Cookman University	Education	654
SMA Behavioral Health Center	Healthcare	590

Source: Volusia-Flagler Business Report, 2014

*Combined total for Halifax Health Medical Centers in Daytona Beach and Port Orange

Table 3.14-10 shows the size of the workforce at KSC year by year from 2000 to 2013.

Table 3.14-10. Workforce at Kennedy Space Center

Year	Number Employed	Year Change
2000	14,716	1,593
2001	13,499	-1,217
2002	13,720	221
2003	13,259	-461
2004	13,816	557
2005	14,045	229
2006	14,678	633
2007	13,858	-820
2008	14,181	323
2009	15,248	1,067
2010	13,631	-1,617
2011	9,011	-4,620
2012	8,319	-692
2013	7,864	-455

Note: Does not include off-site workforce.

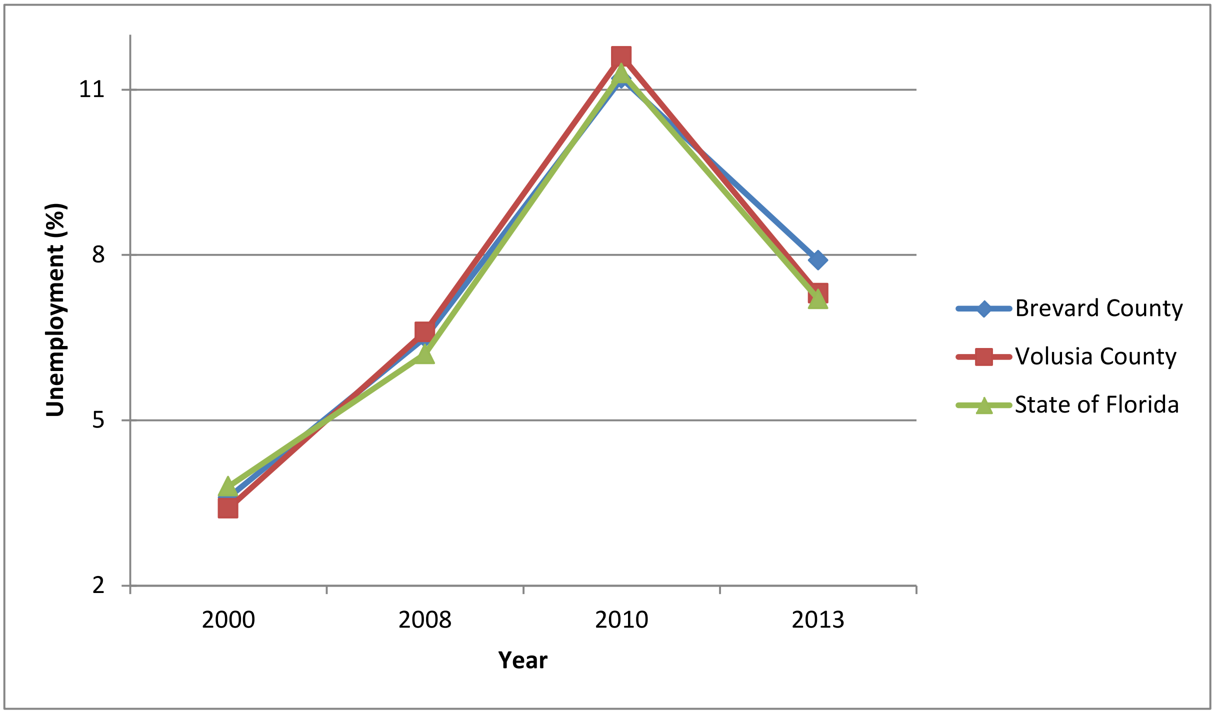
The highest employment levels at KSC were recorded during the Apollo Program. In 1968 a peak population of 25,895 was recorded and an estimated one in four workers in Brevard County was employed by operations at KSC. Employment levels dropped precipitously following the Apollo Program to a historic low in 1976 when a total of 8,441 personnel were employed. Employment levels rose sharply in 1979 when KSC was designated as the launch and operations support center for the STS. Employment levels gradually rose through 1985 following the increasing number of launch events. Another sharp drop in employment levels was seen in 1986 as a result of the loss of the Space Shuttle Challenger (NASA, 2010a, 2015).

The end of the Space Shuttle program in 2011 produced a significant downsizing of the KSC workforce similar to that experienced at the end of the Apollo program in 1972. As part of this downsizing, almost 6,000 contractors lost their jobs at KSC during 2010 and 2011. According to Brevard's Workforce's job placement and training services agency, slightly more than half of those 6,000 have found new jobs. Many in the fields of engineering, mechanics and security have relocated outside of Florida (e.g., South Carolina, Afghanistan). Many former space workers have high salary demands and have had trouble finding local jobs in the area (AP, 2012).

3.14.1.2.3 Unemployment Rates

The unemployment rate is defined as the number of unemployed persons divided by the labor force, where the labor force is the number of unemployed persons plus the number of employed persons. Brevard County's 2013 unemployment rate was 7.9 percent, having decreased from an all-time high in 2010 (11.2 percent). Volusia County's 7.3 percent decreased from an even higher 2010 unemployment rate of 11.6 percent. Both the county and state unemployment rates rose and fell with national trends, which experienced a sharp increase in 2008. The latter can be attributed to the 2008 economic crisis, which was part of the global financial downturn.

Figure 3.14-1. Unemployment in the ROI, 2000-2013



3.14.1.3 Earnings

Several measures are used to discuss earnings, including per capita personal income (PCPI), total industry income, and compensation by industry. Personal income data are measured and reported for the county of the place of residence. PCPI, then, is the personal income for county residents divided by the total county's population. Compensation data, however, are measured and reported for the county of work location, and are typically reported on a per job basis. Compensation data indicate the wages and salaries for work done in a particular place (e.g., a county), but if the worker does not live in the county where the work occurred then a sizeable portion will be spent elsewhere. These expenditures will not remain in or flow back into that county's economy. Total compensation includes wages and salaries as well as employer contribution for employee retirement funds, social security, health insurance, and life insurance.

3.14.1.3.1 Per Capita Personal Income

Personal income is the income received by all persons from all sources, or the sum of net earnings by a place of residence, property income, and personal current transfer receipts (BEA 2013). This includes earnings from work received during the period. It also includes interest and dividends received, as well as government transfer payments, such as social security checks. It is measured before the deduction of personal income taxes and other personal taxes and is reported in current dollars.

Table 3.14-11 contains 2000, 2008, 2010, and 2013 annual PCPI for Brevard and Volusia counties as well as the State of Florida. All dollar estimates are in current dollars (not adjusted for inflation).

Table 3.14-11. Per capita personal income

Location	Income				
	2001	2008	2010	2013	Percent Change, 2000-2013
Brevard County	$28,307	$38,046	$37,431	$39,420	39.2
Volusia County	$24,298	$33,219	$32,763	$34,530	42.1
Florida	$29,570	$39,709	$38,478	$41,497	40.3

Source: Bureau of Economic Analysis, 2013

In 2013, the PCPI in Brevard County was $39,420, representing a 39.2 percent increase since 2000. PCPI in the state increased one percent faster than Brevard County. While PCPI increased almost three percent faster in Volusia County, nominal PCPI is almost $5,000 lower than in Brevard County.

3.14.1.3.2 Industry Compensation

What is often termed in economic data as total industry compensation is somewhat of a misnomer, in that a portion of the "industry earnings" stems from government related activity. This is made clear when the composition of industry compensation is presented. Nevertheless, total industry compensation provides a good picture of the relative sizes of market related economic activity, or business activity, performed in a county (Table 3.14-12).

Income is generated by economic activity in Brevard and Volusia counties through a variety of sectors, including various types of business as well as government. This income is not always received by a person living in the county; for example, a person from neighboring counties may cross county lines to go to work. The employee compensation by industry, however, is a measure of economic activity generated in the counties, regardless of where the employee resides.

The Kennedy Space Center and Cape Canaveral Air Force Station continue to be the main economic drivers in the ROI; as well as recreation and tourism (see Section 3.15), health care, and manufacturing. The sources of economic activity in Brevard and Volusia counties are shown in Table 3.14-12. Government and government enterprises accounted for a total of $2.2 billion (about 20 percent) of the annual compensation of employees in 2013.

Port Canaveral is a vital import/export shipping center and is the first quadramodal port in the world, serving air, land, sea and space transportation (Brevard County 2014). The port has the largest dockside refrigerated storage facility in the country. The foreign trade zone status lowers U.S. production costs and offers savings to export companies. The port is a major deep-water port of entry with nine cargo berths, 46,452 square meters (500,000 square feet) of warehouse and dry cargo storage, and commercial fishing fleets (NASA, 2010a, 2015).

Table 3.14-12. 2013 Compensation of employees by industry in ROI ($000)

Sector	Brevard County	Volusia County
Farm (Crops, livestock, and dairy)	4,826	27,707
Forestry, Fishing, Related Activities	2,724	6270
Mining	282	1,001
Utilities	37,656	32,010
Construction	445,259	393,346
Manufacturing	1,920,825	569,161
Wholesale Trade	418,242	275,928
Retail Trade	850,138	768,052
Transportation and Warehousing	294,552	76,881
Information	152,695	115,450
Finance & Insurance	382,091	274,762
Real Estate and Rental and Leasing	96,462	137,577
Professional, Scientific, and Technical Services	1,009,680	382,017
Management of Companies and Enterprises	137,357	116,016
Administrative and Waste Management Services	842,689	311,450
Educational Services	206,187	275,911
Health Care and Social Assistance	1,667,106	1,452,203
Arts, Entertainment, Recreation	102,791	127,379
Accommodation & Food Services	432,204	430,573
Other Services Except Public Administration	353,834	373,283
Government and Government Enterprises	2,227,756	1,315,566
TOTAL	**11,585,356**	**7,462,543**

Source: Bureau of Economic Analysis, 2013

As discussed in the 2012 Canaveral Port Authority study, Port Canaveral generated nearly $2 billion in business revenue and 17,000 direct, induced and indirect jobs. Port Canaveral business activities were responsible for $808 million of personal income and $248 million of local purchases. Approximately $74 million of state and local taxes were generated by Port activities. Port Canaveral's multi-day cruise passengers in 2014 increase by 4 percent to 3.86 million from 3.71 million in 2013 (PCA, 2012).

3.14.1.4 Public Finance

Property tax and assessment bills can differ for each citizen and vary based on where they live, property values, exemptions and the rates set by various taxing authorities. Using Brevard County as an example, for one dollar of property taxes and assessments for a residence with a taxable value of $100,000:

- Brevard County Board of County Commissioners – 28 cents
- School Board – 33 cents
- Municipality – 37 cents
- Water Management Districts – 1 cent
- Independent Special Districts – 1 cent.

The Brevard County Board of County Commissioners operates independently of the other agencies (Brevard County, 2013).

3.14.1.4.1 Property Values

The calculation of the assessed value of property and then how much of this value is subject to ad valorem taxes varies from state to state. In Florida, each county has an elected Property Appraiser whose office supervises the valuation process following the appropriate state laws and regulations; as well as professional guidelines.

As shown below in Table 3.14-13, total taxable values in Brevard County decreased from 2008 to 2012 by over 30 percent. The taxable value increased from 2012 to 2013 by over 4 percent. New construction in 2013 was about 15 percent compared to new construction in 2008.

Table 3.14-13. Taxable value in Brevard County, 2008-2013

Year	Total Taxable Value	New Construction
2008	$37,872,867,597	$1,225,240,705
2009	$33,298,150,445	$444,401,981
2010	$29,089,009,692	$305,102,302
2011	$24,875,931,599	$210,398,625
2012	$24,626,876,502	$185,650,571
2013	$25,745,155,761	$201,639,416

Source: Florida Department of Revenue, 2014
*Adjusted to 2014 dollars

Table 3.14-14. Total taxable value in Volusia County, 2008-2013

Year	Total Taxable Values	New Construction
2008	$36,394,481,547	$1,009,197,414
2009	$30,080,905,468	$416,927,555
2010	$26,182,716,383	$212,192,435
2011	$24,030,945,998	$156,017,155
2012	$23,621,987,999	$149,669,240
2013	$24,218,417,004	$140,484,401

Source: Florida Department of Revenue, 2014

3.14.1.4.2 Real Estate Transfer Taxes

The state of Florida collects 0.7 percent of the property sales price in each real estate transaction, or a real estate transfer tax. A portion of those revenues go to a fund for state parks (and often other outdoor-related programs). In Florida, transfer tax revenues finance land acquisition for parks and capital projects but not park operations. The Florida Forever program is funded by bonds backed by a document stamp tax, an excise tax assessed on each real estate transaction. State parks receive five percent of Florida Forever funds; the program funds a wide array of other conservation programs and provides grants to local communities (RFF, 2013).

3.14.1.4.3 Tourist Development Tax (Resort Tax)

Tourist Development Tax (Resort Tax) is a 5 percent tax on the total rental amount collected from every person or other party who rents, leases, or lets for consideration living quarters or accommodation in any hotel, apartment hotel, motel, resort motel, apartment, apartment motel, rooming house, mobile home park, recreational vehicle park, or condominiums for a period of 6 months or less. This tax is collected by the Brevard County Tax Collector pursuant to Brevard County Code, Chapter 102, "Taxation," Article III, as authorized by Florida Statute 125.0104. The local Tourist Development Tax is in addition to the 6.5 percent State of Florida Sales and Use Tax remitted to the Florida Department of Revenue (BTC, 2013).

3.14.1.4.4 Payment in Lieu of Taxes

The Payment in Lieu of Taxes (PILT) program was developed by Congress to offset the loss to county governments from public lands that are not part of the tax base. Counties with federal land in their jurisdictions often provide vital services on those lands, such as solid waste management, search and rescue and emergency medical services. PILT payment to counties in Florida total approximately $5 million annually.

BLM, NPS, and the U.S. Army Corps of Engineers (USACE) pay approximately $2.41 dollar per acre to Brevard and Volusia counties each year. PILT funds bridge and road maintenance, law enforcement, search and rescue, emergency medical, fire protection, solid waste disposal, and environmental compliance (USDOI, 2013).

Table 3.14-15. 2013 Payments and acreage in Brevard and Volusia counties

Agency	Brevard County		Volusia County	
	Acres	Payment	Acres	Payment
Bureau of Land Management	600	$1,445	0	0
USFWS	0	$0	933	$13,578
National Park Service	25,600	$61,645	16,266	$39,169
Corps of Engineers	89	$214	3	$7
TOTAL	26,289	$63,310	17,202	$52,754

Source: U.S. Department of the Interior, 2013.

3.14.1.5 Community Cohesion

Community cohesion is the degree to which residents have a sense of belonging to their neighborhood or community, including commitment to the community or a strong attachment to neighbors, institutions, or particular groups. What makes a community cohesive is subjective and cannot be solidly defined, though specific indicators include interaction among neighbors, use of community facilities and services, community leadership, participation in local organizations, desire to stay in the community and length of residency, satisfaction with the community, and the presence of families in communities (FDOT, 2000).

Cohesive communities are associated with specific social characteristics which may include long average lengths of residency, frequent personal contact, ethnic homogeneity, high levels of community activity, and shared goals. Some studies indicate that single-family home ownership, working class families, ethnic group clusters, mothers working at home, parks and other community facilities, and the elderly correlate with active community participation and high community cohesion. Residential stability and longevity can be a strong neighborhood link. The intensity of controversy may be an indicator of potential community disruption (Caltrans, 1997).

Based on 2013 data from the American Community Survey, scoping comments, and a literature review, Brevard and Volusia counties have a low to medium level of community cohesion. Around 30 percent of householders moved into their Brevard or Volusia County unit after 2010. Both counties have high homeownership rates – about 5 to 10 percent higher than the state. About 20 percent of the population in the ROI is over the age of 65, which is comparable to the percentage for the state overall.

Since social classes lack clear boundaries and overlap, there are no definite income thresholds as for what is considered working class. Sociologist Leonard Beeghley identifies a combined household income of $66,000 as a typical working-class family (Beeghley, 2004). Sociologists William Thompson and Joseph Hickey estimate an income range of roughly $16,000 to 30,000 for the working class (Thompson and Hickey, 2005). The "working class" is typically associated with manual labor and high school education. The 2010 median household income in Brevard and Volusia counties were $46,472 and $40,919, respectively. By Beeghley's definition, the ROI qualifies as a working class community; by Thompson and Hickey's definition the ROI does not.

Ethnic homogeneity, or monoculturalism, is a term used to describe an area whose population has a similar ethnic background. In Brevard and Volusia counties, 83.5 and 82.9 percent of the population is identified as having "one race," respectively; in this case, white. As such, the ROI is considered to be an area with ethnic homogeneity.

Table 3.14-16. Community cohesion indicators in ROI

Location	Householder Moved to Unit after 2010 (%)	Median Household Income	Ethnic Homogeneity	Homeowner-ship Rate	Persons 65 Years and Older (%)
Brevard County	32.2	$46,472	83.5	85.3%	22.1
Volusia County	34.4	$40,919	82.9	90.9%	22.9
Florida	29.6	$46,036	76.2	81.3%	18.6

Source: American Community Survey, 2013

3.14.2 Environmental Consequences Including Cumulative Impacts

3.14.2.1 Proposed Action

The analysis for socioeconomics evaluates the social and economic effects, both adverse and beneficial, from changes in KSC's Center Master Plan; actions to meet KSC's mission and core competencies; and future development, transportation facilities, and activities. Components of the Proposed Action that would be funded by NASA - including recapitalization, redevelopment, and future expansion of spaceport capabilities – as stated in the purpose and need for this project, will be analyzed qualitatively in this section. Those components that would not be funded by NASA – like the construction of a KSC Rail System – are also discussed qualitatively, given the scope and purpose of this Programmatic EIS. Applicable parts of this analysis might be tiered in future NEPA documents and site-specific actions would be analyzed separately and as details become known.

As noted earlier, the ROI for the socioeconomic analysis is defined as Brevard and Volusia counties, or the area most likely to be affected by the proposed action. The community could experience direct, indirect, or induced economic impacts as a result of changes in KSC's land use plan, particularly as it relates to future development and the development program. The impacts could consist of changes in short-term employment, community cohesion for area residents, and decreased recreational revenue at MINWR and CNS.

The temporal bounds for analyzing socioeconomics will be guided in part by available data, an assessment of current conditions (without the proposed land use changes or associated activities), and the timing of activities associated with the Proposed Action. Though implementation of the Proposed Action would occur over a 20-year period, some components of the Development Program will change as the market and emerging technology may demand.

3.14.2.1.1 Land Use Plan

Changes in land use categories would not directly impact socioeconomic resources in the ROI in terms of employment or labor income. However, indirectly, changes in economic activity could occur in the future due to actions or development stemming from the change in land use. Future development associated with changes in land use categories would benefit socioeconomic resources in both the short- and long-term.

3.14.2.1.1.1 Recreation

Recreation areas include parks, outdoor fitness, athletic fields, recreation buildings, centers and clubs. Examples of recreation land uses include KARS Park North and KARS Park South complexes. Coastal beaches and supporting facilities are part of the CNS and are classified as Operational Buffer/Public Use. Camping, fishing, picnic and related outdoor activity areas associated with the MINWR are also classified as Operational Buffer/Public Use. No changes in recreation areas would occur and access to facilities would not be hindered. However, more than 4,000 acres of Operational Buffer/Conservation and Operational Buffer/Public Use lands would be impacted. While this would not represent direct changes in employment or economic activity, the overall recreational value(s) of MINWR and CNS could be affected. Additionally, MINWR and CNS could experience decreases in revenue with decreased visitation. See Section 3.15 (Recreation) for a detailed discussion of impacts to ecosystem services.

3.14.2.1.1.2 Launch, Landing, Operations and Support

While visitation expenditures would decrease due to beach closures at Playalinda Beach, the long-term economic impact would be negligible. These activities would generate intermittent minor to moderate adverse effects on the visitor experience during the short-term (i.e. during the launch). However, siting of new vertical launch pads would leverage future partnerships with private entities and help KSC remain competitive and attract new tenants.

3.14.2.1.1.3 Seaport

As mentioned earlier, Port Canaveral is a vital import/export shipping center and is the first quadramodal port in the world, serving air, land, sea and space transportation (Brevard County, 2014). Port Canaveral generated nearly $2 billion in business revenue and 17,000 direct, induced and indirect jobs. Three additional land areas are designated as Seaport to support future development of the sea-based transportation capability. Seaport construction would have beneficial short-term economic impacts in the ROI from construction dollars. In the long-term, seaport(s) would attract tenants, further leverage quinti-modal functionality, and capitalize on surrounding area water accessibility and linkage to Port Canaveral; generating additional business revenue and supporting additional indirect and induced jobs at Port Canaveral.

The seaport designated south of the Assembly, Integration and Processing Area on the east side of the Industrial Area would directly impact the recreational value of the area. Because of the longstanding closure to motorized vessels in an effort to protect manatees, this Manatee Sanctuary/NMZ/Designated Critical Habitat has an abundance of sea life including some of the largest schools of redfish and black drum the state has to offer. Mangroves provide protected nursery areas for fishes, crustaceans, and shellfish that are important to both commercial and sport fisheries. The most popular and direct launch spot for kayaks and canoes is Kennedy Athletic, Recreational and Social Park (KARS) Park – now open to the public with a $5.00 launch fee. Assuming this proposed seaport would be constructed for motorized boating and would require the removal of mangroves, this change in land use could be controversial as it would affect recreational activities such as fishing, boating, and wildlife viewing.

3.14.2.1.2 Future Development Plan

Direct effects would include spending for NASA development activities and consumption spending of new residents and construction workers; indirect effects would include local vendors providing goods and services to the primary firms; and induced impacts would include employees of these firms spending a portion of their earnings in the local economy. Economic activity is measured in terms of income and employment generated (or lost) due to the Proposed Action. With increased spending, many different sectors of the economy benefit, not only the directly impacted sector but also many sectors indirectly, via the multiplier effect. Other impacts could include costs to the local community and surrounding area as well as benefits future development would bring.

> A “multiplier” is a number used by economists to determine the impact of a project on the economy. It is the ratio of total change in output or employment to initial change (or direct change). For example, if an industry were to create 100 new jobs, it would require materials and services from its supplying industries. If this increase in demand created 30 new jobs in the supplying industries, the employment multiplier would be 1.3 [i.e. 100 (direct) + 30 (indirect and induced)].

Much of the equipment and materials would be procured locally, given the presence of manufacturing firms that specialize in equipment, parts, and materials required for launch activities. In FY 2013, 85 percent of the KSC’s $1.8 billion-dollar budget was spent on the purchase of goods and services from commercial providers. From 2010 to

2013, KSC spent about $788 million on procurement in the State of Florida, or about 16 percent of annual procurement dollars spent. Table 3.14-17 compares the procurement dollars spent in Florida and overall for the period from 2010 to 2013.

Table 3.14-17. KSC procurement dollars spent in Florida, 2010-2013

Year	Florida		Total	
	Dollars	Percent	Dollars	Percent
2010	$237,735,099	22.9	$1,035,932,601	100.0
2011	$210,844,264	14.5	$1,454,014,400	100.0
2012	$194,078,927	13.0	$1,488,638,875	100.0
2013	$145,451,742	13.5	$1,073,541,624	100.0
TOTAL	$788,110,032	15.9	$5,052,127,500	100.0

Source: KSC Annual Report, 2010-2013.

NASA does not report, forecast, or set goals for hiring from local communities, but the vast majority of KSC employees live in Brevard, Orange, and Volusia counties (Busacca, 2015). The portion of labor hired locally would be highly dependent on the skill levels of the local labor force at the time. Given the history and presence of KSC in the local economies, the unemployment rate, and the availability of workers specialized in the space industry, it is anticipated that many of the directly created jobs would be filled locally.

Implementation of the action alternatives would have direct and indirect impacts to the local (Brevard and Volusia counties) and State economies in terms of employment, government revenues, personal income, business sales, and quality of life. .

3.14.2.1.2.1 Development Program

The Development Program incorporates future projects that may affect the KSC facility inventory. These projects include prospective new facilities, modifications to existing assets, and unfunded future projects identified by the master planning process. The Development Program describes continuing NASA programs and missions in the context of the 20-year master planning horizon. These timeframes correspond to a phased approach including a baseline (2010) near-term (2012 – 2017), medium-term (2018 – 2022), and long-term (2023 – 2032) timeframe. These planning milestones correlate to the operating model stages associated with the evolution of KSC from a single-user to a multi-user spaceport. However, the transition from one operating model stage to the next is not time-specific, and depends on external factors such as interest and financial commitment from non-NASA entities as well as the level of federal funding allocated to KSC.

New construction and modifications to the existing asset inventory will be required to allow KSC to support continuing programs and remain competitive to attract new tenants. Modifications include the renewal and replacement of existing facilities. The individual projects are categorized into sub-groups of first, second, and third priority using funding source and anticipated construction dates as the main criteria.

First priority projects are funded by NASA and are anticipated to commence in the near future, are already underway, or have just been completed. Project costs are relatively low for NASA-funded projects and would not represent another NASA “boom” (though indirect, long-term impacts from partnerships and new tenants may very well). With the exception of 2016 - where estimated project costs are $14 million - annual project costs would not exceed $2.2 million.

In addition to the value of development projects at KSC, direct impacts would include employment and payroll, especially in 2016. Labor income captures all forms of employment income, including wages and benefits. The increase in economic activity in the local economy, or the value added to the local economy, represents the wealth created by the industry activity (i.e. aerospace). Indirect impacts would occur due to local vendors from whom NASA would make purchases and local establishments where construction workers and contractors would shop. These local vendors and their employees in turn would make additional local purchases. Induced impacts would occur when employees of the directly and indirectly affected industries spend the wages they receive. The indirect and induced jobs created during development projects are often relatively low-wage jobs such as restaurant workers or convenience store clerks.

The 2016 payroll of construction workers would contribute to the total wages and salaries in the ROI. Approximately 80 percent of annual payroll is actually “take home” pay, and the other 20 percent goes toward workers’ compensation, health insurance, unemployment, and Social Security. Thus, not all of the “take home” pay would flow into local economies where employees reside.

As noted above, NASA does not report, forecast, or set goals for hiring from local communities, but the vast majority of KSC employees live in Brevard, Orange, and Volusia counties (Busacca, 2015). Given the history and presence of KSC in the local economies, the unemployment rate, and the availability of workers specialized in the space industry, it is anticipated that many of the directly created jobs would be filled locally, though some construction workers would commute from counties adjacent Brevard and Volusia. With a total population of over 1.5 million in the ROI, a labor force of over 440,000, and an unemployment rate of 7.9 in Brevard and 7.3 percent in 2013, most construction jobs would likely be filled by the ROI. Construction workers are expected to commute to the project area from their residences rather than relocate, and typically commute up to two hours one way for a job, or an average of 73 miles and maximum of 115 miles one way (Gilmore et al. 1982). Given the vacancy rates in Brevard (19.3 percent) and in Volusia (21.2 percent), any population increase would not impact housing during 2016 Development Program first-priority projects. Current plans do not exist to develop nearby temporary housing.

Neither the Proposed Action nor future non-NASA projects at KSC would have direct impacts on tax revenue. PILT payments would not change as land ownership would not be transferred; rather non-NASA launch and landing operations would occur at KSC with NASA as the beneficiary. Indirect business taxes (IBT), or the taxes on production and imports, are distributed among the various tax types (e.g., property) based on the State's distributions as defined by the Annual Census of Government Finances. However, regardless of the project proponent, with NASA as the landowner no direct tax impacts would occur.

As discussed in the Development Program, second priority projects are anticipated in the more distant future and might be funded by NASA or by other commercial or government entities.

Second-priority projects are not analyzed as part of this Proposed Action. Third priority projects have been identified by either the KSC planning team or the master plan and will likely be funded by non-NASA entities. Third priority projects are not yet scheduled or are anticipated in the indeterminate future. NASA funding is not expected for third priority projects and are not analyzed as part of this Proposed Action. Generally, second and third priority projects would augment the NASA facilities budget by transferring CRV and/or maintenance costs for existing facilities to others through Divestitures and Out-Grants. Non-NASA entities located at KSC might also fund larger-scale renovation and construction projects as a result of the commercialization strategy.

Many of the potential social impacts associated with the development and transportation plan (discussed below) are closely tied to boom and bust economies. The introduction of a transient workforce population into an established community often changes the social functioning or fabric of that community. In the past, communities that have become specialized in one industry go through cycles of economic expansion followed by economic collapse. These cycles can stress families and tend to tear the social fabric of communities as workers have to commute out of the area to work or they and their families have to relocate.

Several scoping commenters were concerned with the potential impact to the local area's social fabric – that with uncontrolled development, small coastal towns would lose their sense of community and identity. One commenter added that the simultaneous growth of industry and population growth is already exacerbating the water quality, air quality, and basic quality of life in Florida.

3.14.2.1.3 Future Transportation Plan

Repair and resurfacing of over 29 miles of Kennedy Parkway could delay visitors at Playalinda Beach in the short-term. A commercial entity may require the development of new vertical launch capabilities that meet their specific needs. Should the market necessitate this expansion, the development would be directed to areas north of Launch Pad 39B along Beach Road. The proposed road easement to support access from Beach Road to the pad location (road expansion would be funded by a non-NASA entity) could further delay visitors at Playalinda Beach; affecting visitation revenue. However, these impacts would be intermittent and create negligible economic impacts overall.

Road repair and resurfacing, road easements, and bridge replacement could also benefit socioeconomic resources by further right-sizing NASA and positioning it as a multi-user spaceport. Road divestiture would decrease the funding allocated to infrastructure that is used by KSC and the community as a whole.

During the replacement of the Indian River Bridge, Haulover Canal and Banana River bridges, traffic would be re-directed using an alternative route. MINWR visitation could be affected during these periods, however impacts would be intermittent and create negligible economic impacts overall.

A rail connection between the Florida East Coast railway and Port Canaveral via the KSC railroad would impact the visitor experience at MINWR and could decrease recreational revenue.

Increased noise levels would adversely affect the recreational experience of birders and outdoor activities at the KARS South Complex (e.g., RV camping, tenting) as well as anglers and boaters in the Manatee Sanctuary/NMZ (discussed above under 3.14.2.1.1.3 Seaports). A detailed analysis of impacts to recreational revenues from this divestiture and the construction and operation of a rail connection between Port Canaveral and KSC will be the subject of a separate environmental study.

3.14.2.1.4 Conclusion

Overall, the direct, economic impacts as a result of the Proposed Action would be beneficial but not significant. The Proposed Action would potentially create beneficial impacts of minor to moderate magnitude due to the creation of jobs and labor income, most of which would occur during 2016 as part of the Development Program. The extent of impacts would be medium (localized), since most of the jobs would be filled by area residents. These impacts are probable, since the relationship between an infusion of capital in the local aerospace industry and the resulting economic impact is well-established. Due to ongoing presence of NASA at KSC and historical data with which to compare or base projected impacts, there is moderate confidence in the accuracy of the predictions as to the types, extent, and likelihood of impacts. However, indirect and long-term impacts from non-NASA (second and third priority) projects on the local economy depend on external factors such as interest and financial commitment from non-NASA entities. The precedence and uniqueness of the impact would be minor due to historical and ongoing NASA activities at KSC.

In the long-term, however, with KSC having leveraged its position as a multi-user spaceport and positioned itself to attract new tenants, indirect economic impacts would be beneficial and significant. Future employees from non-NASA projects at KSC (e.g., Space X) would represent new purchasing power that would support additional jobs and payroll at local retail and service establishments in the ROI. There is a larger multiplier effect associated with the consumer spending of employees directly supported by KSC (though these future employees would not directly be employed by NASA). Through this spending, the Proposed Action could indirectly support thousands of indirect and induced jobs.

3.14.2.1.5 Cumulative Effects

With the potential number of combined additional launches proposed for KSC and the Shiloh Launch Complex, and other regional developments, total annual visitation at CNS could decrease considerably. Increases in water runoff, sedimentation, and potential spills would cumulatively impact recreational water-based activities in and around Mosquito Lagoon. Additionally, the increase in non-point source runoff from spin-off development as a result of these two proposed projects could affect water quality in the Indian River Lagoon over the long-term. The development of launch facilities would degrade the high aesthetic or amenity value (i.e., cultural services) associated with CNS and MINWR, contradicting and offsetting the natural attributes that contribute to their natural beauty and aesthetic quality.

3.14.2.2 Alternative 1

The direct, indirect, and cumulative socioeconomic impacts associated with Alternative 1 would be broadly similar to those of the Proposed Action, though on a somewhat smaller scale, because facilities such as two proposed new seaports would not be built, and others might not be built.

3.14.2.3 No Action Alternative

Assuming that the proposed project is not implemented, no socioeconomic changes would occur to Brevard or Volusia counties. Since ongoing activities would be substantially the same as those already occurring, no significant additional change in community character and setting would be anticipated. Existing conditions would remain substantially unchanged and have no effect on the populations of concern.

There would be no change to population, housing, employment, income characteristics, economic activity, taxes and revenues, or quality of life conditions. Fluctuations or changes would occur at rates consistent with historical trends.

3.15 Recreation

3.15.1 Affected Environment

The analysis of recreational resources identifies aspects of the proposed activities as they relate to expenditures, revenue, and ecosystem services that are sensitive to changes and that may be affected by the proposal for KSC to transition over a 20-year period (2012-2032) to a multi-user spaceport. The analysis specifically considers how the proposed and alternative actions might affect the recreational resources and its economic value to individuals and communities within Brevard and Volusia counties as well as the State of Florida.

Brevard and Volusia counties, located on Florida's Space Coast, provide a myriad of recreational activities. The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation revealed that 4.7 million Florida residents and nonresidents 16 years or older fished, hunted, or observed wildlife in Florida, and wildlife-related recreation expenditures totaled nine billion in 2011. Of the total number of participants, two million fished or hunted and 3.6 million participated in wildlife-watching activities, which include observing, feeding, and photographing wildlife. The most popular activity was wildlife watching, followed by fishing and then hunting (USFWS, 2011). Swimming, picnicking, boating, hiking, camping, and photography are other popular activities in the area.

The Merritt Island National Wildlife Refuge (MINWR) was established by agreement as an overlay of the NASA's Kennedy Space Center (KSC) in 1963. The National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS) co-manage about 34,345 acres of the refuge. Spanning the beach and dune system, estuarine waters, forested and non-forested wetlands, impounded wetlands, and upland shrublands and forests and supporting habitat for a variety of federally-listed species, State-listed species, and species of management concern, the MINWR manages >140,000 acres, including areas separate from KSC in the Turnbull Creek area (Figure 1.2-1). These diverse habitats of MINWR support more than 1,000 species of plants and more than 500 species of fish and wildlife, including a variety of waterfowl, shorebirds, and neotropical migratory birds. Canaveral National Seashore (CNS) includes 58,000 acres of barrier island, open lagoon, coastal hammock, pine flat woods and 24 miles of undeveloped beach. Biologists have documented more than 310 species of birds, including the bald eagle, wood stork, the Florida scrub jay, and roseate spoonbills. CNS logs more than 4,000 sea turtle nests each season, and in 2014 the USFWS designated critical habitat for the loggerhead turtle to include KSC, CNS and the shoreline south of Patrick Air Force Base (AFB), extending into northern Indian River County (USFWS, 2013).

Figure 3.15-1. Canaveral National Seashore showing beach, ocean, and Mosquito Lagoon

Recreational visits, access, expenditures, and economic value of both the MINWR and CNS are described below. In addition, MINWR and CNS and their resources provide economic benefits to Brevard and Volusia counties through a multitude of ecosystem services, or the products and services produced by the environment. Ecosystem services provided by natural processes, aesthetic values, and non-consumptive resource use can affect the fiscal health of a community through reducing costs. A literature review is used to describe certain economic values to Brevard and Volusia counties, as well as to the state of Florida. The nonmarket value of birds and their roles in these fragile ecosystems are also described qualitatively.

Potential impacts would be felt most by individuals, communities, and residents in Brevard and Volusia counties. Businesses and recreational outfits in these counties would likely change the most in response to the implementation of the Proposed Action, and are therefore defined as the ROI for the analysis of recreational impacts. Impacts that extend outside of the ROI are discussed where applicable throughout the section.

Federal and state recreational areas, wildlife management areas, rivers, and water access points are identified using data from KSC, USFWS, NPS, and Florida Department of Environmental Protection (FDEP). This section describes the recreational resources on federal and state lands as they relate to the KSC.

3.15.1.1 Merritt Island National Wildlife Refuge

MINWR is located along Florida's east central coast about 40 miles east of the city of Orlando, and was established by agreement as an overlay of the NASA's KSC in 1963. The refuge covers more than 140,000 acres and lies within one of the most productive estuaries in the country, the Indian River Lagoon, which has more species of plants and animals than any other estuary in North America. The NPS and USFWS co-manage about 34,345 acres of the refuge, located on one of the last extensive undeveloped barrier islands on the eastern coast of Florida.

A wide array of habitats exist on the refuge, including the beach and dune system, estuarine waters, forested and non-forested wetlands, impounded wetlands and coastal scrub and forests. These diverse habitats support more than 1,000 species of plants and more than 500 species of fish and wildlife, including a variety of waterfowl, shorebirds, and neotropical migratory birds, as well as nine federally-listed species that are common to MINWR and six species that occur infrequently. In addition, there are numerous State-listed species. More than 300 species of birds (resident and migratory) have been identified using the refuge (USFWS, 2013).

3.15.1.1.1 Recreation Visits and Access

Popular with anglers, kayakers, birders, wildlife enthusiasts, and photographers, MINWR has the distinction of being one of the most visited refuges in the entire National Wildlife Refuge System, with almost 1.2 million visitors in 2011. The partnership between space technology and exploration and abundant natural resources is unique to MINWR.

Figure 3.15-2. Visitor center at MINWR

Table 3.15-1 shows that in 2011, MINWR had nearly 1.2 million recreation visits. Non-consumptive recreation accounted for 1.0 million visits with residents comprising 42 percent of total visitation. In general, more non-residents (than residents) participated in non-consumptive activities at the MINWR, including walking (i.e. pedestrian), auto tours, photography, and other recreation. And in general, more residents (than non-residents) participated in consumptive activities (i.e., fishing and hunting), though residents and non-residents participated equally in saltwater fishing.

Table 3.15-1. 2011 Recreation visits at MINWR

Activity	Residents	Non-Residents	Total
Non-Consumptive			
Pedestrian	110,517	165,776	276,293
Auto Tour	79,242	118,863	198,105
Boat Trail/Launch	7,000	7,000	14,000
Bicycle	1,120	480	1,600
Interpretation	7,200	4,800	12,000
Photography	21,149	31,724	52,873
Other Recreation	180,673	271,010	451,683
Hunting – Migratory Birds	1,525	269	1,794
Fishing			
Freshwater	11,670	5,002	16,672
Saltwater	83,361	83,361	166,721
Total Visitation	**503,457**	**688,284**	**1,191,741**

Source: U.S. Fish and Wildlife Service, 2013

Note that the estimates for fishing are considered low for Mosquito Lagoon, as access from Parrish Park, Titusville Marina, Jones Landing, Scottsmoor Landing, and River Breeze boat ramps is not captured. These estimates also do not include fishing visitation in the Banana River. In FY 2014, a total of 341,486 recreation visits on the MINWR were for fishing, with some overlap with other uses (USFWS, 2015a).

Fishing, crabbing, clamming, oystering, and shrimping are permitted in the Indian River Lagoon, Mosquito Lagoon, Banana River Lagoon, Mosquito Control Impoundments and Interior Freshwater Lakes except for the restricted areas of KSC. Fishing at night is permitted from a boat in the waters of the Haulover Canal, Mosquito Lagoon, Indian River Lagoon and Banana River Lagoon. Permitted anglers are allowed 24-hour access at the Haulover Canal and the Bairs Cove and Beacon 42 boat ramps. In advance of launches, the normal restricted area is expanded to temporarily close certain waters that are normally open to sports fishing (USFWS, 2015b).

Waterfowl hunting is permitted on 36,000 acres of the refuge's 140,000 acres. Waterfowl Hunt Area 1 is generally the area west of Peacock's Pocket Road and south of State Route 402, excluding the area surrounding the Refuge Visitor Center. Watercraft access for waterfowl hunters exist at Catfish/E. Gator Creek and Peacock's Pocket. Waterfowl Hunt Area 4 generally includes the area west of State Route 3 inbetween Mosquito Lagoon and the Indian River Lagoon. Several watercraft access points for waterfowl hunters are located west of State Route 3 on the Indian River Lagoon, at at L Pond and M Pond. Hunters may not access hunt areas from

Scrub Ridge Trail or Playalinda Beach Road (USFWS, 2015c). The remainder of the refuge is closed to hunting to protect non-game birds and endangered specis and to permit other recreational activities. Common species on the refuge include scaup, mottled ducks, blue-winged teal, and pintail.

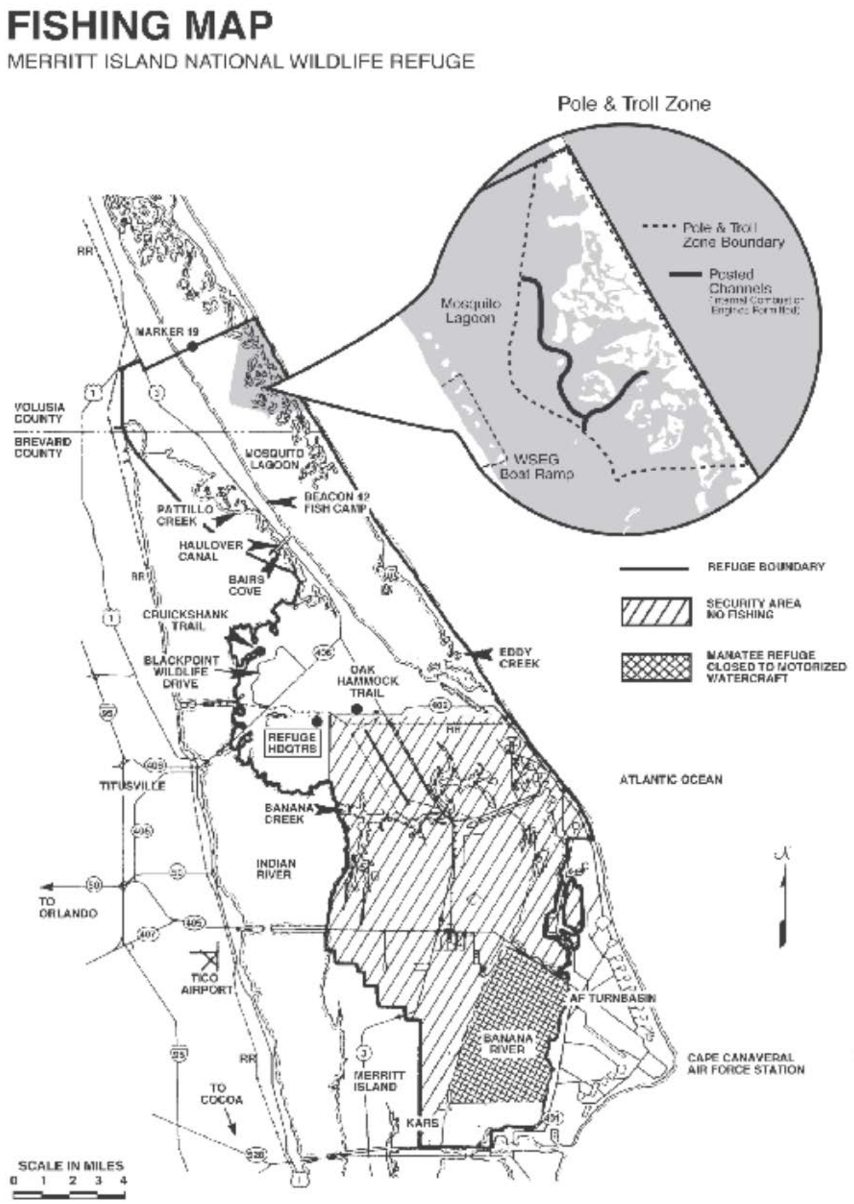


Figure 3.15-3. MINWR Fishing Map
Source: MINWR, 2015

On hunt days, permitted hunters are allowed access to the refuge before sunrise (at 4:00 AM); all hunting stops at 1:00 PM. Hunting is allowed on Saturdays, Sundays, Wednesdays, Christmas, Thanksgiving, and New Year's Day within the framework of the State hunt season (USFWS, 2015c). The first phase of the 2014-2015 State hunt season for waterfowl and coot occurred from

November 22-30, 2014; and the second phase from December 6, 2014 to January 25, 2015 (FFWCC, 2014).

Refuge roads, trails, and boat ramps are open daily from sunrise to sunset. From the north, access is available from US 1 on the Kennedy Parkway (SR 3) about two miles south of the community of Oak Hill. Access is not available from the south on SR 3 because of the restricted area surrounding the Kennedy Space Center. From the south, visitors must use the Titusville entrance. Historically, the MINWR closes south of the Haulover Canal prior to launch activities (USFWS, 2015a; USFWS, 2015b).

3.15.1.1.2 Visitor Expenditures

Tourists usually buy a wide range of goods and services while visiting an area. Major expenditure categories include lodging, food, supplies, and gasoline. Spending associated with refuge visitation can generate considerable economic benefits for the local communities near a refuge (USFWS, 2013). Visitor expenditures for the MINWR are assumed to occur primarily in Brevard, Orange, and Volusia counties and are therefore the dollar values reported in Table 3.15-2. As such, visitor expenditures may be overestimated for the purposes of this analysis.

In FY 2011, total expenditures were $39.1 million with non-residents accounting for $32.1 million or 82 percent of total expenditures. Expenditures on non-consumptive activities accounted for 79 percent of all expenditures.

Table 3.15-2. Visitor recreation expenditures at MINWR (2011 $000)

Activity	Residents	Non-Residents	Total
Non-Consumptive	$2,997.8	$28,027.8	$31,025.6
Hunting	$44.0	$19.1	$63.1
Fishing	$4,026.0	$4,021.7	$8,047.8
Total Expenditures	$7,067.8	$32,068.7	$39,136.5

Source: U.S. Fish and Wildlife Service, 2013

For an individual, net economic value is that person's total willingness to pay (WTP) for a particular recreation activity minus his or her actual expenditures for that activity. The economic value for MINWR is $24,522. The economic value is derived by multiplying net economic values for hunting, fishing, and non-consumptive recreation use (on a per-day basis) by estimated visitor days for that activity. This figure is combined with the estimate of total expenditures and divided by the refuge's budget for 2011, or $3,614,500. Said otherwise, for every $1 of budget expenditures, $17.61 of total economic effects are associated with these budget expenditures (USFWS, 2013).

Table 3.15-3 summarizes the local economic effects associated with recreation visits. The output, or value of production, totaled $60.4 million with associated employment of 466 jobs; $18.1 million in labor income (i.e. wages and salaries); and almost $7.5 million in total tax revenue.

Table 3.15-3. 2011 Economic impact of MINWR

Contribution of all Visitor Spending			
Jobs	**Labor Income**	**Tax Revenue**	**Output**
466	$18,077,300	$7,471,200	$60,441,800

Source: United States Fish and Wildlife Service, 2013

3.15.1.2 Canaveral National Seashore

Congress created Canaveral National Seashore (CNS) in 1975. The park straddles the border of Brevard and Volusia counties and includes 58,000 acres of barrier island, open lagoon, coastal hammock, pine flat woods and 24 miles of undeveloped beach. Semi-tropical climate merges with the temperate climate zone, creating a diversity of plants and animals found few other places in the world. Biologists have documented more than 310 species of birds, including the bald eagle, wood stork, the Florida scrub-jay, and roseate spoonbills (USFWS, 2013).

Figure 3.15-4. Beach at Canaveral National Seashore

CNS logs more than 4,000 sea turtle nests each season. In 2014, the USFWS designated critical habitat for the loggerhead turtle to include KSC, CNS and shoreline south of Patrick AFB, extending into northern Indian River County. Cape Canaveral Air Force Station (CCAFS), Patrick AFB and several other military bases are not included because those already have natural resource-management plans in place to conserve loggerhead sea turtles. Because sea turtles are already protected, the critical habitat designations will not they further restrict non-federal lands, unless federal funds, permits or activities are involved, such as those for beach renourishment (USFWS, 2014).

3.15.1.2.1 Recreation Visits and Access

Year-round recreation includes fishing, boating, canoeing, surfing, sunbathing, swimming, hiking, camping, enjoying nature and historic trails, and exploring cultural resources. Additional opportunities for activities have recently become available at sites such as Seminole Rest archeological and historic site and the rehabilitated Eldora State House (NPS, 2014).

Recreation visits are defined here as one person entering a park system unit for any part of a day for recreation purposes, and overnight stays are one person spending the night in a backcountry campsite. Since 2010, the national seashore hosted between about 970,000 and 1.4 million recreation visits annually. Visitation has fluctuated by as much as about 300,000 visitors from year to year.

Table 3.15-4. Recreation visits at CNS (2010-2014)

Year	Recreation Visits	Recreation Overnight Stays (Backcountry campers)
2010	966,099	2,702
2011	1,005,001	3,146
2012	994,430	2,769
2013	1,133,688	2,128
2014	1,451,225	3,161

Source: National Park Service, 2013

The eastern shore of CNS is a series of three beaches – Playalinda Beach, Klondike Beach, and Apollo Beach (from south to north). While Playalinda and Apollo beaches have entrance stations; Klondike Beach is a remote 12-mile-long beach reached on foot, horseback (seasonally), or boat with access by permit only.

Traffic counts to Playalinda Beach and Apollo Beach and are displayed in Figures 3.15-5 and 3.15-6. On average, the highest traffic counts at Apollo Beach occurred from March-July. Traffic counts at Apollo beach were highest in 2010 with a total of 168,949 and lowest in 2012 with 122,054 (NPS 2010-2014).

On average, the highest traffic counts at Playalinda Beach also occurred from March-July. Traffic counts were highest in 2010 and have decreased each year since; in 2014 the traffic count was 165,936 (NPS 2010-2014).

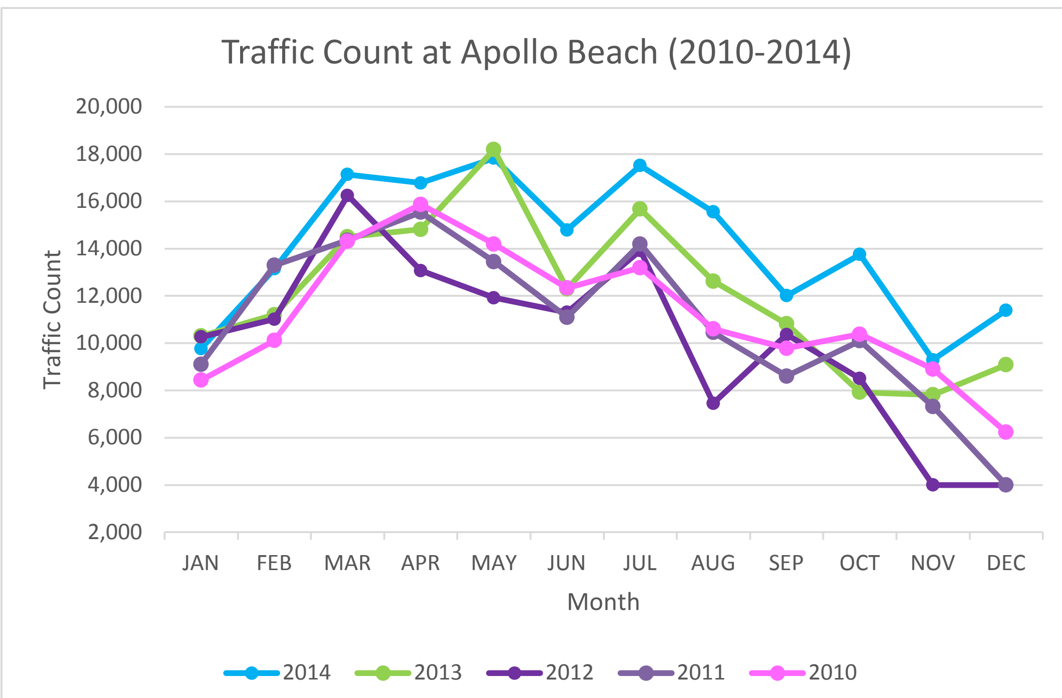


Figure 3.15-5. Traffic count at Apollo Beach (2010-2014)
Source: National Park Service, 2010-2014

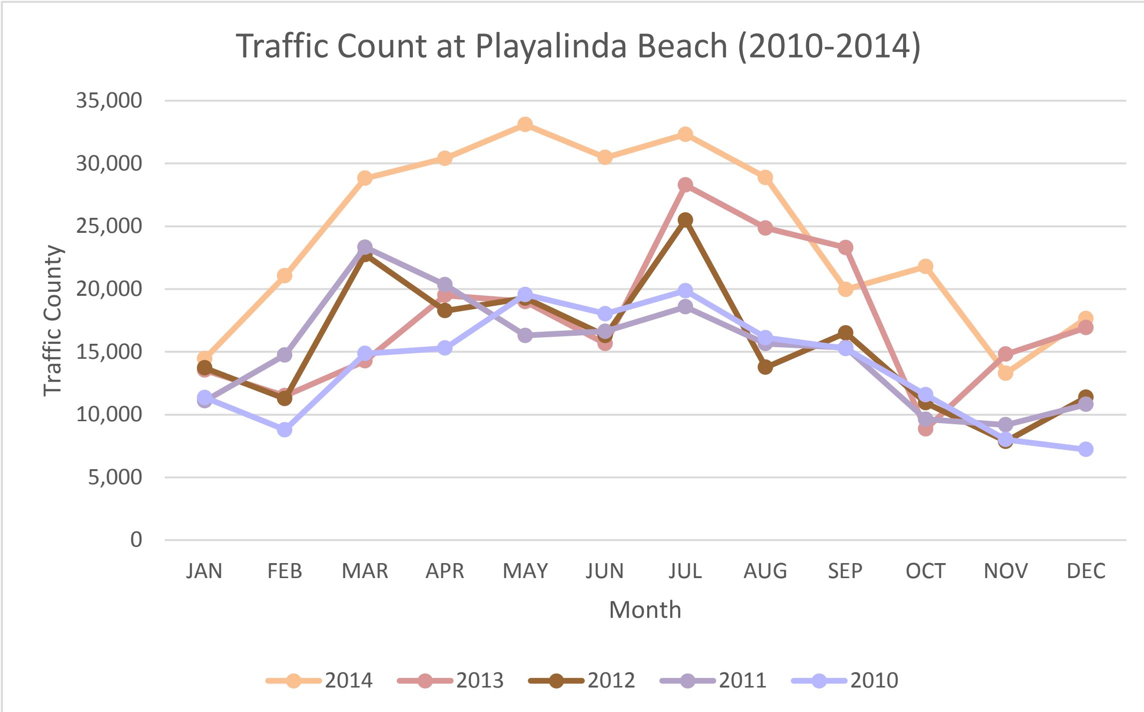


Figure 3.15-6. Traffic count at Playalinda Beach (2010-2014)
Source: National Park Service, 2010-2014

Table 3.15-5 shows annual visitation data for Gomez Grant, Mosquito Lagoon, North District (Apollo Beach), and South District (Playalinda Beach) from 2010 to 2014. An inductive loop traffic counter is located on the entrance lane to Apollo Beach. The traffic count is multiplied by the PVV multiplier of 3.2 for December, January, February, and March and 3.0 for April through November. As shown in Table 3.15-5 below, visitation to Apollo Beach decreased in 2011 and 2012 compared to 2010, but rebounded in 2013 and 2014.

A pneumatic tube traffic counter is located on the entrance lane to Playalinda Beach. The traffic county is multiplied by the persons-per-vehicle (PVV) multiplier of 3.0. Annual visitation at Playalinda has increased from 2010 to 2014. Access to the Southern District of CNS – which includes all lands east of State Route 3 south of the Gomez Grant Line and north of the Kennedy Space Center – closes three days prior to some rocket launches at KSC/Cape Canaveral; access reopens the day after a successful launch. Playalinda Beach closed a total of 40 days from 2010 to 2014. No closures occurred in 2012, 2013, or 2014 (NPS, 2010-2014).

Gomez Grant is estimated as having five vehicles per day, and the monthly vehicle count is multiplied by the PPV multiplier of 3.0. Gomez Grant has about 5,475 visitors annually. Mosquito Lagoon is estimated as having 20 boats per day, or about 18,250 per year (NPS, 2010-2014). The monthly boat count is multiplied by the persons-per-boat (PPB) multiplier of 2.5 (CNS, 2015). Since boats can access water via several boat ramps outside of Mosquito Lagoon, visitation is not counted by the number of boats on the water (Palfrey, 2015).

Table 3.15-5. CNS annual visitation by management district (2010-2014)

Special Use Area	2010	2011	2012	2013	2014
Gomez Grant	5,475	5,475	5,475	5,475	5,475
Mosquito Lagoon	18,250	18,250	18,250	18,250	18,250
North District (Apollo Beach)	410,815	402,691	374,466	444,767	517,132
South District (Playalinda Beach)	497,808	544,833	562,488	631,446	876,615
# Days Playalinda Beach was closed	21	19	0	0	0

The Kennedy Parkway (SR 3) borders the western boundary of the southern two-thirds of CNS and bisects the KSC. It provides visitor access to two designated but undeveloped public boat launch areas accessing Mosquito Lagoon, a manatee viewing area adjacent to Haulover Canal, and a developed public launch facility at Haulover Canal. NASA uses Gate 6TT on the Kennedy Parkway, just south of the boat launch, to restrict public access during launch and landing operations.

Titusville Road (State Route 406) provides access to Beach Road (S.R. 402) and MINWR's Black Point Wildlife Drive. KSC's gate 4TT, which is used to restrict public access during NASA launch and landing operations, is just east of the Max E. Brewer Causeway over the Indian River on S.R. 402.

Beach Road provides access to Playalinda Beach and the northern section of the space center complex; overnight public use in this area of CNS is prohibited. Bio Lab Road connects Beach Road with the Kennedy Parkway. It traverses the southwestern shoreline of Mosquito Lagoon (NPS 2014). Note that Bio Lab Road is a public use road managed and maintained by the USFWS as part of the MINWR; it is not managed and maintained by the NPS and it is not part of the CNS.

3.15.1.2.2 Visitor Expenditures

Local economic significance and economic impacts of visitor spending were estimated by the NPS using multipliers for local areas around each park. Multipliers capture both the direct and secondary effects around the parks in terms of jobs, labor income, and output (i.e. value added, in this case). Table 3.15-6 displays the economic impacts from spending by non-local visitors, or those who do not reside in Brevard or Volusia counties. Economic impact measures estimate the likely losses in economic activity to Brevard and Volusia counties in the absence of CNS. Should the park opportunities not be available, it is assumed that local residents would spend the money on other local activities, while visitors from outside the ROI would not have made a trip to the area. Spending by local residents on visits to CNS would not represent "new money" to the ROI and therefore NPS generally excludes this spending when estimating impacts (NPS 2011).

Table 3.15-6. 2013 Economic impact of CNS on Brevard and Volusia counties

Non-Local Visitor Spending	Contribution of Non-Local Visitor Spending		
	Jobs	Labor Income	Output
$67,887,400	897	$30,831,900	$86,027,500

Source: National Park Service, 2013

3.15.1.3 Ecosystem Services Valuation

The Ecosystem Services concept was formally defined by the United Nations' 2004 Millennium Ecosystem Assessment (MEA), a four-year study involving more than 1,300 scientists worldwide. Ecosystem services are grouped into four broad categories:

1. *Provisioning services* – The supply of goods of direct benefit to people, and often with clear monetary value, such as timber from forests, medicinal plants, and fish from the oceans, rivers, and lakes. The regulation of water for drinking and irrigation is directly or indirectly moderated by the diverse roles played by different ecosystems.
2. *Regulating Services* – The range of functions carried out by ecosystems which are often of great value but generally not given a monetary value in conventional markets. They include regulation of climate through the storing of carbon and control of local rainfall, the removal of pollutants by filtering the air and water, protection from disasters such as coastal storms, and control of disease.
3. *Supporting Services* – Not of direct benefit to people but essential to the functioning of ecosystems and therefore indirectly responsible for all other services. Examples such as pollination, seed dispersal, water purification, and nutrient cycling.
4. *Cultural Services* – Not providing direct material benefits, but contributing to wider needs and desires of society, and therefore to people's willingness to pay (WTP) for conservation. Cultural services provide recreational opportunities, inspiration for art and music, and spiritual value. They include the spiritual value attached to particular ecosystems such as sacred groves and the aesthetic beauty of landscapes or coastal formations that attract tourists and recreationists.

Both MINWR and CNS provide all four of these ecosystem services to refuge/park visitors and more generally, to residents of Florida and citizens of the United States.

3.15.2 Environmental Consequences Including Cumulative Impacts

3.15.2.1 Proposed Action

The effects analysis considers how visitor experiences would change with implementation of the Proposed Action and what contributes or detracts from desirable visitor opportunities. Desirable visitor opportunities can be described as the ability to experience the fundamental resources and values within their natural and cultural settings. Hindering or facilitating access to various recreational resources is controversial – and is considered as it relates to traffic in the area, recreational revenue, and cultural services (one of the four categories of ecosystem service). The impact to provisioning, supporting, regulating, and cultural services is discussed throughout, considering the nonmarket good or service to Brevard and Volusia counties.

3.15.2.1.1 Land Use Plan, Future Development Plan, and Functional Area Plans

Changes in KSC's land use plan, actions to meet KSC's mission and core competencies, and future development, transportation facilities, and activities could in combination have both adverse and beneficial impacts on recreational resources and ecosystem services. The magnitude, extent, duration, and probability of impacts on recreational resources would depend on the activity itself and its location as it relates to ecosystem services.

The long-term consolidation of NASA support services and administrative buildings into a smaller geographic footprint, a major component of the Future Land Use Plan, would generally benefit recreational resources if developed land is re-vegetated and allowed to return to its natural state. The expansion of existing facilities would create impacts of lesser magnitude compared to construction of new facilities on pristine land, since infrastructure such as access roads and utilities have already been constructed.

Recreation areas include parks, outdoor fitness, athletic fields, recreation buildings, centers and clubs. Examples of recreation land uses include KARS Park North and South complexes. Additional Recreational land use areas are not planned, so future development and/or expansion of recreational functions, if necessary, would occur within the already established recreational land areas.

Buffer land area is submerged, vulnerable to inundation by rising water whether the result of storm event or climate change, or is a high-value uplands habitat for species of critical concern, such as the Florida scrub jay. Two sub-categories of Operational Buffer are designated: Conservation and Public Use. Operational Buffers represent the largest type of land use at KSC – 44,583 acres for Conservation and 34,844 acres of Public Use – together representing more than half of the total acreage. Development in Operational Buffer areas may include infrastructure, operations of low impact, or small footprint facilities that may be required for support of space launch or landing operations.

The Operational Buffer/Public Use category, northern Indian River Lagoon, southern Mosquito Lagoon, and much of the Banana River are publically accessible areas of KSC that are under the management of MINWR and CNS as a conditional use subject to the operational activities associated with KSC's mission and in accord with 16 USC § 459(j) that established CNS. Coastal beaches and supporting facilities at CNS and areas and facilities to support hunting, fishing, observing and photographing wildlife, environmental education and interpretation at MINWR are classified as Operational Buffer/Public Use. Approximately 20 acres of Operational Buffer/Public Use would be removed as part of the Proposed Action.

Operational Buffer/Conservation areas correspond to land areas in the southern portion of KSC that may never have been developed, or sites that may have reverted to a natural environment over the years. The proposed action would remove approximately 4,386 acres of land designated for Operational Buffer/Conservation. The difference in total acreage (as shown in Table 2.1-1) is due to the addition of Vertical Landing category (approximately 76 acres), which lies within the same geographical footprint as the Horizontal Launch and Landing Category.

3.15.2.1.1.1 Vertical Launch Sites and Launch Operations and Support

Approximately 176 additional acres are designated for Vertical Launches and 107 acres for Launch Operations and Support. The development of launch complex (LC) 49 as well as LC-48 would directly impact opportunities for recreational activities; the visitor experience; and ecosystem services. The magnitude and type of impact to ecosystem services would depend on the extent of the project, site topography, type of habitat, and impervious surfaces.

As discussed in Section 3.3 Soils and Geology and 3.4 Water Resources, ground-disturbing construction activities could cause increased runoff; accelerated soil erosion; sedimentation; create habitat for colonization by invasive species; decrease soil porosity, decreasing the transfer of air and water through the soil and causing decreased vegetative productivity due to root restriction (i.e. regulating services). Impacts to soils and water from the development of LC 49 would especially affect cultural services; increased noise and murky waters would affect water-based recreational activities or passive use of Playalinda Beach. Best Management Practices (BMPs) would be implemented during project activities to prevent or reduce soil erosion into water surfaces and minimize adverse soil impacts.

A 2007 Vertical Launch Site Evaluation Study concluded that a vertical pad could also be sited to the south of 39A and to the north of pad 41. This proposed Vertical Launch Pad would occur in isolated coastal wetlands at Pintail Creek targeted for reconnection by the SJRWMD (SRJWMD, 2002). In the past, reconnection of impounded rivers or wetlands was considered by NASA to mitigate environmental impacts caused by its future development activities. As shown in Figure 3.9-8 (Distribution of oak scrub habitat and major Florida scrub-jay populations), this Vertical Launch Pad would also occur in potential oak scrub habitat.

Colonization of invasive species from disturbing soils could adversely impact resident birds which provide regulating services in the form of pest control and carcass removal (Wenny et al., 2011). The endangered Florida scrub-jays are restricted to shrublands that have many scrub oaks and few trees – like the land cover of the proposed launch complexes. Florida scrub-jays are omnivorous and eat a wide variety of acorns, seeds, peanuts, insects, tree frogs, turtles, snakes, lizards, and young mice. Insectivory, pollination, seed dispersal, and nutrient cycling benefit plants that then produce oxygen, food, flood and erosion control, aesthetics, recreation and other benefits for human society.

3.15.2.1.1.2 Horizontal Launch and Landing and Vertical Landing

Over the long term, as the market and emerging technology may demand, additional horizontal launch infrastructure can be constructed in an area identified just south of Beach Road that would support an east-west horizontal launch capability. This area - adjacent Playalinda Beach and just south of Mosquito Lagoon - is managed by both NASA and NPS. As mentioned above, the difference in total acreage between the existing and future land use (approximately 76 acres) is due to the addition of the Vertical Landing category, which lies within the same geographical footprint as Horizontal Launch and Landing category.

Construction activities could result in substantial ground disturbance and movement of earth with relatively large areas of exposed soils, increasing the likelihood of soil erosion and sediment delivery to nearby surface waters and wetlands, resulting in localized turbidity increases and mobilization of fine sediments. Siltation and runoff can degrade water quality. Increased turbidity could cause an increase in water temperature as turbid water heats more readily when exposed to sunlight. Elevated levels of turbidity could also lead to decreases in primary production and dissolved oxygen levels. There could also be increased short-term fine sediment and loss of benthic food resources – impacting the supply of goods of direct benefit to people (provisioning services) or in this case, fish from the ocean. In addition, Playalinda Beach has a high aesthetic or amenity value related to the passive benefit (visual enjoyment) and wellbeing that people receive when experiencing nature. Increased noise and impacts to air and water quality associated with construction activities would contradict the natural attributes of Playalinda Beach that contribute to its beauty and aesthetic lucidity, or the cultural services it provides. Insulation and other noise reducing equipment and dust abatement would help reduce the potential impacts to visitor experience.

Increased traffic on Beach Road and Bio Lab road could hinder or delay access to Playalinda Beach during construction, though avoiding construction activities during peak visitation months (March-July) could reduce the magnitude of this impact.

3.15.2.1.1.3 Seaport

Future development of the sea-based transportation capability west of the SLF at Cedar Hammock Creek (Banana Creek) could impact ecosystem provisioning and supporting services. Accidental fuel spills in the Banana Creek could flow affect water quality. The removal or impact to tidal wetlands could hinder natural flood control, reducing barriers for sea level rise and storm surge. Increased sedimentation due to construction activities could degrade anadromous fish spawning grounds. Note that a separate NEPA analysis would be required for the proposed seaport west of the SLF at Cedar Hammock Creek (Banana Creek). The pursuant analysis could be referenced or tiered in the future analysis.

As displayed in Figure 3.4-4, the State of Florida classifies Banana Creek as Class III (Recreation-Propagation and Management of Fire and Wildlife) Waters. Class III water standards are intended to maintain water quality suitable for body contact sports and recreation and the production of diverse fish and wildlife communities (NASA, 2010a, 2015). Most of the shoreline on KSC/MINWR is impounded with no direct runoff into the Indian River Lagoon. While surface water quality impacts would be minimal, increased traffic with the expansion of water access areas could hinder the quiescent waters and increase turbidity in the long-term. Increased traffic from the proposed seaport to Canaveral could impact cultural services such as recreational boating and fishing around Brock's Point and Peacock's Pocket, though Banana Creek itself is closed to the public. The FDED has also designated this area as a Manatee Protection Zone.

Because of the various man-made modifications related to the space program and mosquito control, circulation between Mosquito Lagoon and the Banana River was blocked in the earlier 1960s. In the MINWR, over 14,100 acres of impoundments have been reconnected or fully restored (i.e., impoundment dikes completely removed). Restored wetlands provide greater ecological benefits than reconnected wetlands. Designation and future development of this Seaport would occur in intertidal saltwater marsh herbaceous wetlands that were reconnected via underground culverts by the SJRWMD (SJRWMD, 2002). The beneficial role of birds in consuming arthropods, and especially their responses to and influence on insect outbreaks is well documented (Whelan et al., 2008), and provides supporting services.

Tidal wetlands can play an important role in flood control, acting much like a sponge, absorbing rainfall and therefore reducing the speed and volume of runoff entering streams and rivers. Thus, downstream water levels rise more slowly, reducing the potential for destructive flooding. In terms of flood control per unit of area, wetlands are generally assessed to provide a more valuable service than other land classifications. In the event of extreme flooding, the loss of tidal wetlands could translate to infrastructure damage and the cost to rebuild in Brevard and Volusia counties. As discussed in Section 3.9 (Biological Resources), mitigation would be needed to compensate for unavoidable wetland loss. This could include purchase of credits from a wetland mitigation bank, a monetary compensation for wetland loss, or wetland restoration or preservation.

Future development of an additional seaport south of the Assembly, Integration and Processing Area on the east side of the Industrial Area is designated in Buck Creek on the Banana River. Note that a separate NEPA analysis would be required for this proposed seaport; the pursuant analysis could be referenced or tiered in the future analysis. This proposed seaport would occur in mangroves that were reconnected via underground culverts (SJRWMD, 2002). Mangroves play an important role in the biogeochemical cycles of the coastal environment. Mangrove litter fall and root biomass have been implicated as the ultimate source of carbon and nutrients. When ecosystem nutrient pools increase in size through nutrient addition, process rates increase as nutrients cycle at a higher speed. The nutrients such as inorganic phosphorus, nitrogen, potassium, and organic carbon are provided to adjacent coastal and marine, as well as terrestrial ecosystems through active and passive transport (Hussain and Badola, 2008).

Birds provide supporting and regulating services such as insect pest control, seed dispersal, and nutrient cycling. Through their foraging (i.e., consuming and processing resources), birds act as mobile links that transfer energy both within and among ecosystems, and thus contribute to ecosystem function and resilience. Aquatic birds nesting colonially in coastal areas particularly contribute to nutrient cycling since they process large amounts of food in small areas. In this manner, seabirds transport nutrients from the aquatic zone to the terrestrial zone. Such large inputs of phosphate-rich guano can influence the structure and composition of plant communities (Ellis 2005). Conversely, removal of nesting birds after introduction of a predator fundamentally alters the plant community (Croll et al., 2005; Bellingham et al., 2010).

In the Indian River Lagoon, mangrove communities support the continued existence of barrier islands against tidal and wave forces. Mangroves serve as storm buffers by functioning as wind breaks and through prop root baffling of wave action. Their roots stabilize shorelines and fine substrates, reducing turbidity, and enhancing water clarity. Mangroves improve water quality and clarity by filtering upland runoff and trapping waterborne sediments and debris (USFWS, 2014).

In 1990, the USFWS designated critical habitat for the endangered Florida manatee, including the location of the Seaport on the Banana River. By consuming huge quantities of aquatic vegetation they help spread plant seeds and control plant overgrowth. Manatees are good indicators of the health of the ecosystem because they can be highly susceptible or highly resistant to certain environmental stressors – aiding in early disease detection and tracking epidemiologic patterns (Sulzner et al. 2012).

Because of the longstanding closure to motorized vessels in an effort to protect manatees, this Manatee Sanctuary/NMZ has an abundance of sea life including some of the largest schools of redfish and black drum the state has to offer. Mangroves provide protected nursery areas for fishes, crustaceans, and shellfish that are important to both commercial and sport fisheries. The most popular and direct launch spot for kayaks and canoes is KARS Park – now open to the public with a $5.00 launch fee. With the development of this seaport, the introduction of motorized boating, and removal of mangroves, the increased disturbance of fish spawning areas and nesting and roosting bird and impacts to water quality and habitat are likely to lower the refuge's biological integrity.

Assuming this proposed seaport would be constructed for motorized boating and would require the removal of mangroves, this single change in land use would create the most adverse impacts to provisioning (i.e., fishing), supporting (i.e., nutrient cycling), regulating (i.e., water quality) and cultural (i.e., manatees, boating, passive benefit) ecosystem services.

3.15.2.1.2 Launch, Landing, Operations and Support

3.15.2.1.2.1 Vertical Launch and Landing

The proposed action includes five to seven launches annually over the next 20 years. In the past, closures have generally been short-lived, although some continue for several days or longer and can have a profound impact on the visitation and public use programs at CNS and MINWR. The southern portion of the national seashore including Playalinda Beach, Klondike Beach, and the southern end of Apollo Beach, would close to the public during the countdown period before space shuttle launches/landings at KSC. The area north of old Haulover Canal would be unaffected by KSC's launch closures and would always remain open to the public.

MINWR facilities, trails, and programs would also close for KSC launches and landings. In the past, closures have generally included the area south of Haulover Canal and east of the Max Brewer Bridge, including the Visitor Information Center, Refuge headquarters, Oak and Palm Hammock trails, Scrub Ridge Trail, Cruickshank Trail, Dummit Cove, and the Sendler Education Outpost Pavilion. Access or impoundment road closures have included Bio Lab Road, Black Point Wildlife Drive, L Pond Road, Pump House Road, impoundment roads south of SR 406 and SR 402 (including East and West Gator Creek roads and Peacock Pocket's Road).

Hunting Areas 1 and 4 could both close during vertical launches and landings. Avoiding launches between the hours of 4 AM and 1 PM on the 25 hunt days from November through January would eliminate or avoid direct impacts to waterfowl hunting at the MINWR. Closing the Bairs Cove, Eddy Creek (at Playalinda Beach), and BioLab boat ramps would create adverse impacts to saltwater fishing at CNS and MINWR in the Indian River, Indian River North, Mosquito Lagoon, and Eddy Creek.

Visitation to MINWR and associated expenditures on the Refuge and in the local community would be adversely impacted by launch and landing activities due to closures of facilities, trails, boat ramps, roads, and fishing and hunting areas. While visitation expenditures would decrease due to beach closures at Playalinda Beach, the long-term economic impact would be negligible. Therefore, these activities would generate intermittent minor to moderate adverse effects on the visitor experience during the short-term (i.e., during the launch).

3.15.2.1.2.2 Horizontal Launch and Landing

Erosion caused by site runoff and contamination by chemical spills (e.g., fueling) can impact surface water quality. Additionally, non-point sources can potentially impact surface and ground water quality, such as oil and grease from paved street and road surfaces that wash into a water body or are absorbed into the water table. Healthy, well-functioning ecosystems can play a vital role in purifying water through pollutant capture provided by vegetation, soils, and sediments. High levels of nutrients like phosphorus, for instance, can be considerably reduced by wetlands. The effects to local water quality and hydrology during construction would be adverse and short-term; the degree of effect would depend on the extent of the disturbance and proximity to water. The direct economic impact to Brevard and Volusia counties would occur in the additional cost associated with processing the water when it enters the municipal water supply.

Similar potential impacts would occur from closures during horizontal launch and landing as those discussed under vertical launches and landings. Potential impacts to visitation, associated expenditures, and recreational activities at MINWR and CNS and in the local community would be adverse due to launch and landing activities with the closures of facilities, trails, boat ramps, roads, and fishing and hunting areas. However, the long-term economic impact would be negligible. Therefore, these activities would generate intermittent minor to moderate adverse effects on the visitor experience during the short-term (i.e., during the launch).

3.15.2.1.3 Future Transportation Plan

A rail connection between the Florida East Coast railway and Port Canaveral via the KSC railroad would impact ecosystem services provided by flora and fauna in Florida scrub jay habitats. The rail connection would transect potential Florida scrub jay upland habitat in the MINWR, or further fragment Florida scrub jay habitat and adversely impact their movement and dispersal, since the rail easement would utilize the existing rail line at KSC. A detailed analysis of ecosystem services and recreational impacts of this divestiture and the construction and operation of a rail connection between Port Canaveral and KSC is the subject of a separate environmental study.

3.15.2.1.4 Conclusion

Changes in KSC's land use, actions to meet KSC's mission and core competencies, and future development, transportation facilities, and activities would have both adverse and beneficial impacts on recreational resources and ecosystem services. The long-term consolidation of support services and expansion of existing facilities would create impacts of lesser magnitude compared to the construction of new facilities on pristine land, since infrastructure such as access roads and utilities have already been constructed.

The development of vertical launch sites and launch operations and support would affect regulating services due to increased runoff, soil erosion, and sedimentation and create negligible to minor impacts in the short-term with BMPs. Construction activities in MINWR uplands could prevent the Florida scrub-jay from performing key functions such as insectivory, pollination, seed dispersal, and nutrient cycling that then produce several benefits for human society. The development of horizontal launch infrastructure could hinder or delay access to Playalinda Beach; construction activities would contradict its natural attributes that contribute to its beauty and aesthetic quality, or the cultural services it provides. Short-term adverse impacts would likely be minor with the use of BMPs, and depend on the extent of the project; site topography; whether impervious surfaces would be installed; timing of construction activities, and access roads. Launch and landing activities would likely generate intermittent, adverse effects on the visitor experience (i.e., during the launch) at CNS and MINWR due to beach, boat ramp, facility, road, and trail closures, and would not exceed the threshold of significance.

Future development of two seaports could include the removal of saltwater marsh wetlands or mangroves, which would hinder natural flood control, degrade finfish and shellfish spawning grounds and nurseries, impact boating and fishing experiences, and further impact the Florida manatee with the introduction of motorized boating. Adverse impacts to provisioning (i.e., fishing), supporting (i.e., nutrient cycling, seed dispersal), regulating (i.e., water quality, regulation of climate, flood control) and cultural (i.e., manatees, boating, angling, passive benefit) ecosystem services would occur in both the short- and long-term and could be significant.

The extent of impacts would be medium (localized), occurring mostly at and around the proposed seaport(s). The impacts to ecosystem services are possible: while the ecosystem services that wetlands provide are well-established – as is the causal relationship of turbidity and sedimentation on fish and shellfish in coastal wetlands and mangroves, and motorized boating on manatee populations – development of either seaport would necessitate a further, site-specific environmental review. While KSC does not currently operate a seaport, and the land use surrounding KSC includes an active seaport, the precedence and uniqueness of developing either of the proposed seaports could be moderate given the exact locations of the proposed seaports. While other seaports exist nearby that would have required dredging and the removal of mangroves or tidal wetlands, none were constructed in critical habitat for the endangered Florida manatee; a FDEP Manatee Protection Zone; or a Manatee Sanctuary/NMZ after having been designated as such.

3.15.2.1.5 Cumulative Impacts

With the potential number of combined additional launches proposed for KSC and the Shiloh Launch Complex, as well as other regional developments, total annual visitation at CNS could decrease considerably. Increases in water runoff, sedimentation, and potential spills would cumulatively impact recreational water-based activities in and around Mosquito Lagoon. Additionally, the increase in non-point source runoff from spin-off development as a result of these two proposed projects could affect water quality in the Indian River Lagoon over the long-term. The development of launch facilities would degrade the high aesthetic or amenity value (i.e., cultural services) associated with CNS and MINWR, contradicting and offsetting the natural attributes that contribute to their natural beauty and aesthetic quality.

As mentioned elsewhere in this chapter (e.g., Section 3.2.1), by 2040, Brevard County is projected to have 677,451 residents (an increase of more than 100,000 from the population at present), and Volusia County 595,077, an increase of nearly 100,000. This will put added pressure on existing recreational resources and facilities, such as those at CNS and MINWR. Furthermore, a larger population and levels of development and higher amounts of non-source pollution within the watershed of the IRL will make it more difficult to maintain and improve the water quality of the IRL that is indispensable for ecosystem health, including healthy and abundant bird, fish, and aquatic/marine invertebrate populations, upon which both consumptive and non-consumptive outdoor recreation depend.

Over a still longer time frame, climate change and sea level rise are likely to have pronounced, and likely adverse, effects on local ecosystems and dependent outdoor recreation.

3.15.2.2 Alternative 1

Direct, indirect and cumulative impacts on recreation from Alternative 1 would be substantially less than those of the Proposed Action because the two proposed new seaports would not be constructed and operated and because development of launch and landing facilities north of Beach Road might not occur. This would avoid impacts from the Proposed Action on outstanding recreational opportunities in and around Merritt Island, Banana Creek, Mosquito Lagoon, Playalinda Beach, CNS and MINWR. Some cumulative adverse impacts on recreation at CNS and Playalinda Beach may still occur because of the Shiloh proposal.

3.15.2.3 No Action Alternative

Under the No Action Alternative, land use would not change on Operational Buffer and Public Use areas. Without future development of horizontal launch and vertical landing facilities, vertical launch pads, and seaports, the value of ecosystem services at CNS and MINWR would not change (or would fluctuate with market forces). The continued increase in visitor numbers, as well as urban development of the area surrounding the national seashore, will likely degrade visitor experience and the uncrowded beach and lagoon experience at CNS. With more users, noise levels and the demand for services and facilities will likely increase, as well as the likelihood of resource damage.

Sea level rise and erosion from climate change, or the need to protect certain areas or species, may alter visitor access to certain parts of CNS and MINWR. Visitation for birding and fishing may change if new species shift northward; or extant species move northward or have dramatic declines in population, as might occur with the temperature-sensitive manatee.

3.16 Environmental Justice and Protection of Children

3.16.1 Affected Environment

Executive Order (EO) 12898 “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” requires that Federal agencies consider as a part of their action any disproportionately high and adverse human health or environmental effects to minority and low-income populations. Agencies are required to ensure that these potential effects are identified and addressed.

The U.S Environmental Protection Agency (EPA) defines environmental justice as: "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The goal of "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high adverse impacts on minority and low-income communities and identify alternatives to mitigate any adverse impacts. For purposes of assessing environmental justice under NEPA, the Council on Environmental Quality (CEQ) defines a minority population as one in which the percentage of minorities exceeds 50 percent, or is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis (CEQ, 1997).

EO 13045 "Protection of Children from Environmental Health Risks and Safety Risks" places a high priority on the identification and assessment of environmental health and safety risks that may disproportionately affect children. The EO requires that each agency "shall ensure that its policies, programs, activities, and standards address disproportionate risks to children." It considers that children's physiological and social development makes them more sensitive than adults to adverse health and safety risks, and recognizes that children in minority, low-income, and indigenous populations are more likely to be exposed to, and have increased health and safety risks from, environmental contamination than the general population.

KSC is situated in Central Florida west of Cape Canaveral on Merritt Island. KSC encompasses all northeast areas of Brevard County and extends north to include the southern edge of Volusia County. Therefore, Brevard County and Volusia County, Florida are the regions of influence (ROI) for any direct and indirect impacts that may be associated with the implementation of the proposed action. For purposes of comparison, the state of Florida is defined as the region of comparison (ROC), or the "general population" as it corresponds to the CEQ definition. Demographic and income data for Brevard County and Volusia County (the ROI), are compared to demographic and income data for the state of Florida (the ROC) throughout the section.

3.16.1.1 Minority Populations

The CEQ defines "minority" as including the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic (CEQ, 1997). All figures and calculations are based on Demographic Profile Data from the 2010 United States Census.

The CEQ defines a minority population in the following ways:

1. "…If the percentage of minorities exceeds 50 percent... (CEQ, 1997)." As this definition applies to the PEIS Proposed Action, if more than 50 percent of either Brevard County or Volusia County populations consist of minorities, they would qualify as constituting an environmental justice population.
2. "… [If the percentage of minorities] is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis

(CEQ, 1997)." For purposes of this analysis, a discrepancy of ten percent or more between minorities (the sum of all minority groups) in Brevard County or Volusia County compared to the state of Florida would be considered "substantially" higher, and would categorize either Brevard County or Volusia County as constituting an environmental justice population. This approach also applies to individual minority groups. A discrepancy of ten percent or more between individual minority groups (American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic) in Brevard or Volusia County and the percentage of individual minority groups in the state of Florida would be considered "substantially" higher, and would categorize Brevard or Volusia County as constituting an environmental justice population.

Table 3.16-1 summarizes the representation of all minorities in Brevard County, Volusia County, and the state of Florida.

Table 3.16-1. Summary of minorities and minority population groups

Location	Total Population	Minority (%)	American Indian & Alaska Native (%)	Black or African American (%)	Asian (%)	Native Hawaiian & Other Pacific Islander (%)	Hispanic or Latino (%)
Brevard County	543,376	20.8	0.4	10.1	2.1	0.1	8.1
Volusia County	494,593	23.6	0.4	10.5	1.5	0.0	11.2
Florida	18,801,310	41.4	0.4	16.0	2.4	0.1	22.5

Source: U.S. Census Bureau, 2010

As the table indicates, neither Brevard County nor Volusia County meets the regulatory definition of consisting a minority population or minority group(s). All minorities in Brevard County, Volusia County, and the state of Florida represent less than 50 percent of the total population. The percentage of each minority population group in both Brevard County and Volusia County is lower than the percentage of minority population groups in the state of Florida. By both CEQ definitions of a minority population, the ROI does not constitute an environmental justice population.

3.16.1.2 Low-Income Populations

Low-income populations are defined as those with a preponderance of households with incomes below the Federal poverty level. There are two slightly different versions of the Federal poverty measure: poverty thresholds and poverty guidelines. The poverty thresholds are the original version of the Federal poverty measure, and are updated each year by the U.S. Census Bureau. The thresholds are used mainly for statistical purposes, for instance, preparing estimates of the number of Americans in poverty each year. All official poverty population figures are calculated using the poverty thresholds, not the guidelines.

Environmental Justice Guidance Under NEPA suggests that Census poverty thresholds should be used to identify low-income populations (CEQ, 1997). Census uses a set of income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family threshold, that family and every individual in it is considered to be in poverty. The official poverty thresholds do not vary geographically, but are updated for inflation. The official poverty definition considers pre-tax income and does not include capital gains or non-cash benefits such as public housing, Medicaid, and food stamps (CEQ, 1998).

The U.S. Department of Health and Human Services (DHHS) guidelines represent the basis for many state and regional guidelines, including Head Start, the Food Stamp Program, the National School Lunch Program, the Low-Income Home Energy Assistant Program, and the Children's Health Insurance Program. The DHHS poverty guidelines are simplifications of the Census's detailed matrix of poverty thresholds. Like the Census poverty thresholds, the DHHS poverty thresholds are updated annually, vary based on family size and age, and do not vary geographically.

The DHHS poverty guidelines define low-income populations as those whose median household income is at or below the maximum annual income of $14,570 for a family of two and $18,310 for a family of three (USDHHS, 2010).

Table 3.16-2. Summary of economic characteristics

Location	Percentage of All People Below the Poverty Level	Percentage of Families Below the Poverty Level	Median Household Income*	Median Family Income
Brevard County	10.5%	7.2%	$49,523*	$60,842
Volusia County	13.8%	9.4%	$44,400*	$55,569
Florida	13.8%	9.9%	$47,661*	$57,204

Source: U.S. Census Bureau, 2006-2010
*In 2010 inflation-adjusted dollars

As displayed in Table 3.16-2, the percentage of all people below poverty in Brevard County is 3.3 percent lower than in the state of Florida while Volusia County has the same percentage of all people below poverty as the state of Florida. The percentage of families in Brevard County below poverty is 2.7 percent lower than in the state of Florida. In Volusia County, the percentage of families below poverty is 0.5 percent lower than the percentages in the state. The median household income in Volusia County is $3,261 lower than the state of Florida, or approximately 6.8 percent lower, while the median household income in Brevard County is $1,862 more than in the state, or approximately 3.9 percent higher. Although Volusia County has a median household income 6.8 percent less than the state of Florida and a median family income 2.9 percent less than the ROC, the population is still significantly above designated poverty levels by the DHHS definition. In addition, since the percentage of all people and families below the poverty level is either below or equal to the state of Florida, the ROI does not constitute an environmental justice population.

3.16.1.3 Protection of Children

EO 13045 *Protection of Children From Environmental Health Risks and Safety Risks* was prompted by the recognition that children are more sensitive than adults to adverse environmental health and safety risks because they are still undergoing physiological growth and development. It is the responsibility of each Federal agency to:

1. Identify and assess environmental health risks and safety risks that may disproportionately affect children; and
2. Ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

EO 13045 "defines environmental health risks and safety risks [to] mean risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to)." Children may have a higher exposure level to contaminants, because they generally have higher inhalation rates relative to their size. Children also exhibit behaviors, such as spending extensive amounts of time in contact with the ground and frequently putting their hands and objects in their mouths, which can lead to much higher exposure levels to environmental contaminants. It is well documented that children are more susceptible to things like exposure to mobile source air pollution, particulate matter from construction, or diesel emissions.

The *Memorandum Addressing Children's Health Through Reviews Conducted Pursuant to the National Environmental Policy Act and Section 309 of the Clean Air Act* recommends that EISs "describe the relevant demographics of affected neighborhoods, populations, and/or communities and focus exposure assessments on children who are likely to be present at schools, recreation areas, childcare centers, parks, and residential areas in close proximity to the proposed project, and other areas of apparent frequent and/or prolonged exposure" (EPA, 2012).

EO 13045 requires assessment of readily available information regarding demographic data on the local, regional, and national populations, and, in particular, children less than 18 years old to evaluate the number and distribution of children in the region and whether these children are exposed to environmental health and safety risks from the proposed action. Information to support this analysis is derived from the 2010 Census and locations with potentially high concentrations of children, such as schools, recreational areas for children, and residential areas identified.

Table 3.16-3. Summary of children by age group

Location	Total Population	Children Under 5 Years		Children 5 to 18 Years		All Children Under 18 Years	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Brevard County	543,376	26,809	4.9	80,877	14.9	107,686	19.8
Volusia County	494,593	24,337	4.9	68,936	13.9	93,273	18.9
Florida	18,801,310	1,073,506	5.7	2,928,585	15.6	4,002,091	21.3

Source: U.S. Census Bureau, 2010

In general, the Brevard County and Volusia County population is slightly older than that of the state as a whole. The percentage of children under 5 years in Brevard County and Volusia County is lower than the percentage in the state. Similarly, the percentage of children between the ages of 5 and 18 in Brevard County and Volusia County is lower than the percentage in the state. The percentage of children in the ROI – whether under 5 years, between 5 and 18 years, or all children under 18 years – is lower than the percentages in the state of Florida and as such does not constitute an unduly sensitive population on this basis.

3.16.2 Environmental Consequences Including Cumulative Impacts

Consideration of the potential consequences of the Proposed Action for environmental justice and protection of children requires three main components:

1. A demographic assessment of the affected community to identify the presence of minority, low-income, or youth populations that may be potentially affected.
2. An assessment of all potential impacts identified to determine if any result in significant adverse impact to the affected environment.
3. An integrated assessment to determine whether any disproportionately high and adverse impacts exist for minority, low-income, or youth groups present in the study area.

For an environmental justice impact to occur, the human health or environmental consequences must be adverse, high, and disproportionate. CEQ guidance for establishing disproportionately high and adverse impacts includes the following criteria (CEQ, 1997):

- For human health impacts, assessing whether:
    - The impacts, including bodily impairment, infirmity, illness, or death, are significant or above generally accepted norms;
    - The risk or rate of hazard exposure by a minority population, low-income population, or Native American Tribe to an environmental hazard is significant and appreciably exceeds, or is likely to appreciably exceed, the risk or rate to the general population or another appropriate comparison group; and
    - The impacts occur in a minority population, low-income population, or Native American Tribe affected by cumulative or multiple adverse exposures to environmental hazards.
- For environmental impacts, assessing whether:
    - There is or will be an impact on the natural or physical environment—ecological, cultural, human health, economic, or social—that significantly and adversely affects a minority population, low-income population, or Native American Tribe when that impact worsens the impacts on the natural or physical environment;
    - The environmental impacts are significant and are, or may be, having an adverse impact on minority populations, low-income populations, or Native American Tribes that appreciably exceeds, or is likely to appreciably exceed, those on the general population or another appropriate comparison group; and

- The environmental impacts occur, or would occur, in a minority population, low-income population, or Native American Tribe affected by cumulative or multiple adverse exposures to environmental hazards.

This analysis does not attempt to predict environmental justice impacts for a given KSC activity or for the program as a whole. Rather, it addresses the types of impacts that the Proposed Action could produce on minority and low-income communities. It addresses the potential severity of these impacts in the context of site-specific circumstances, where possible. Environmental justice analysis for actions included here is necessarily site-specific; that is, the direct impacts of these actions affect resident populations at the specific locations where the actions occur and not at the larger regional or national level. As a result, evaluating individual actions on a site-specific basis through tiered EIS and Environmental Assessment (EA) processes proves more effective.

Where minority, low-income, or youth populations are found to represent a high percentage of the total affected population, the potential for these populations to be displaced, suffer a loss of employment or income, or otherwise experience adverse effects to general mental and physical health and well-being is assessed for posing an environmental justice concern.

As discussed above, Brevard County and Volusia County represent the primary focus and ROI for any direct and indirect impacts that may be associated with implementation of the Proposed Action. For purposes of comparison, the state of Florida was defined as the ROC.

3.16.2.1 Proposed Action

3.16.2.1.1 Minority Populations

Neither Brevard County nor Volusia County constitutes an environmental justice population because in both counties, neither the percentage of minorities exceeds 50 percent nor is substantially higher than the percentage of minorities in the state. Disproportionate impacts to minorities in both Brevard and Volusia Counties would therefore be negligible.

3.16.2.1.2 Low-Income Populations

As previously established in Table 3.16-2, Brevard County and Volusia County do not constitute an environmental justice population since poverty levels coupled with median household income levels are lower or comparable with the rest of Florida, the ROC, and the majority of the population in the ROI is living well above the HHS poverty guidelines definition of poverty.

3.16.2.1.3 Protection of Children

As previously established and summarized in Table 3.16-3, children do not represent more than 50 percent of the population in the ROI. The percentage of children, whether under the age of 5 or between the ages of 5 and 18, does not represent a substantially higher percentage in the ROI compared to the state. Disproportionate impacts to the health and safety of children in Brevard and Volusia counties would not occur. Potential impacts to community services, including schools, are discussed in Section 3.15, Socioeconomics.

3.16.2.1.4 Employment

Since there are no environmental justice populations existing in the ROI there would be no impacts to air quality, water quality, noise, recreation, or traffic and transportation that would disproportionally affect an environmental justice population. However, the Proposed Action would produce a number of skilled jobs on an incremental basis, which would be filled by the local labor force to the extent possible. KSC has been one of the leading employers of both Brevard and Volusia counties (KSC, 2010). After the shutdown of the 30-year Shuttle program in 2011 almost 8,000 employees were laid off (Alvarez, 2012).

According to the Federal Reserve Economic Data in August 2011 Brevard County had an unemployment rate of 11.2% (FRED, 2014). The end of the Shuttle program had a direct impact on the local economy. Unemployment in Brevard County consistently dropped every year since the end of the shuttle program, and has rested at a rate of 6.4% since October 2014 (FRED, 2014). With the implementation of the Proposed Action it can be expected that additional jobs will be created in the local communities. Beneficial impacts would be felt most by those in search of highly skilled technical jobs, but the Proposed Action would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers (see Section 3.15, Socioeconomics, for a detailed discussion of jobs and economic activity).

3.16.2.1.5 Air Quality

As described in Section 3.6, Air Quality, the air quality at KSC is influenced by operations, land management practices, vehicle traffic, and other emission sources. Most KSC operations such as space launches, training fires, and fuel load reduction burns (prescribed fire on MINWR) influence air quality as episodic events (KSC, 2010). KSC has obtained all the required permits to date and is in total compliance with all the permit condition requirements, thus ensuring no adverse impact on human health or the environment, and no consequent impact on minority or low-income populations in the surrounding area (KSC, 2010). In the future, when implementing the Proposed Action, KSC would require any additional mandated permits.

3.16.2.1.6 Water Quality

As discussed in Section 3.4, Water Resources, impacts to water quality are anticipated to be generally minor, to a small extent, and unlikely adverse. KSC maintains operating permits for four domestic wastewater treatment facilities (KSC, 2010). The nearest domestic water treatment facility is located approximately 3.7 miles from the nearest community, thus ensuring no adverse impact on human health or the environment, and no consequent impact on minority or low-income populations in the surrounding area. KSC operates several facilities that treat Industrial Wastewater. However, the nearest facility is located approximately 2.7 miles from the nearest community, thus ensuring no adverse impact on human health or the environment, and no consequent impact on minority or low-income populations in the surrounding area (Google Earth, 2014).

Potential pollution could be caused by stormwater interacting with disturbed areas during construction activities such as haul roads, parking areas, and equipment staging areas. The required multi-sector general permit for stormwater discharges associated with industrial activity will require preparation of a Storm Water Pollution Prevention Plan (SWPPP). Additional recommendations include the installation and use of BMPs for prevention of non-point source pollution and the routine inspection, maintenance, and recordkeeping for all stormwater pollution control facilities. Because the construction activities are limited to the KSC boundaries, no adverse impact on human health or the environment, and no consequent impact on minority or low-income populations in the surrounding area is expected.

3.16.2.1.7 Acoustic Environment

As discussed in Section 3.8, Acoustic Environment (Noise), impacts caused by future KSC operations implemented by the Proposed Action would be minor and will mainly be contained to the KSC property boundaries. Noise generated at KSC can be attributed to six general sources: a) Sonic booms, b) launches, c) aircraft movements, d) industrial operations, e) construction, and f) traffic noise (KSC, 2010). According to the KSC Environmental Justice Plan, areas surrounding KSC and MINWR are far enough away from operational areas that they are exposed to relatively low ambient noise levels, in the range of 35 to 40 dBA (KSC, 2010). Therefore, it is not expected that the Proposed Action would have an adverse impact on human health or the environment, and no consequent impact on minority or low-income populations in the surrounding area is expected.

3.16.2.1.8 Recreation

As discussed in Section 2.1.1.2.12, Recreation, recreational activities that may occur within the area are numerous due to the diverse habitats and ecosystems of the region. NASA manages approximately 1,500 acres of citrus groves on the MINWR, as well as commercial fishing for oysters, shrimp, and other river fish species (KSC, 2010). KSC's Visitor Center Complex is a popular tourist attraction giving the public a chance to learn about the latest space technology and KSC programs firsthand. MINWR and CNS are additional attractions as popular parks for recreational activities such as bird and wildlife observation, manatee observation, fishing, hunting, boating, and paddling (Recreation, 2014). As discussed above, potential impacts to water and air quality would be local in extent. Any potential risks to recreationists would be mitigated by safety measures mandated by KSC, including exclusion zones during flight operations at launch facilities.

3.16.2.1.9 Community Services and Traffic

Minor impacts would occur to the local transportation network due to a net increase of vehicles in the area during construction phases over the course of implementation of the Proposed Action. The closest residential areas are nine miles to the south on Merritt Island and seven miles to the west in Titusville; the distances of these areas from the Proposed Action preclude any direct impacts from construction or operations (Google Earth, 2014). The Merritt Island community to the south includes the Merritt Island High School, Jefferson Junior High School and three elementary schools. Titusville includes the Astronaut and Titusville High Schools, two middle schools, and seven elementary schools. The surrounding communities also include the Parish Medical Center and Riverside Medical Hospital in Titusville, as well as the Cape Canaveral Hospital, just east of Merritt Island (Google Earth, 2014). Increases in traffic are expected to have minimal to no impact to community services in the area. Any potential impacts to community services, including schools, are discussed further in section 3.15, Socioeconomics.

3.16.2.1.10 Conclusion

The Proposed Action is not expected to produce any adverse consequences related to environmental justice. The proposed construction and future government and commercial operations at KSC are also not expected to generate air pollutants at a level that would adversely affect the human health and the environment of the surrounding area. Noise levels are also not expected to adversely affect populations living near KSC except for sporadic operations. All future construction activities under the Proposed Action would be implemented within the boundaries of KSC. The distance between existing and zoned residential areas of Merritt Island, 9 miles to the south, and Titusville, seven miles to the west, and the construction and operation activity prevent direct impact to populations (KSC, 2010). In addition, launch pads are located in remote areas and launch trajectories are aimed over the open ocean, away from populated areas of the ROI. Therefore, launch activities would not be expected to adversely impact human health in either Brevard or Volusia Counties.

Launch accidents are possible but pose no significant risk to the surrounding populations. Toxic or hazardous material as discussed in section 3.5, Hazardous Materials and Waste, could be released into the environment during an accident but would not extend beyond the immediate vicinity of the launch operation pads. It is NASA policy to keep members of the public off KSC land from areas that may be at risk during launch operations. NASA would continue to consider Environmental Justice issues during the implementation of the Proposed Action consistent with the agency-wide strategy pertaining to environmental justice (KSC, 2010). Because of the small, incremental nature of planned KSC activities and the relative absence of impacted populations, adverse effects to minority and low-income populations, and children in the KSC area as a whole would not be significant. Therefore, negligible-to-minor direct or indirect adverse impacts would be expected from the Proposed Action under consideration. Likewise, because of the modest incremental changes involved in the Proposed Action, no significant cumulative impacts would be expected. However, if in the future any disproportionately high or adverse human health or environmental effects of the Proposed Action at KSC on low-income or minority populations appear, they would be identified and action would be taken to resolve any public concerns.

3.16.2.2 Alternative 1

The direct, indirect, and cumulative impacts of Alternative 1 on environmental justice and protection of children would be virtually identical to those of the Proposed Action.

3.16.2.3 No Action Alternative

The No Action Alternative would continue KSC’s ongoing program at the current level of operations. No new potential for environmental justice effects or increased risk to children would be anticipated under this alternative. In general, all members of the affected communities would experience both the potential beneficial and adverse effects of the No Action Alternative equally. Minority or low-income individuals would unlikely experience high or disproportionate effects from the actions to be taken under this alterative.

3.16.2.4 Mitigation

NASA has also already undertaken measures to ensure that their actions do not have disproportionately high adverse human health or environmental effects on minority or low-income populations in the surrounding Kennedy community by developing the KSC Environmental Justice Plan (KSC-PLN-1917) in 1997 which was updated in 2010 (NASA, 2010a, 2015). The Plan outlines numerous programs that have been put in place to show KSC's commitment to its surrounding community and is updated periodically to ensure relevance (KSC, 2010). Such programs described in the Environmental Justice Plan include:

- Interdisciplinary National Science Project Incorporating Research and Education Experience (INSPIRE) – This program is designed to provide grade-appropriate NASA related resources and experiences to encourage and reinforce student's aspirations to pursue science, technology, engineering, and mathematics.
- KSC Intern Program (KIP) – The objective of this program is to provide students valuable work experience related to their academic studies and knowledge of KSC's mission.
- Motivating Undergraduates in Science and Technology (MUST) – This scholarship program is designed to attract and retain students in science, technology, engineering, or mathematics disciplines, and is led by the Hispanic College Fund with the support of the Society of Hispanic Professional Engineers and the United Negro College Fund Special Programs Corporation.
- Undergraduate Student Research Program (USRP) – This program offers undergraduates in science, math, and engineering mentored internship experiences at KSC.
- Exploration Systems Mission Directorate Student Project (ESMD) - This is a higher education student program with the goal to train and develop the highly skilled scientific, engineering, and technical workforce of the future needed to implement the Vision for Space Exploration.
- Annual Day of Caring Program - This program allows KSC employees four hours off to help and provide assistance in the community work.
- Combined Federal Campaign (CFC).
- A teacher-resource center that provides extensive information about NASA and KSC on the Internet and enables users to obtain material on science, math, and related topics.
- Annual Earth Day.
- Family Day.
- African-American Heritage Month.
- Hispanic Heritage Month.
- Asian Pacific Islanders Heritage Month.
- Native American Heritage Month.
- National Disability Employment Awareness Month.

3.17 Unavoidable Adverse Impacts

Sec. 102(C)(ii) of NEPA [42 USC § 4332] requires an EIS to list “any adverse environmental effects which cannot be avoided should the proposal be implemented.” Table 3.17-1 lists, by resource topic, unavoidable adverse impacts that would result from the Proposed Action, i.e., full implementation of the CMP Update, and Alternative 1, which is similar to the Proposed Action but lacks several of its facilities and land use features. As noted throughout this chapter, some of these adverse effects can be mitigated to some extent, and many of these adverse effects are not considered significant adverse effects even without mitigation.

Table 3.17-1. Unavoidable adverse impacts

Resource topic	Unavoidable adverse effects	
	Proposed Action	Alternative 1
Soils and Geology	• Impacts on upland and wetland soils and geology from clearing, grubbing, grading, excavating, and filling. • Vertical and horizontal launches may result in local adverse impacts on soils and geology from the deposition of rocket engine emissions (e.g., acids, various metals, and other substances); elevated metal concentrations and changes in soil pH would be expected from such deposition within a small radius of the launch pad.	• Impacts on upland and wetland soils and geology from clearing, grubbing, grading, excavating, and filling. • Vertical and horizontal launches may result in local adverse impacts on soils and geology from the deposition of rocket engine emissions (e.g., acids, various metals, and other substances); elevated metal concentrations and changes in soil pH would be expected from such deposition within a small radius of the launch pad.
Water Resources	• Non-point sources can potentially impact surface and ground water quality, such as oil and grease from paved street and road surfaces that wash into a water body or are absorbed into the water table. • Impervious or semi-impervious surfaces would likely contribute to more surface drainage than at present. • Vertical & horizontal launches may result in local adverse impacts on freshwater and marine systems, from deposition associated with rocket engine emissions, the deposition of spent launch vehicle equipment, or landing of a reentry	• Non-point sources can potentially impact surface and ground water quality, such as oil and grease from paved street and road surfaces that wash into a water body or are absorbed into the water table. • Impervious or semi-impervious surfaces would likely contribute to more surface drainage than at present. • Vertical & horizontal launches may result in local adverse impacts on freshwater and marine systems, from deposition associated with rocket engine emissions, the deposition of spent launch vehicle equipment, or landing of a reentry

Resource topic	Unavoidable adverse effects	
	Proposed Action	Alternative 1
Water Resources (continued)	vehicle or its associated equipment. • Impacts from HCl (formed during rocket launches) on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A normal launch would have no substantial impacts on local water quality. • Impacts to waters of the U.S. including wetlands from constructing two new seaports and a new launch facility.	vehicle or its associated equipment. • Impacts from HCl (formed during rocket launches) on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A normal launch would have no substantial impacts on local water quality. • Potential impacts to waters of the U.S. including wetlands from constructing a new launch facility.
Air Quality	• Could affect air quality in several ways: through airborne dust and other pollutants generated during construction; by the introduction of new stationary sources of pollutants, such as heating boilers and backup generators; and through increases in transportation-based emissions such as launches and automotive traffic. • Short-term effects from demolition of aging or obsolete facilities would be from airborne dust and other pollutants. • Long-term effects would be from introduction of new stationary sources such as boilers and generators, as well as increases in transportation-based emissions such as launches and automotive traffic.	• Could affect air quality in several ways: through airborne dust and other pollutants generated during construction; by the introduction of new stationary sources of pollutants, such as heating boilers and backup generators; and through increases in transportation-based emissions such as launches and automotive traffic. • Short-term effects from demolition of aging or obsolete facilities would be from airborne dust and other pollutants. • Long-term effects would be from introduction of new stationary sources such as boilers and generators, as well as increases in transportation-based emissions such as launches and automotive traffic.
Climate	• Sea level rise will affect KSC habitats and facilities. • KSC GHG emissions will contribute measurably through negligibly to the global,	• Sea level rise will affect KSC habitats and facilities. • KSC GHG emissions will contribute measurably through negligibly to the global, cumulative

Resource topic	Unavoidable adverse effects	
	Proposed Action	**Alternative 1**
Climate (continued)	cumulative increase in atmospheric GHG concentrations.	increase in atmospheric GHG concentrations.
Acoustic Environment (Noise)	• Would result in the continuation of many of the types of noise presently occurring at KSC but potentially in greater amounts. • Short-term increases in noise would result from the use of heavy equipment during construction and demolition activities. • Long-term effects would be from the addition of stationary sources of noise such as standby generators, and changes in both vertical and horizontal launch activities.	• Would result in the continuation of many of the types of noise presently occurring at KSC but potentially in greater amounts. • Short-term increases in noise would result from the use of heavy equipment during construction and demolition activities. • Long-term effects would be from the addition of stationary sources of noise such as standby generators, and changes in both vertical and horizontal launch activities.
Biological Resources	• Reduction of 4,406 acres of operational buffer, both public use and conservation components, meaning that 4,406 acres of native vegetation communities (both upland and wetland) would be lost to development. • Vertical and horizontal launches may result in local adverse impacts on native upland and wetland vegetation. • Impacts of two new seaports on 286 acres of wetlands vegetation and manatee critical habitat, Essential Fish Habitat, seagrasses, water quality, hydrology and flow. • Loss of wildlife habitat would result from conversion of up to 4,386 acres of operational buffer/ conservation to other more developed land uses. This would constitute about 5% of the non-water land area at KSC. • Launches at KSC would likely continue to have recurring, short-term, localized to medium, minor to moderate adverse impacts to aquatic habitats and fish for the	• Reduction of 3,305 acres of operational buffer, both public use and conservation components, meaning that 3,305 acres of native vegetation communities (both upland and wetland) would be lost to development. • Vertical and horizontal launches may result in local adverse impacts on native upland and wetland vegetation. • Loss of wildlife habitat would result from conversion of up to 3,286 acres of operational buffer/ conservation to other more developed land uses. This would constitute about 4% of the non-water land area at KSC. • Launches at KSC would likely continue to have recurring, short-term, localized to medium, minor to moderate adverse impacts to aquatic habitats and fish for the duration of the Center Master Plan. • Potential exists for adverse cumulative impacts to the Florida scrub-jay.

Resource topic	Unavoidable adverse effects	
	Proposed Action	**Alternative 1**
Biological Resources (continued)	duration of the Center Master Plan. • Potential exists for adverse cumulative impacts to the Florida scrub-jay. • Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, and widespread.	• Overall cumulative impacts from climate change and (climate change related) sea level rise on existing native wildlife at KSC, both terrestrial and aquatic, will likely be substantial, adverse, and widespread.
Transportation	• Short-term increases in traffic would result from construction worker commutes during construction and demolition activities. • Would be traffic peaks caused by spectators of launching and landing.	• Short-term increases in traffic would result from construction worker commutes during construction and demolition activities. • Would be traffic peaks caused by spectators of launching and landing.
Recreation	• Impacts on public use of MINWR, CNS, and Playalinda Beach. • Increased loss of visitor access to and use of CNS and MINWR. • Impacts from seaports on recreational assets in IRL. • Loss of 1,874 acres now designated as Open Space and 19 acres of Operational Buffer/ Public Use. • Impacts of 2 seaports on visitor experience in the Banana River.	• Loss of 1,874 acres now designated as Open Space and 19 acres of Operational Buffer/ Public Use.

3.18 Relationship Between Short-Term Uses of the Environment and Maintenance and Enhancement of Long-term Productivity

Sec. 102(C)(iv) of NEPA [42 USC § 4332] and 40 CFR 1502.16 require an EIS to address: “the relationship between local short-term uses of man’s environment and the maintenance and enhancement of long-term productivity.” This involves the consideration of whether a Proposed Action is sacrificing a resource value that might benefit the environment in the long term, for some short-term value to the project proponent or the public.

The purpose and need of the Proposed Action and Alternative 1 – implementing the CMP Update or implementing a modified version of the Update (Alternative) – is to repurpose the Kennedy Space Center over the coming two decades and guide its transition to a multi-user spaceport. One of the primary aims of the CMP Update is to pursue environmental stewardship and sustainability both at KSC and globally. Many facilities would be consolidated and more renewable energy would be produced.

NASA acknowledges that there are tradeoffs inherent in any allocation of land and natural resources. In the present instance, implementation of the Proposed Action would involve the long-term conversion of approximately 1,874 acres of KSC's designated Open Space, 3,245 acres of Operational Buffer/Conservation, and 35 acres of Operational Buffer/Public Use to more developed uses. Implementation of Alternative 1 would entail the long-term conversion of approximately 1,874 acres of KSC's designated Open Space, 3,941 acres of Operational Buffer/Conservation, and 19 acres of Operational Buffer/Public Use to more developed uses.

Implementation of the Proposed Action, but not Alternative 1, would also involve construction and operation of two new seaports, which would affect natural habitats including wetlands. Effects on wetlands, in any case, as mandated by Section 404 of the Clean Water Act, would require a permit from the U.S. Army Corps of Engineers. Before such a permit could be issued, any seaport proposal involving dredging or fill in waters of the United States would need to be evaluated using the Section 404(b)(1) Guidelines developed by EPA in conjunction with the Department of the Army. These guidelines are heavily weighted towards preventing environmental degradation of waters of the United States (including wetlands) and so place additional constraints on Section 404 discharges.

Efforts on the part of NASA and KSC both to adapt to climate change and sea level rise, as well as to control and reduce KSC's own greenhouse gas emissions (thereby limiting NASA's contribution to this long-term, cumulative environmental challenge), can be interpreted as pursuing maintenance and enhancement of long-term productivity.

3.19 Irreversible and Irretrievable Commitment of Resources

Sec. 102(C)(v) of NEPA [42 USC § 4332] requires an EIS to address "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." Irreversible and irretrievable commitments of resources mean losses to or impacts on natural resources that cannot be recovered or reversed.

More specifically, "irreversible" implies the loss of future options. Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species, removal of mined ore or pumped oil and gas, permanent conversion of wetlands, loss of cultural resources, soils, wildlife, agricultural, and socioeconomic conditions. The losses are permanent, incapable of being reversed. "Irreversible" applies mainly to the effects from use or depletion of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time.

"Irretrievable" commitments are those that are lost for a period of time, such as the temporary loss of timber productivity in forested areas that are kept clear for use as a right-of-way, road, or winter sports site. The lost forest production is irretrievable, but the action is not irreversible. If the use changes back again, it is possible to resume timber production.

3.19.1 Irreversible Commitments of Resources

Under the Proposed Action and Alternative 1 – implementing the CMP Update or a modified version of it – the following would constitute essentially irreversible commitments of resources:

- Consumption of the fossil fuels (primarily diesel) and lubricants by the heavy construction equipment (bulldozers and Caterpillars, graders, scrapers, excavators, loaders, trucks, etc.) used both for demolition of existing obsolete facilities and the excavation and construction of proposed facilities

- Materials used to construct all proposed facilities, including cement/concrete, soil cement, steel, slurry material, clay, sand, gravel, iron, and other metallic alloys, copper wiring, PVC piping, and so forth.

- Energy, supplied by fossil fuels or some other source of electricity, used over the operational life of the existing and proposed facilities at KSC.

- Chemical propellants used to launch rockets and payloads, which require fossil fuels and energy in their synthesis and manufacture.

- Wetlands eliminated to construct two seaports (Proposed Action only).

- Existing wildlife habitat that would be eliminated by newly developed areas.

- Possible undiscovered archeological, cultural or other heritage resources within the footprint of newly developed sites.

3.19.2 Irretrievable Commitments of Resources

As noted above, "irretrievable" commitments of resources are those that are lost for a period of time, but not permanently. The Proposed Action would entail certain irretrievable commitments. The following two items represent such irretrievable commitments:

- Short-term impacts on water quality and aquatic biota during periods of construction.

- Sites containing natural habitats that are developed with facilities but later decommissioned and abandoned or allowed to return natural habitat either passively through natural succession or actively through restoration efforts.

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4.0 SUMMARY OF MITIGATION MEASURES

This chapter summarizes not only mitigation measures under the different sections or resource topics in Chapter 3 but also planning considerations and NEPA compliance issues that may arise as the Kennedy Space Center is evaluating future projects as the Center Master Plan is implemented and KSC transitions to a multi-user spaceport in the coming decades.

4.1 Soils and Geology

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1:

- Best Management Practices (BMPs) will be implemented during all construction activities involving ground surface disturbance, excavation, and earth movement to prevent or reduce soil erosion into water surfaces and minimize adverse soil impacts.

- During construction and preparation activities, topsoil should be removed and stockpiled wherever possible and reused in the area where it was salvaged. After construction is complete, the establishment of a native vegetative cover in disturbed areas would aid in reestablishing biological activity in the soil.

- Mitigation measures to reduce impacts on surrounding soils from vertical and horizontal launches could include sediment blocks in areas with outfalls outside the launch perimeter fence to prevent off-site migration of soils containing elevated metal concentrations.

- Certain actions which would impact soils and geology would require additional site-specific NEPA analysis (EIS or EA) that should tier off this Programmatic EIS. These actions include development of railroads and seaports.

4.2 Water Resources

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1:

- BMPs to control erosion, sediment release, and stormwater surface runoff will be utilized during all project activities to minimize adverse impacts on water resources. All disturbed areas should be planted with native vegetation once a project is complete, thus stabilizing soils, reducing long-term effects such as erosion, sedimentation, and runoff, and improving water quality in nearby receiving waters. Identifying and staking the limits of clearing and earth work, installing silt fences, establishing a controlled area for construction material and equipment, and preparing a sediment and erosion control plan would minimize the potential for adverse impacts to water quality, hydrology, floodplains and wetlands. Vigorous application of appropriate BMPs will minimize erosion and sediment runoff to surface waters and wetlands at the project site and in the surrounding vicinity.

- To prevent accidental fuel or chemical spills, no refueling would occur near surface water. The fueling operation would be closely monitored, and an emergency spill kit containing absorption pads, absorbent material, a shovel or rake, and other cleanup items should be readily available on-site in the event of an accidental spill.

- BMPs limiting the amount of disturbance to just the project footprint will be implemented to reduce adverse impact to wetlands, floodplains, and riparian areas.

- Upon ignition of the main engines and Solid Rocket Boosters, deluge waters are discharged to the flame trench for sound attenuation. As the launch proceeds, more water is discharged to the fixed service structure and moveable launch platform to dissipate launch heat energy. Within 10 minutes of a launch, pad facilities are washed down with up to 326,000 gallons of water. The high concentrations of hydrogen chloride (HCl) gas produced by ignition of the SRBs significantly lower the pH of the collected wash water. Operational procedures require that the contained launch waters be neutralized with 50 percent sodium hydroxide (NaOH) to a pH of 8.5 +/- 0.5 within 72 hours following launch. Future practices will continue to follow the industrial wastewater permit.

4.3 Hazardous Materials and Waste

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1:

- Due to the regulatory and safety requirements inherent in the industry and the nature of expected operations it is considered likely that sufficient engineering and administrative controls would mitigate the risks associated with the presence of these materials to the lowest possible level. The severity of an unplanned event is unlikely to increase.

- The probability of an accidental release would increase due to the increased activities and quantity of materials, but best practices would ensure this increase in risk is small, with the probability of a major spill kept at a minimum.

4.4 Air Quality

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1.

Future or tiered NEPA will require air quality assessment for:

- Actions that include more than 1,000,000 gsf/yr of demolition or construction.
- Actions that included stationary sources that exceed the PSD major source threshold.
- Increases in vertical launch and landing activities at KSC.
- Increases in horizontal launch and landing activities at KSC.
- Establishment of any new seaports at KSC.
- Establishment of any new runways at KSC.

4.5 Climate Change

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1:

- Consistent with NASA land management practices and the Office of Strategic Infrastructure addressing a climate adaptation strategy, KSC will implement elevation-based zoning and development controls to insure that any future development is constructed at an elevation of six feet above mean sea level. Land areas that do not naturally offer this condition should be avoided or incur the cost of fill and drainage improvements, potentially making them economically less attractive.
- Areas of existing facilities or structures that are in 0-3 foot above mean sea level zones must be hardened or raised to accommodate future climate and weather or relocated to ground six feet or above.
- Critical facilities are to be moved outside the 500-year flood plain or, if not practicable, hardened to withstand a hurricane event.
- As part of its climate adaptation strategy, KSC created a Dune Vulnerability Team to address beach and sand dune erosion as the sand dunes are the physical protection barrier for NASA's Launch Pads 39A and 39B from the sea. The Dune Vulnerability Team consists of CASI scientists, the U.S. Geological Survey, the University of Florida, and the U.S. Fish and Wildlife Service. The team will be activated as necessary in the future to manage and protect dunes and the KSC facilities and infrastructure that they in turn help to protect.

4.6 Acoustic Environment (Noise)

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1.

Future or tiered NEPA will require noise assessment for:

- Actions that include construction or demolition activities within 800 feet of the KSC boundary for more than 1 year or have blasting activities for which a blast management plan addressing noise and vibration has not been prepared.

- Increases in vertical launch and landing activities at KSC.

- Actions that increased the total number of annual operations above 90,000 of propeller or small jet aircraft, or 700 annual operations of medium and large jets.

- Actions that include the addition of any permanent source of noise that would operate regularly or ongoing basis.

- Actions that added new roadways or had lane additions to access controlled highways.

- Establishment of any new seaports at KSC.

- Establishment of any new runways at KSC.

4.7 Biological Resources

- Heavy equipment may cause temporary disturbance and damage to plants in adjacent areas beyond the footprint of a project site; impacts to surrounding vegetation could be minimized by plainly demarcating site boundaries. The overall impact on vegetation would be reduced by concentrating the area of disturbance to the smallest area necessary to complete the project.

- In order to minimize soil erosion, inhibit the establishment and propagation of invasive exotic plant species, and reestablish the natural vegetation community, disturbed project areas should be revegetated or reseeded with native plant species once construction is complete.

- Other actions in this plan that would impact upland vegetation would need separate NEPA analysis and would not be covered under this Programmatic EIS. These actions include development of railroads and seaports.

- Construction of two new seaports under the Proposed Action – one on Banana Creek (a tributary of the Indian River Lagoon) and one on the Banana River just south of the Exploration Park and Industrial Functional Areas (see Figure 2.1-3 for a more detailed map) –would take place in wetlands and waters of the U.S. (see Figure 2.1-1 and Figure 3.9-2), occupying 286 additional acres, much or most of which is wetlands. Unless mitigated, this would constitute a permanent, adverse, medium-scale, moderate to major, potentially significant impact on wetlands and waters of the U.S. However, under its

Section 404 Clean Water Act permitting authority, the U.S. Army Corps of Engineers would require avoidance or compensatory mitigation for construction (dredging and filling) in wetlands on this scale.

- Impacts to wetlands and wetland vegetation will be mitigated by the use of BMPs to reduce erosion and sedimentation during construction activities. These practices include minimizing the length of time bare soil is exposed, along with timely reseeding and mulching. In addition, construction and maintenance of portable and long-term sediment and surface-water retention features would further reduce the potential for erosion and sedimentation. Landscaping within and near wetlands will include the planting of native species.

- NASA will try to keep unavoidable wetland impacts within the threshold of the USACE and state-issued required permits. Mitigation will be needed to compensate for unavoidable wetland loss. This could include purchase of credits from a wetland mitigation bank, a monetary compensation for wetland loss, or wetland restoration or preservation.

- Applying the Central Campus concept will allow NASA to recapitalize, over time, functions and capabilities into more efficient facilities on a smaller footprint and combine once spread-out non-hazardous functions into a smaller, more efficiently secured geographic footprint.

- To ensure that impacts of invasive species do not surpass the threshold of significance, BMPs and mitigation measures should be followed during project activities, and an exotic plant management program should be implemented over the long-term, including regular monitoring and control measures.

- In the FAA's regular review of licenses for launch and reentry as well as its review of applications for an experimental permit that proposes to launch from the Shuttle Landing Facility at KSC, the FAA would coordinate with NASA in determining if there is a need to further consult with either the Fish and Wildlife Service and/or the National Marine Fisheries Service based on any new activities proposed by the applicant. The FAA would similarly coordinate with NASA regarding any need to further consult with the appropriate State agency regarding any applicable requirements for State listed protected species and habitat. If potential impacts are identified, the FAA would consult with the appropriate agencies to develop any mitigation measures that may be warranted.

4.8 Cultural Resources

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1.

- All activities that may have adverse effects on cultural resources at KSC would be managed in accordance with the KSC Cultural Resources Management Plan. The CRMP provides an inventory of significant cultural resources and a plan of action to identify, assess, manage, preserve and protect these resources. It also includes a guide for impact analysis review and a set of SOPs for ongoing cultural resource management activities.

- Although specific project locations are not currently known, it is possible that some project locations may occur in or adjacent to areas with a high potential for the presence of archaeological sites. As the project locations are defined, the NHPA Section 106 process would be initiated and determinations would be made for the APE and potentially impacted cultural resources. Appropriate surveys and studies would be conducted so that the effect of the undertaking upon the cultural resources can be determined.

- Consultations would be undertaken on a project-by-project basis with the respective SHPO or THPO and interested or affected Native American tribes. Should previously undiscovered artifacts or features be unearthed during any of the proposed projects, work would be stopped in the immediate vicinity of the find, a determination of significance made, and a mitigation plan formulated (in consultation with the respective THPO or SPHO and with American Indian entities that may have interests in the project area).

- When implementing the Proposed Action or Alternative 1, NASA will continue to follow stipulations identified in the CRMP, existing Memoranda of Agreements (MOAs), and an existing Programmatic Agreement (PA). If a specific project of detailed dimensions and scale is proposed at a specific location, this PEIS will serve as a master NEPA document off which future NEPA compliance documents may be “tiered”.

- If the need arises, NASA will develop new MOAs or modify the existing PA to address proposed activities that are not currently addressed in the existing agreements.

- KSC will conform to the consultation, identification and documentation standards set forth in 36 CFR Part 800.8(c), and will notify in advance, the SHPO and ACHP where it intends to use the NEPA process to comply with Section 106.

4.9 Land Use

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1.

- By separate Memorandum of Agreement (MOA), effective February 23, 2001, with the EPA and Florida Department of Environmental Protection (FDEP), KSC, on behalf of NASA, agreed to implement Center-wide, certain periodic site inspection, condition certification and agency notification procedures designed to ensure the maintenance by Center personnel of any site-specific land use controls (LUCs) deemed necessary for future protection of human health and the environment.

- Although the terms and conditions of the MOA are not specifically incorporated or made enforceable within each LUC Implementation Plan (LUCIP) by reference, it is understood and agreed by NASA KSC, EPA, and FDEP that the permanence each LUCIP's proposed measures shall be dependent upon the Center's substantial good faith compliance with the specific LUC maintenance commitments. Should such compliance not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy may be reconsidered and that additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment. LUCIPs are generally prepared for sites undergoing some type of corrective action and will remain in place until the site conditions requiring land use controls are eliminated.

- Special land use permits will be considered during review of facility siting requests. Both duration of the permit and assignment of the permit vary.

- The future land use plan aims to support expansion of the site's quint-modal capabilities to provide multi-use spaceport users increased support. The plan outlines where development can occur, how land can be used, and how strategic capabilities can be expanded to support KSC's evolution to a multi-user spaceport. Through this approach, KSC aims to better separate potentially hazardous operations from less-hazardous operational areas and non-NASA operations from NASA operations.

4.10 Transportation

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1.

Future or tiered NEPA would require assessment of effects to traffic and/or transportation resources for:

- Actions that include a substantial amount of demolition or construction, the addition of new roadways, or the closure of existing roadways, any or all of which would be considered likely to induce an appreciable change (especially an increase) in traffic volume.

- Action that includes an appreciable change in the number of aircraft operations at KSC.

- Actions that include the addition of new roadways, bridges or access control points, or permanent closure of existing roadways, bridges or access control points.

- Establishment or closure of any seaports or rail spur at KSC.

- Establishment, expansion or closure of any runway at KSC.

4.11 Recreation

The measures listed here would apply both to the Proposed Action (Center Master Plan Update) and Alternative 1.

- Increased noise and impacts to air and water quality associated with construction activities would contradict the natural attributes of Playalinda Beach that contribute to its beauty and aesthetic lucidity, or the cultural services it provides. Insulation and other noise reducing equipment and dust abatement would help reduce the potential impacts to visitor experience.
- Increased traffic on Beach Road and Bio Lab road could hinder or delay access to Playalinda Beach during construction, though avoiding construction activities during peak visitation months (March-July) could reduce the magnitude of this impact.

4.12 Environmental Justice

NASA has also already undertaken measures to ensure that their actions do not have disproportionately high adverse human health or environmental effects on minority or low-income populations in the surrounding Kennedy community by developing the KSC Environmental Justice Plan (KSC-PLN-1917) in 1997 which was updated in 2010. The Plan outlines numerous programs that have been put in place to show KSC's commitment to its surrounding community and is updated periodically to ensure relevance (KSC, 2010). Such programs described in the Environmental Justice Plan include:

- Interdisciplinary National Science Project Incorporating Research and Education Experience (INSPIRE) – This program is designed to provide grade-appropriate NASA related resources and experiences to encourage and reinforce student's aspirations to pursue science, technology, engineering, and mathematics.

- KSC Intern Program (KIP) – The objective of this program is to provide students valuable work experience related to their academic studies and knowledge of KSC's mission.

- Motivating Undergraduates in Science and Technology (MUST) – This scholarship program is designed to attract and retain students in science, technology, engineering, or mathematics disciplines, and is led by the Hispanic College Fund with the support of the Society of Hispanic Professional Engineers and the United Negro College Fund Special Programs Corporation.

- Undergraduate Student Research Program (USRP) – This program offers undergraduates in science, math, and engineering mentored internship experiences at KSC.

- Exploration Systems Mission Directorate Student Project (ESMD) - This is a higher education student program with the goal to train and develop the highly skilled scientific, engineering, and technical workforce of the future needed to implement the Vision for

Space Exploration.

- Annual Day of Caring Program - This program allows KSC employees four hours off to help and provide assistance in the community work.

- Combined Federal Campaign (CFC).

- A teacher-resource center that provides extensive information about NASA and KSC on the Internet and enables users to obtain material on science, math, and related topics.

- Annual Earth Day.
- Family Day.

- African-American Heritage Month.

- Hispanic Heritage Month.

- Asian Pacific Islanders Heritage Month.

- Native American Heritage Month.

- National Disability Employment Awareness Month.

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Donald Dankert	National Aeronautics and Space Administration, Kennedy Space Center
Annie Dziergowski	U.S. Fish and Wildlife Service
Peter Eggert	Space Florida
Cheri M. Ehrhardt	U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge
Nancy English	National Aeronautics and Space Administration, Kennedy Space Center
Garland Grey	National Aeronautics and Space Administration, Kennedy Space Center
Layne Hamilton	U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge
Shawn Harris	National Park Service, Canaveral National Seashore
Kylie Johnson	National Aeronautics and Space Administration, Kennedy Space Center
Dale Ketcham	Space Florida
Jim Kuzma	Space Florida
Tim Leech	United States Air Force
Mike Legare	U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge
Ted Martin	National Aeronautics and Space Administration, Kennedy Space Center
Barbara Naylor	National Aeronautics and Space Administration, Kennedy Space Center
Tina Norwood	National Aeronautics and Space Administration Headquarters
Myrna Palfrey	National Park Service, Canaveral National Seashore
David Pierce	National Aeronautics and Space Administration, Kennedy Space Center
Taylor Pitcock	National Aeronautics and Space Administration, Kennedy Space Center
Nancy Potts	National Aeronautics and Space Administration, Kennedy Space Center
Heath Rauschenberger	National Park Service, Canaveral National Seashore

John Schafer	National Aeronautics and Space Administration, Kennedy Space Center
Pam Schanel	ICF International for the Federal Aviation Administration
Glenn Semmel	National Aeronautics and Space Administration, Kennedy Space Center
Alex Vinson	National Aeronautics and Space Administration, Kennedy Space Center
Dorn Whitmore	U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge
Tracy Young	NASA, Kennedy Space Center

8.0 INDEX OF TERMS

M

N

O

P

Q

R

S

T

U

V

APPENDIX A

ACRONYMS AND ABBREVIATIONS

A

Ac	Acres
ACH	Advisory Council on Historic Preservation
ADP	Area Development Plan
Ag	Silver
AGL	above ground level
AIRFA	American Indian Religious Freedom Act
Al	Aluminum
Al_2O_3	Aluminum Oxide
AP	Ammonium Perchlorate
APE	Area of Potential Effect
APU	Auxiliary Power Unit
ARPA	Archaeological Resources Protection Act
As	Arsenic

B

Ba	Barium
Be	Beryllium
BMPs	Best Management Practices

C

C	Candidate (species for federal listing)
CAA	Clean Air Act
Ca	Calcium
CCAFS	Cape Canaveral Air Force Station
CCP	Commercial Crew Program (NASA), or Comprehensive Conservation Plan (USFWS)
Cd	Cadmium
CEQ	Council on Environmental Quality (Office of the White House)
CFR	Code of Federal Regulations
Cl	Chlorine
CMP	Center Master Plan
CNS	Canaveral National Seashore
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Co	Cobalt
COTS	Commercial Orbital Transportation Services
COZ	Commercial Operations Zones
Cr	Chromium

CRD	Comment Responses Document
CRMP	Cultural Resources Management Plan
CRS	Commercial Resupply Services
CRV	Current Replacement Value
Cu	Copper
CUP	Consumptive Use Permit
CWA	Clean Water Act

D

DEIS	Draft Environmental Impact Statement
DEP	Department of Environmental Protection (Florida)
DO	Dissolved Oxygen
DoD	Department of Defense
DPEIS	Draft Programmatic Environmental Impact Statement

E

E	Endangered
E	Exotic (table-specific)
EAB	Environmental Assurance Branch at KSC
EIS	Environmental Impact Statement
ELV	Expendable Launch Vehicle
EMB	Environmental Management Branch at KSC
EO	Executive Order
ERD	Environmental Resources Document
ESA	Endangered Species Act
EPA	Environmental Protection Agency

F

FAA	Federal Aviation Administration
FAA-AST	FAA Office of Commercial Space Transportation
FDC	Future Development Concept
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
Fe	Iron
FFWCC	Florida Fish and Wildlife Conservation Commission
FMSF	Florida Master Site File
FP	Fibropapillomatosis
FP&L	Florida Power & Light
FY	Fiscal Year

G

GMP	General Management Plan

H

HAP	Hazardous Air Pollutant

HCl	Hydrogen Chloride
HCLV	Heavy Class Launch Vehicle
Hg	Mercury
H_2O	Water
HMCF	Hypergolic Maintenance and Checkout Facility
HMF	Hypergol Manufacturing Facility
HPO	Historic Preservation Officer
HQ	Headquarters
HVAC	heating, ventilation, and air conditioning

I

ICRMP	Integrated Cultural Resources Management Plan
IOZ	Industrial Operations Zone
IPA	Isopropyl Alcohol
IRL	Indian River Lagoon
ISC	Institutional Services Contractor
ISS	International Space Station

J

K

K	Potassium
KARS	Kennedy Athletic & Recreation Social (Park)
KSC	Kennedy Space Center

L

Lbf	Pound Force
lb	Pound
LC	Launch Complex
LEO	Low Earth Orbit
LOX	Liquid Oxygen
LSP	Launch Services Program
LV	Launch Vehicle

M

MACT	Maximum Achievable Control Technology
MCC	Mission Command & Control
MCLV	Medium Class Launch Vehicle
Mg	Magnesium
MILA	Merritt Island Spaceflight Tracking and Data Network station
MINWR	Merritt Island National Wildlife Refuge
MMH	Monomethylhydrazine
Mn	Manganese
MOA	Memorandum of Agreement
Mt	million tons

MPCV	Multi-Purpose Crew Vehicle

N

NAAQS	National Ambient Air Quality Standards
Na	Sodium
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NESHAPs	National Emission Standards for Hazardous Air Pollutants
Ni	Nickel
N_2	Nitrogen
NO_2	Nitrogen Dioxide
N_2H_2	Diazene
N_2H_4	Hydrazine
N_2O_4	Nitrogen Tetroxide
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPD	NASA Policy Directive
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NSR	New Source Review
NWR	National Wildlife Refuge

O

OC	Operations and Checkout
OEA	Office of Environmental Analysis (of the Surface Transportation Board or STB)
O&M	Operations and Maintenance
O_3	Ozone
OFW	Outstanding Florida Waters
OPF	Orbital Processing Facilities

P

PA	Programmatic Agreement
PAH	Polycyclic Aromatic Hydrocarbon
PAMS	Permanent Air Monitoring System
Pb	Lead
PCB	polychlorinated biphenyl
PEIS	Programmatic Environmental Impact Statement
PM_{10}	Particulate Matter below 10 microns in diameter (total inhalable [10-micron] particulates)
ppm	Parts Per Million
ppt	Parts Per Thousand
PRF	Parachute Refurbishment Facility

PSD	Prevention of Significant Deterioration
PTE	potential to emit

Q

QD	Quantity-Distance

R

RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
RLV	Reusable Launch Vehicle
RMP	Risk Management Program
RP-1	Rocket Propellant-1
RV	Reentry Vehicle

S

Sb	Antimony
SCAPE	Self-Contained Atmospheric Protective Ensemble
SCLV	Small Class Launch Vehicle
Se	Selenium
SHCLV	Super Heavy Class Launch Vehicle
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SIS	Strategic Intermodal System
SJRWMD	St. Johns River Water Management District
SLAMM	sea level affecting marshes modeling
SLF	Shuttle Landing Facility
SLS	Space Launch System
S&MA	Safety and Mission Assurance
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
Space-X	Space Exploration Technologies Corporation
SRB	Solid Rocket Booster
SSC	Species of Special Concern
SSPF	Space Station Processing Facility
STB	Surface Transportation Board
SWORDS	Soldier-Warfighter Operationally Responsive Deployer for Space

T

T&E	Threatened and Endangered [species]
TDS	Total Dissolved Solids
THPO	Tribal Historic Preservation Officer
Tl	Thallium
TMDL	Total Maximum Daily Loading
TOC	Total Organic Carbon
TSDF	Transportation, Storage and Disposal Facility

TVC	Thrust Vector Control

U

UAS	Unmanned Aerial Systems
ULA	United Launch Alliance
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service

V

VAB	Vehicle Assembly Building
VFP	Vertical Processing Facility
VOC	volatile organic compounds
Vn	Vanadium
VSDS	Vehicle Stabilization and Damping Subsystem

W

X

Y

Z

ZAP	Zone of Archaeological Potential
Zn	Zinc

APPENDIX B

SCOPING REPORT

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National Aeronautics and Space Administration

Kennedy Space Center

Final Scoping Report for the Programmatic Environmental Impact Statement (PEIS) on Center-Wide Operations at the Kennedy Space Center

Prepared for:
Environmental Management Branch
TA-A4C, NASA Kennedy Space Center

solv™

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Acronyms and Abbreviations

ADP	Area Development Plan
CCAFS	Cape Canaveral Air Force Station
CEQ	Council on Environmental Quality
CIP	Capital Improvement Program
CRV	Current Replacement Value
CFR	Code of Federal Regulation
CMP	Center Master Plan
CNS	Canaveral National Seashore
EO	Executive Order
FAA	Federal Aviation Administration
GHG	Greenhouse Gases
KSC	Kennedy Space Center
MINWR	Merritt Island National Wildlife Refuge
NASA	National Aeronautics and Space Administration
NGO	Non-Governmental Organization
NEPA	National Environmental Policy Act
NPS	National Park Service
PEIS	Programmatic Environmental Impact Statement
PSA	Public Service Announcement
RFI	Request for Information
SLF	Shuttle Landing Facility
SLS	Space Launch System
SR	State Road
T&E	Threatened and Endangered
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USDOI	United States Department of Interior
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

Pursuant to the National Environmental Policy Act (NEPA), as amended, (42 U.S.C. 4321 et seq.), the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA; 40 Code of Federal Regulations (CFR) Parts 1500–1508; and NASA policy and procedures, 14 CFR part 1216, Subpart 1216.3, NASA intends to prepare a PEIS covering Center-wide operations at KSC. The United States Fish and Wildlife Service (USFWS), National Park Service (NPS), and the Federal Aviation Administration (FAA) will serve as Cooperating Agencies. They possess both regulatory authority and specialized expertise regarding the Proposed Action of this PEIS.

This PEIS is being prepared in conjunction with an updated Center Master Plan (CMP) to evaluate potential environmental impacts from proposed Center-wide operations and activities for a 20-year planning horizon from 2012–2032. The PEIS will consider a range of future scenarios from repurposing existing facilities and recapitalizing infrastructure, to reorganizing KSC management of its land resources with various types of commercial partnerships. The PEIS is intended to ensure NASA is in compliance with applicable environmental statutes as it sets program priorities for future operations and activities. A CMP for KSC was developed in 2002 with a 75-year planning horizon. NASA Policy Directive 8810.2, Master Planning for Real Property, requires the CMP to be updated every five years. The 2008 CMP update was based on the now cancelled Constellation Program, while the current CMP update will guide KSC as it transitions towards a multi-user spaceport over the next 20 years.

In cooperation with USFWS, NPS, and FAA, NASA held two public scoping meetings as part of the NEPA process associated with the development of the PEIS. This report describes the Proposed Action, agency and public scoping meetings and materials, and summarizes substantive public comments received during the public scoping period held from June 4 through July 7, 2014.

In addition, this document includes the following 11 appendices:

- Appendix A: Notice of Intent
- Appendix B: Public Meeting Newspaper Notices and Affidavits
- Appendix C: PSA text and List of Radio Stations
- Appendix D: Scoping Meeting Sign-In Sheets
- Appendix E: KSC Maps
- Appendix F: Public Scoping Poster Display
- Appendix G: Scoping Comment Form and Handout
- Appendix H: PowerPoint Presentation
- Appendix I: Transcript of June 4th and 5th Scoping Meetings
- Appendix J: Index of Public and Agency Comments by Source and Date
- Appendix K: Index of Public and Agency Comments by Category

2.0 PROJECT DESCRIPTION

2.1 KSC HISTORY

In the late 1950s the U.S. embarked on a new era of human space exploration. The first human space flight initiative was Project Mercury in 1958. The crewed spacecraft first launched from Cape Canaveral Air Force Station (CCAFS) in the early 1960s. In 1962 the Launch Operations Center was established as a separate NASA field installation responsible for the management and operation of the "Merritt Island Launch Area." In 1963, after the death of President John F. Kennedy, Lyndon B. Johnson renamed the Launch Operations Center as the "John F. Kennedy Space Center." Project Mercury was followed by Project Gemini, which served to perfect maneuvers in Earth's orbit. The Apollo Program began in 1961, and aboard Apollo 11, American astronauts successfully landed on the moon and returned safely to Earth in July 1969. Eventually, six Apollo missions landed 12 astronauts on the moon, the last of which was in December 1972.

In the mid-1970s, NASA initiated development of the Space Transportation System (commonly called the Space Shuttle) as the next crewed vehicle. Designed solely for missions to lower Earth orbit, the Space Shuttle was the first and, to date, the only winged spacecraft capable of vertically launching a crew into orbit and horizontally landing upon return. The Space Shuttle era lasted 30 years, from the Columbia launch on April 12, 1981, to the Atlantis landing on July 21, 2011. The Space Shuttle fleet supported 135 missions, recovered and repaired satellites, conducted cutting-edge scientific research under zero gravity conditions, and helped construct and service the International Space Station, the largest structure built in space.

2.2 KSC LOCATION AND FACILITIES

KSC is located on Merritt Island in Brevard and Volusia counties, Florida, north-northwest of Cape Canaveral on the Atlantic Ocean, midway between Miami and Jacksonville on Florida's Space Coast, approximately 50 miles east of Orlando. It is 34 miles (55 km) long and roughly six miles (10 km) wide, covering 219 square miles (570 km2).

The total KSC land and water area jurisdiction is approximately 140,000 acres. Only a very small part of the total acreage of KSC is developed or designated for NASA's operational and industrial use. Merritt Island consists of prime habitat for unique and endangered wildlife. In 1962 NASA entered into an agreement with the USFWS to establish a wildlife preserve within KSC boundaries known as the Merritt Island National Wildlife Refuge (MINWR). Public Law 93–626 created the Canaveral National Seashore (CNS), and thereby, an agreement with the Department of the Interior was also formed in 1975 due to the location of CNS within KSC boundaries.

Since December 1968, all launch operations have been conducted from Launch Complex 39 (LC–39) Pads A and B. Both pads are close to the ocean and three miles (five km) east of the Vehicle Assembly Building. From 1969–1972, LC–39 was the departure point for all six Apollo manned moon-landing missions using the Saturn V rocket. LC– 39 was used from 1981–2011 for all Space Shuttle launches. The Shuttle Landing Facility, located just to the northwest, was used for most Shuttle landings. At 15,000 feet (4,572 meters or 2.8 miles) it is among the longest runways in the world. The KSC Industrial Area, where many of the Center's support facilities are located, is five miles (eight kilometers) south of LC–39. It includes the Headquarters Building, the Neil Armstrong Operations and Checkout Building, Space Station Processing Facility and the Central Instrumentation Facility. KSC is a major central Florida tourist destination and approximately a one- hour drive from the Orlando area. The Visitor Complex offers public tours of the Center and CCAFS. Because much of the installation is a restricted area and only nine percent of the land is developed, the site also serves as an important wildlife sanctuary. Mosquito Lagoon, Banana River, Indian River, MINWR, and CNS are other natural area features.

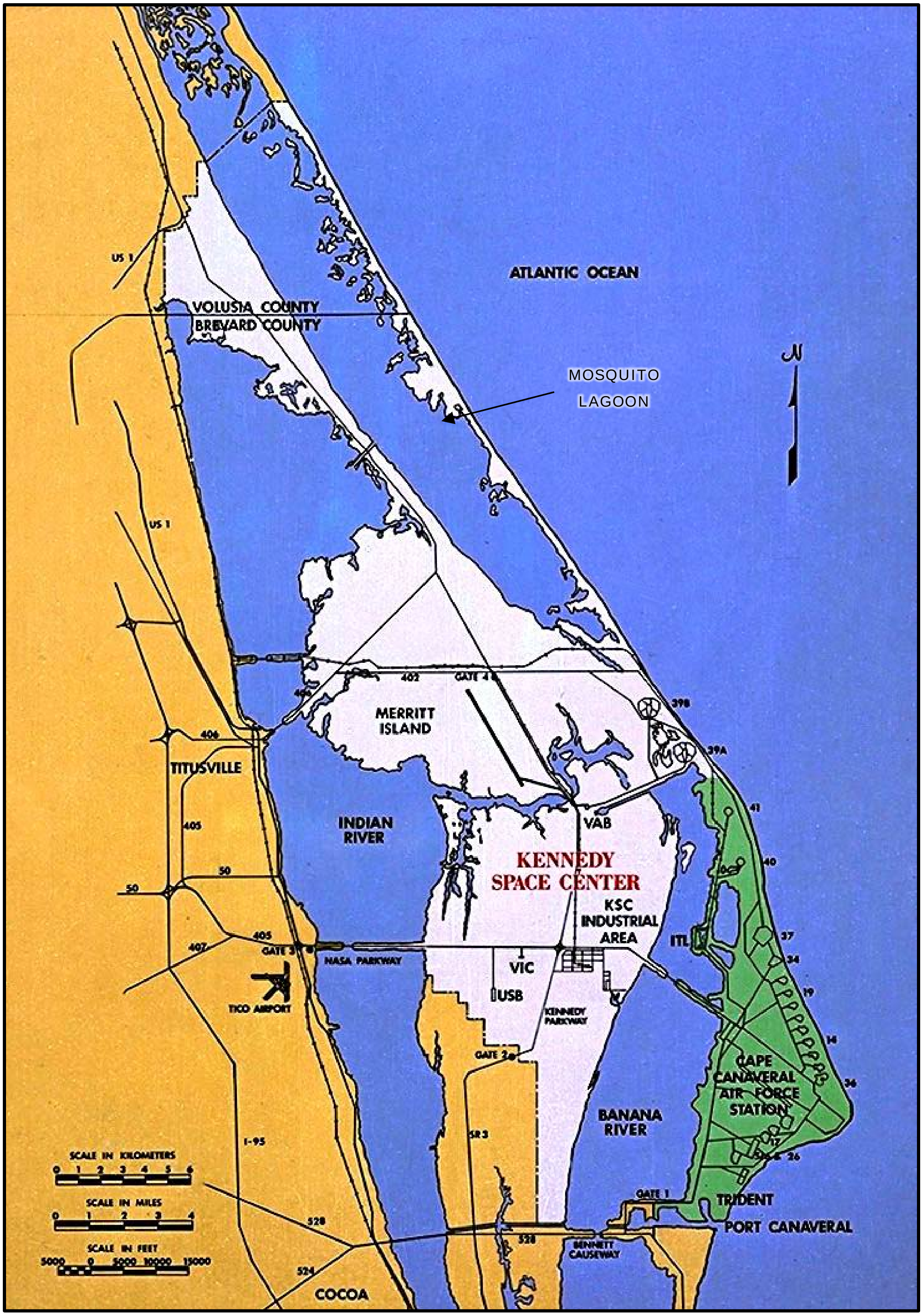

Figure 1. Location map of the Kennedy Space Center

2.3 PURPOSE AND NEED

In the years ahead, KSC will transition from a government and program-focused, single-user launch complex to a more capability-centric and cost-effective multi-user spaceport. KSC's new mission will be to furnish both government and commercial space providers with the facilities, experienced workforce and knowledge necessary to support existing mission sets and new space programs.

In support of these endeavors, KSC is engaged in a master planning process identified in NASA's institutional requirements report to the Congress, pursuant to Section 1102 of the NASA Authorization Act of 2010. The resulting CMP will result in changes to KSC's infrastructure, land uses, customer base of space transportation providers and users, and business model over a 20-year planning horizon extending from 2012-2032.

KSC's last major revision to its CMP was completed in 2002, with an update to define Area Development Plans (ADPs) in 2008. The 2002 plan was a forward-looking, 75-year, unconstrained plan for land uses and facilities to support the evolution of KSC and the neighboring CCAFS into a more unified spaceport community supporting a robust increase in flight rates. The 2002 plan did not, however, provide a clear approach to implementation, or furthermore, anticipate dramatic changes in the pace of space commercialization and the challenging Federal budgetary circumstances that exist at present.

Thus, the current planning environment necessitates a revised baseline (NPR 8810.1A, Center Master Planning). The space transportation industry, both its technology and its economy, is evolving globally. The Space Shuttle Program has run its course. In the context of government-wide initiatives, NASA is implementing policies to reduce its facilities infrastructure footprint, consolidate for greater efficiency and sustainability, reduce operations and maintenance costs, and meet energy and water conservation goals.

2.4 PROPOSED ACTION

Under the Proposed Action, KSC will implement the aforementioned CMP update and transition from a government, program- focused, single-user launch and landing complex to a more central capability, cost effective, and multi-use spaceport. KSC's new mission will be to furnish both government and commercial space providers with the necessary facilities, experienced workforce, and knowledge to support existing mission sets and new space programs.

The KSC master planning process is identified in NASA's institutional requirements to report to Congress, pursuant to the NASA Authorization Act of 2010, Section 1102. The CMP update will result in changes to the infrastructure, land use, space transportation providers and users' customer base, and business model over a 20-year planning horizon from 2012– 2032. The CMP update will include a number of component plans, including future land use, facility development, area development, transportation, utilities systems, and safety and security control. Implementing the future land use plan will promote the right-sizing of NASA KSC operations and attract non-NASA investment by providing more operational autonomy. Consolidating KSC or NASA-managed facilities into a smaller geographic footprint is a major component of the future land use plan. Applying the Central Campus concept, for example, allows NASA to recapitalize functions and capabilities into higher-efficiency facilities and combine nonhazardous and spread out functions into a more efficient, smaller, secured geographic footprint. Likewise, directing future NASA and non-NASA development into functional areas with defined, allowable operations will streamline safety and security considerations while promoting maximum utilization of KSC's horizontal infrastructure capacities. In addition, the future land use plan supports expansion of the quint-modal capabilities to provide multi-use spaceport users increased support.

The future land use plan identifies 18 land use categories, their existing acreages, and their proposed future acreages. Changes in the size and location between existing and proposed land uses will constitute the basis for differential potential environmental impacts between the Proposed Action and the No Action alternatives. Figure 2 is a map of the proposed Land Use at KSC.

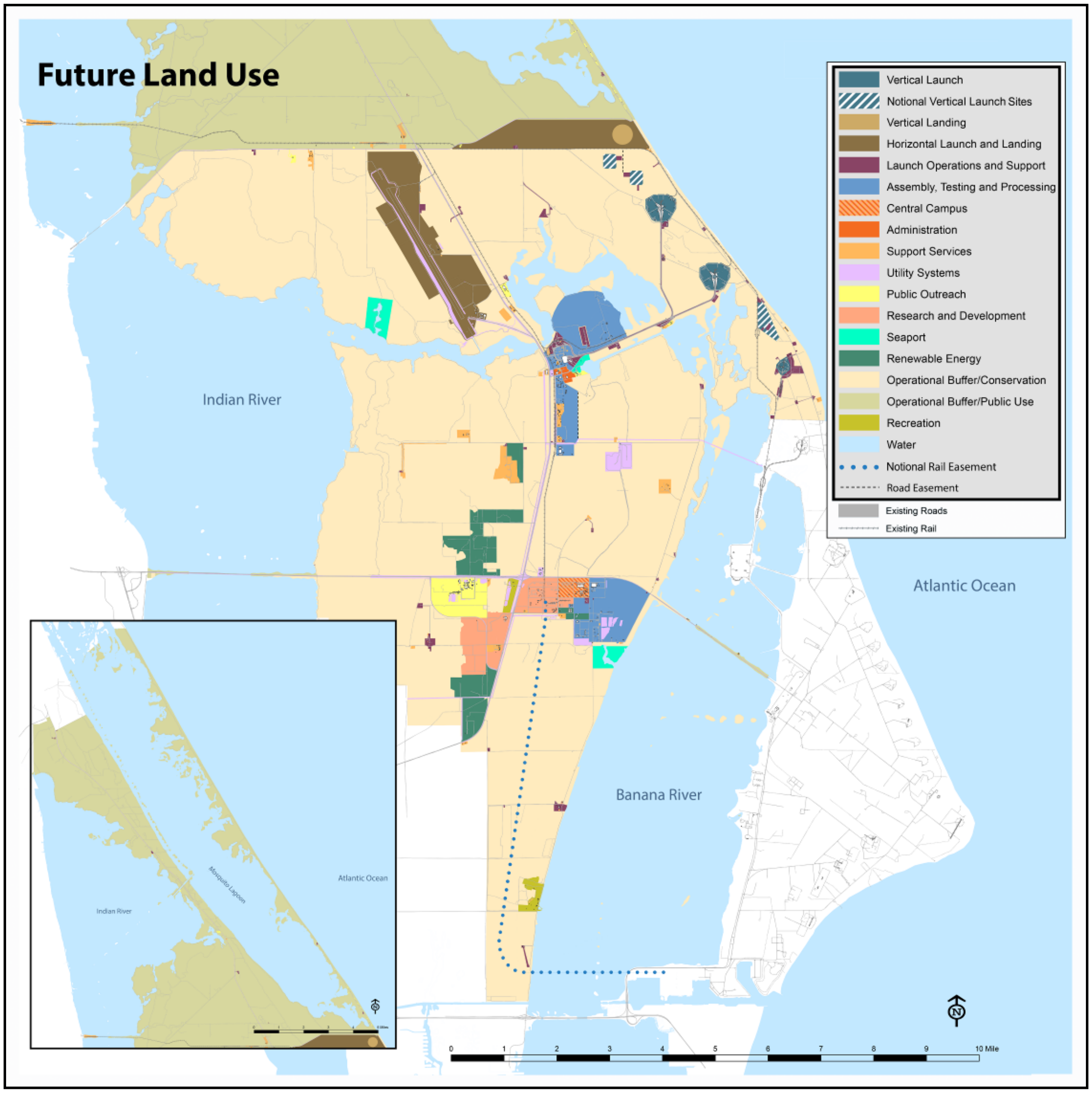

Figure 2. Map of proposed Land Use at the Kennedy Space Center

2.5 NO ACTION ALTERNATIVE

Under the No Action Alternative, KSC would not transition towards a multi-use spaceport with fully integrated NASA programs and non- NASA users. Each NASA program would continue to operate to a significant degree as an independent entity, funded separately and managing activities and buildings in support of its own program. A limited non-NASA presence would continue at KSC.

2.6 SCOPE OF THIS PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

This PEIS outlines and broadly describes actions associated with KSC's proposed programs in the limited detail in which they are known at present. Two programmatic alternatives are described and their potential environmental effects are assessed in fairly general terms. Agencies rely on programmatic or broad-scale analyses to focus the scope of alternatives, environmental effects analysis, and mitigation in subsequent tiered levels of documentation. At such time as a given specific project of detailed dimensions and scale is proposed at a specific location, and is in the process of being reviewed and approved, this PEIS can serve as a master NEPA document off which future NEPA compliance documents may be "tiered". Programmatic NEPA analyses and tiering can reduce or eliminate redundant and duplicative analysis and effectively address cumulative effects. Ideally, this will serve to expedite the environmental review process and facilitate project approval, funding, and implementation.

3.0 NOTIFICATION OF SCOPING MEETINGS

3.1 NOTICE OF INTENT

A Notice of Intent (NOI) was published in the Federal Register (FR) on Tuesday, May 20, 2014 informing the public of NASA's intent to prepare a PEIS and conduct scoping. The notice also included details about the public scoping meetings held on June 4 and 5, 2014. A copy of the NOI as it appears in the FR is provided in Appendix A.

3.2 NEWSPAPERS

Notices were printed in local newspapers in the weeks preceding the public scoping meetings. Notices included NASA's intent to prepare a PEIS and conduct scoping; provided a brief description of the project, and identified meeting times and locations. A list of the names of the publications and dates of the five legal advertisements and two display ads are included in Table 1. Copies of the newspaper advertisements and affidavits of legal notices are included in Appendix B.

Table 1. Newspapers and Dates of Public Notices

Newspaper	Publication Dates	Location
Florida Today	May 22nd and 25th	Brevard County
The Daytona Beach News-Journal	May 23rd and 25th	Volusia County
Orlando Sentinel	May 25th and June 1st	Lake, Orange, Volusia, Seminole, and Osceola Counties

3.3 RADIO STATIONS

A 30-second Public Service Announcement (PSA) was sent to multiple local radio stations for the week prior to and the week of the public scoping meetings. The PSA was provided in both English and Spanish. A copy of PSA text and a list of radio stations contacted are included in Appendix C.

4.0 PUBLIC SCOPING MEETINGS

4.1 MEETING DATES AND LOCATIONS

NASA conducted two public scoping meetings in a combined open house and open forum format. The first was held from 5-8 p.m. on Wednesday, June 4th at the Eastern Florida State College Titusville Campus, John Henry Jones Gymnatorium in Titusville. The second was held also from 5-8 p.m. on Thursday, June 5th at the New Smyrna Beach High School Auditorium, located on 1015 10th Street in New Smyrna Beach.

4.2 PURPOSE

The purpose of the public scoping meetings is to provide the public with information regarding the Proposed Action and proposed CMP, answer questions, identify concerns regarding the potential environmental impacts that may result from implementation of the Proposed Action, and gather information to determine the scope of issues to be addressed in the PEIS.

4.3 OPEN HOUSE FORMAT

For the first hour of both scoping meetings, an open house format was used to encourage discussion and information sharing and to ensure that the public had opportunities to speak with representatives of NASA, USFWS, and NPS. Several stations with exhibits, maps, and materials were staffed by representatives of NASA, USFWS, NPS, and Solv. Information stations at the public scoping meetings included the following:

- Sign-in and Welcome table
- KSC Land Use Maps
- KSC Core Competencies
- NEPA/NEPA Process
- Purpose and Need and Proposed Action
- Cooperating Agencies
- Cumulative Effects
- Scoping Comments

The posters displayed during the open house portions of the scoping meetings are included in Appendix F.

Sign-in sheets (Appendix D), handouts and comment forms (Appendix G) were made available to all scoping meeting attendees. The proposed CMP was also available for review on three iPads.

Figure 3. Don Dankert (KSC Project Manager), New Smyrna Beach Public Scoping Meeting

4.4 OPEN FORUM FORMAT

For the second hour of both scoping meetings, Don Dankert, Trey Carlson, and Leon Kolankiewicz gave a brief PowerPoint Presentation. Don Dankert, Project Manager for the PEIS, introduced the purpose of the Scoping Meeting(s) as part of the NEPA Process and the Proposed Action. Trey Carlson, KSC Master Planner, described KSC's mission, goals, and the updated Master Plan. Leon Kolankiewicz, Project Manager for the PEIS (Solv), detailed the NEPA Process and future development of the PEIS.

Figure 4. Trey Carlson (KSC Master Planner), Titusville Public Scoping Meeting

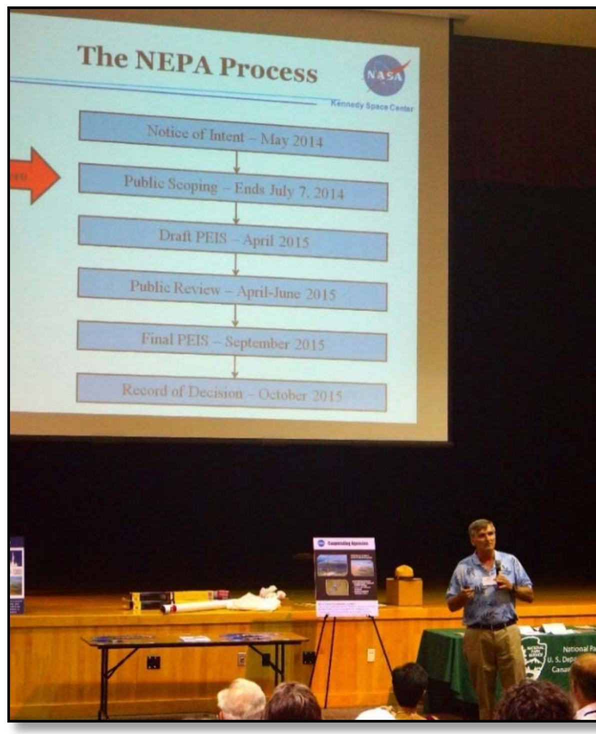

Figure 5. Leon Kolankiewicz (Solv Project Manager), New Smyrna Public Scoping Meeting

At the conclusion of the PowerPoint Presentation, the public was invited to approach the microphone and deliver remarks in front of the audience and for the record. Commenters were asked to fill out a color-coded slip of paper with their name and affiliation (if any). Commenters were then called up to the microphone in groups of 10 (based on the color of the slip of paper) to make a comment for the record.

Figure 6. Commenter at Titusville Public Scoping Meeting

A court reporter transcribed the presentation as well as comments from the public. Transcripts of both meetings are included in Appendix I.

5.0 PUBLIC SCOPING MEETING COMMENTS

5.1 COLLECTING COMMENTS

Both written and oral comments were made for the record. Written comments were submitted using comment forms, letters, and emails. All comments were directly delivered to NASA. Oral comments were made during the open forum portion of the scoping meetings. Others made comments for the record by dictating to the court reporter.

5.2 SUMMARY OF COMMENTERS

Comments were indexed based on the source, or commenter. Commenters included federal, state, or local agencies (A), non-government organizations (NGO), or members of the Public (P). Each comment was cataloged with a code based on the source of the comment and the order in which it was received (e.g., P-13 was the 13th comment received from a member of the Public). A total of 60 commenters including 54 unique commenters provided input during the Scoping Period. For purposes of this report, a unique commenter is defined as an individual that provided input at least once. Six (6) commenters provided input on more than one occasion (e.g., orally at both Public Scoping Meetings). Comments were received from 54 unique commenters or 54 different people. Appendix J includes an index of comments by source and date.

5.3 ISSUES IDENTIFIED DURING SCOPING

Each concern or question associated with a commenter was categorized by resource area. Comment categories, discussed in the following sections, include Alternatives; Cultural and Historic Resources; Cooperating Agencies; Cumulative Effects; Health and Safety; Land Use; Mitigation; NEPA Process/PEIS; Public Involvement; Noise; Purpose and Need; Recreation, Regulatory Compliance; Socioeconomics; Threatened and Endangered Species; Transportation; Water Resources; and Wildlife.

An overview of the most common or substantive comments are discussed in the pursuant sections and in Table 2. A total of 384 comments were received during the Scoping Period. If a commenter provided the same or very similar input more than once, whether submitted in a different form or simply repeated on the same occasion, this comment was only counted once. Appendix K is an index of comments by category and commenter, and includes a summary of each comment submitted.

Table 2. Summary of Scoping Comments for KSC Center-wide Operations PEIS

Category	Number of Commenters	Number of Comments	Summary of Issues
Alternatives	6	16	The analysis of the Proposed Action and the No Action Alternative is insufficient or too limited for this PEIS. Several requests to consider alternative locations (specifically for Launch Pads 34C and D [sic]) in order to minimize potential impacts to various natural resources, CNS, MINWR, Mosquito and Indian River Lagoons. Recommended development of alternatives with USACE, USAF, and Space Florida.
Cultural and Historic	3	5	Potential impact to historic sites and landmark in areas managed by the USFWS and NPS, specifically the Elliot Plantation Complex. General support of the designation north of SR 402 and Beach Access Road as Operational Buffer/Public Use for the preservation of historic properties.
Cooperating Agencies	15	19	Working cooperatively with the USAF could obviate the need to build new launch facilities in light of the unused launch facilities and infrastructure within the CCAFS. Also recommend USACE as a Cooperating Agency to determine the viability of seaport permitting when considered against other alternatives. Several urged NASA to follow the recommendations of and work closely with the USFWS and NPS to determine appropriate methods, locations, and mitigations within KSC, MINWR, and CNS.
Cumulative Effects	19	28	• Appropriations made by Congress in the 1980s to move the access road a safe distance to the north to reduced closures of Playalinda Beach for shuttle launches should be considered. Analyze potential impacts from loss of public access to CNS and MINWR east of SR 3. • Many suggested that widespread water quality issues in Mosquito and Indian River Lagoons should be evaluated before siting new launch facilities in this area. • Concerned with Space Florida's proposal to build a spaceport within the Shiloh area of the MINWR for commercial launches, and how this Proposed Action would affect the timing and operations of the other.
Health and Safety	4	4	General concern for the safety of nearby residents, as well as specific concern for the potential threats to visitor and employee safety at CNS. Evaluate how the safety, security, and operational priorities required by NASA's Exploration Program and

Category	Number of Commenters	Number of Comments	Summary of Issues
			SLS launch operations at Pad 39B might interact with the proposed commercial operations at Pads 39C and 39D.
Land Use	16	26	• General concerns included development by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS. Some supported Space Florida's concept of a state-managed control complex, or were concerned that the Proposed Action would affect an area larger than Shiloh. • Specific concerns include inconsistencies of Future Land Use Plan with CMP; CMP is too vague to enable meaningful analysis in PEIS; footprint in Future Land Use Plan is much larger than existing footprint for SLF.
Mitigation	10	12	The most appropriate, long-term programmatic mitigation for potential environmental impacts is the permanent transfer of lands north of SR 402 to USDOI for management as part of the MINWR and CNS; as well as the right of first refusal for any future release of KSC property in these areas. Work closely with USFWS and NPS to develop comprehensive mitigation plan, especially in Mosquito and Indian River Lagoons.
NEPA Process/PEIS	7	14	Concerns that CMP is too vague to enable meaningful environmental analysis in PEIS or attract broad and meaningful stakeholder scoping input. PEIS should capture/incorporate/include all of the future development plans for the SLF area that have been prepared by both NASA and Space Florida; information obtained from RFI to identify potential partners interested in developing vacant land consistent with KSC Master Plan; Space Florida's concept of a state-managed control complex; direct, indirect, and cumulative adverse impacts on recreation, socioeconomics, T&E species, wildlife, water resources; historic sites and landmark; as well as increased protection of resources that would result from Proposed Action.
Noise	1	2	Concerns regarding potential noise impacts on wildlife; as well as to residential homes bordering KSC property along North Merritt Island.
Proposed Action	38	68	• General support for the strategies like re-development and in-fill of areas currently developed; core values stated for the master plan, including evolution to a multi-user spaceport; leaner and greener; promotion of compatible relationships between adjacent land uses; recognition of wetlands at KSC and need for mitigation and development costs; preservation of Florida scrub jay habitat and recognition that future planning must recognize sea level rise. Many also

Category	Number of Commenters	Number of Comments	Summary of Issues
			supported the underlying justification of the master plan to accommodate non-governmental users of launch facilities within KSC as a reasonable and practicable alternative to the proposed Shiloh Project. • Others concerned that mixing a free enterprise with a government entity on government property for leased land will cause problems in the future; NASA should stay out of commercial launches. Some supported instead Space Florida's concept of a state-managed control complex. • Specific comments concerning the location and feasibility of proposed launch facilities, including the two seaports and Launch Pads 39C and 39D. Specific concerns include inconsistencies of Future Land Use Plan with CMP; reduction and realignment with current and future NASA mission needs and requirements to reduce its institutional footprint; and long-term recapitalization liability.
Public Involvement	9	12	• A more collaborative planning process should have been used to develop CMP; recommended more dialogue and collaboration between KSC and its stakeholders before proceeding with a PEIS, even if it requires modification of the CMP. • Several attendees noted that while notification for the Public Scoping Meetings was legally adequate, larger and earlier distribution would have resulted in more attendees. Others appreciated the NASA-sponsored meetings about the future of the space program, as well as the opportunity for one-on-one meetings.
Purpose and Need	3	7	Comments revolved around whether the Proposed Action would meet the Purpose and Need; and whether it is appropriate for NASA's current and future mission.
Recreation	27	39	• Large majority of commenters were concerned with impacts to hiking, fishing, bird watching, wildlife viewing, enjoyment of cultural and historic resources, visual resources, boating, guided fishing/angling, and limited public access to Playalinda Beach, CNS, MINWR, and Mosquito and Indian River Lagoons. This same majority tended to support the designation north of SR 402 and Beach Access Road as Operational Buffer/Public Use for habitat conservation, preservation of historic properties, and public enjoyment. • Several were concerned with how recreational activities would impact revenue and jobs due to limited visitation at CNS and MINWR.
Regulatory Compliance	3	7	Requests that project comply with regulations and permitting requirements, specifically Section 106 of the NHPA; Section 404 of the CWA; ESA; as well as the

Category	Number of Commenters	Number of Comments	Summary of Issues
			2010 National Space Policy and the 2013 National Space Transportation Policy.
Socioeconomics	27	44	Comments regarding impacts to taxes, jobs, social fabric, the commercial viability of the Proposed Action, and lost revenue associated with limited access at CNS and MINWR. Comments requested that the PEIS examine the potential direct, indirect, and cumulative, social and economic impacts from the Proposed Action; as well as clarify the total projected CIP funding requirements envisioned during the 20-year planning horizon. Several were concerned that with uncontrolled development, small coastal towns would lose their sense of community and identity.
Threatened and Endangered Species	11	18	• Concern that many of the 16 federally-listed species at MINWR would be adversely impacted by construction and operation of the proposed launch site. Commenters urged the PEIS to consider impacts to listed species and migratory birds from the volume of water used to cool launch facilities during a launch and the proposed source of cooling water for new vertical launch operations and support facilities (34C and D [sic]). • Several comments were specific to the Florida scrub jay, noting that the construction of new launch facilities further north would prevent/interfere with prescribed burning necessary to restore and maintain its habitat.
Transportation	3	9	Comments related to access roads and the impact on public access to surrounding beaches. Need to analyze the utilization and/or expansion of current existing seaport facilities on and off KSC to meet future transportation requirements; identify and analyze impacts of access roads through wetlands to service these sites, and what level of utilities would be extended from existing KSC service areas to provide required power and deluge water. Comments also concerned with the route and details of the proposed rail system and bridge.
Water	19	31	• Comments focusing on the Proposed Action's effects to water quality, wetlands, and the seashore as they relate to recreational opportunities and wildlife. The majority of comments regarded the direct, indirect, and cumulative adverse impacts of Launch Pads 39C and 39D on wetlands and water quality near, in, or on the MINWR, CSN, Mosquito and Indian River Lagoons, and the seashore environment. Many were also concerned with impacts from construction of the proposed seaports at Banana Creek. • Commenters specifically requested that the total amount of impacted wetlands and surface waters be identified in PEIS; impacts to water resources be

Category	Number of Commenters	Number of Comments	Summary of Issues
			minimized per Section 404 of the Clean Water Act; and mitigation address any damage that cannot be avoided.
Wildlife	16	23	Comments concerning the direct, indirect, and cumulative adverse impacts to wildlife and wildlife habitats for common species in the area. Implementation of the Master Plan could result in potential negative effects from loss and/or fragmentation of habitat, especially in MINWR and CNS, and the waters and sea grass nurseries of the Indian River and Mosquito Lagoons that support a varied and plentiful fish population. One commenter was also concerned about the potential impacts to birds in Bald Paint Pond.
Total	**237**	**384**	

5.4 SUMMARY OF COMMENTS BY CATEGORY

5.4.1 Alternatives

Sixteen (16) comments were received from six (6) unique commenters. Several commenters noted that the analysis of the Proposed Action and the No Action Alternative would be, while legally compliant, insufficient or too limited for this PEIS. Several requested the consideration of alternative locations (specifically for Launch Pads 34C and D [sic] and 39C and D) in order to minimize potential impacts to various natural resources, CNS, MINWR, Mosquito Lagoon, and Indian River Lagoon.

Several other alternatives, or aspects of alternatives, were suggested or recommended for analysis, including:

- A land management alternative based on transfer of property title, or jurisdictional control in lieu of title transfer, for appropriate areas of the KSC geography that might be operated and sustained independently of NASA but in coordination with federal partners.
- A Future Land Use alternative based on NASA divestment of all KSC land north of State Road (SR) 402.
- Governance structure and near-term spaceport authority implementation timeframe alternatives that present more options for a spaceport authority in lieu of continued NASA field center status for KSC, including options based on federal, state, or hybrid authority structures and legal powers.
- A shared rail system like the one from the Orlando Airport to Port Canaveral.
- Place the rail alongside the 528 Beach line to connect to the existing rail in Cocoa.
- Consult with USACE to determine the viability of permitting a seaport when considered against other alternatives, including utilization and/or expansion of current existing seaport facilities on and off KSC to meet future transportation requirements.
- An alternative that utilizes existing infrastructure on the CCAFS.
- Distinguish in CMP between KSC geographic boundaries and KSC jurisdictional responsibilities over the land and built environment within those boundaries.

A few argued that the alternatives are inconsistent with the intent of the President's 2013 Space Transportation Policy, the direction of Congress, or the best interests of either the nation or the State of Florida.

5.4.2 Cooperating Agencies

Nineteen (19) comments were received from fifteen (15) unique commenters. Most comments emphasized that working cooperatively with the Air Force could obviate the need to build new launch facilities in light of the unused launch facilities and infrastructure within the Cape Canaveral Air Force Station. The USACE was also recommended as a Cooperating Agency to determine the viability of seaport permitting when considered against other alternatives, including utilization and/or expansion of current existing seaport facilities on and off KSC to meet future transportation requirements.

Some noted that the evolution of KSC to a multi-user spaceport would likely increase the complexity of managing MINWR. Several urged NASA to follow the recommendations of and work closely with the USFWS and NPS to determine appropriate methods, locations, and mitigations within KSC, MINWR, and CNS.

5.4.3 Cultural and Historic Resources

Five (5) comments were received from three (3) unique commenters. Commenters expressed concern that the Proposed Action would impact historic sites in areas managed by the USFWS and NPS; the direct, indirect, and cumulative adverse impacts should be studied in the PEIS. In response to the threat posed by the development of the Shiloh Space Complex, a few requested that NASA consider taking affirmative action to protect the Elliot Plantation Complex, and grant permission to move forward with National Historic Landmark and/or National Register of Historic Places nomination.

Several commenters support the Buffer Designation north of SR 402 and Beach Access Road as Operational Buffer/Public Use for the preservation of historic properties, and public enjoyment.

5.4.4 Cumulative Effects

Nineteen (19) comments were received from fifteen (15) unique commenters regarding cumulative effects, and the need for a comprehensive evaluation of the cumulative impacts of all space activities from the past, present, and reasonably foreseeable future.

Several noted that the appropriations made by Congress in the 1980s to move the access road a safe distance to the north significantly reduced closures of Playalinda Beach for shuttle launches, and the recurring loss of public access to CNS and MINWR should be considered when analyzing cumulative impacts to recreation and socioeconomics.

Many discussed NASA’s impact to Brevard and Volusia counties and KSC's neighboring municipalities; some have suffered significant business and tax revenue disruption already from federal space program employment and funding reductions and still others have benefited from the jobs of the aerospace sector and support its presence along Florida’s “Space Coast”.

Some expressed concern that Florida's statewide aerospace sector economy and competitive position in the commercial space industry are increasingly disadvantaged by reliance on federal spaceport infrastructure, land use policies, and a heritage operating environment tied to the past; or that mixing a free enterprise with a government entity on government property for leased land will cause problems in the future. Others supported the return of business and global competiveness.

Many of the comments suggested that widespread water quality issues from debris, ammonia, oxygen-depleting organic compounds, and other pollutants specifically in Mosquito and Indian River Lagoons should be evaluated before siting new launch facilities in this area. Several noted that the simultaneous growth of industry and population exacerbating the water quality, air quality, and basic quality of life in the State of Florida should be evaluated in the PEIS.

Many were concerned with Space Florida's proposal to build a spaceport within the Shiloh area of the MINWR for commercial launches, and how this Proposed Action would affect the timing and operations of MINWR and KSC. One noted that the planned seaport on Banana Creek to the west of the Shuttle Landing Facility (SLF) could pose an operational conflict with the horizontal space launch and recovery operations that will drive Space Florida's future planned development and operations of the SLF. Another suggested that the Proposed Action could address the problem of the Shiloh launch proposal by making sites available in the revised plan for entities like Space Florida.

5.4.5 Health and Safety

Four (4) comments from four (4) commenters concerned health and safety. In addition to the general concern for the safety of nearby residents, there was a specific concern for the potential threats to visitor and employee safety from the development of launch facilities within and adjacent to CNS. One commenter requested that the PEIS evaluate how the safety, security, and operational priorities required by NASA's Exploration Program and SLS launch operations at Pad 39B might interact with the proposed commercial operations at Pads 39C and 39D. This same commenter requested that the PEIS describe the priority of scheduling and operations if safety clearance requirements cause conflict between NASA activities on Pad 39B and commercial operations on Pads 39C and 39D.

5.4.6 Land Use

Twenty-six (26) comments were received from sixteen (16) unique commenters addressing land use, many of which are closely tied to the Section 5.4.10 (Proposed Action).

General concerns included development by commercial space companies in light of the availability of unused launch facilities and infrastructure within the CCAFS. Some supported Space Florida's concept of a state-managed control complex, or were concerned that the Proposed Action would affect an area larger than Shiloh.

Several commenters stated that the most appropriate, long-term programmatic mitigation for potential environmental impacts is the permanent transfer of lands north of SR 402 to USDOI for management as part of the MINWR and CNS; as well as the right of first refusal for any future release of KSC property in these areas. Another stated that any attempt by any group to change the intended federal purpose or ownership of these lands should be rejected.

Specific comments regarding the CMP and Future Land Use Plan as they relate to the PEIS include:

- Future vertical launch facilities designated as Pads 39C and 39D and seaport facilities to the west of the SLF at Banana Creek and on the shoreline of the Banana River east of the Industrial Area illustrate an inconsistency of the Future Land Use Plan with environmental stewardship objectives described in CMP.
- No distinction in CMP between KSC geographic boundaries and KSC jurisdictional responsibilities over the land and built environment within those boundaries.
- CMP-proposed land use developments, affected areas, and project definitions are too vague to enable meaningful environmental analysis, even at the PEIS conceptual level.
- The Future Land Use Plan identifies an area significantly larger than the existing footprint for the SLF.

5.4.7 Mitigation

Many of the twelve (12) comments from ten (10) unique commenters suggested that the most appropriate, long-term programmatic mitigation for potential environmental impacts is the permanent transfer of lands north of SR 402 to USDOI for management as part of the MINWR and CNS; as well as the right of first refusal for any future release of KSC property in these areas. Some simply suggested that NASA work closely with the USFWS and NPS for mitigation within the KSC/MINWR/CNS boundaries.

More generally, commenters encourage a comprehensive mitigation plan to accompany the comprehensive land use plan, emphasizing mitigation for any damage under Section 404 of the Clean Water Act that cannot be avoided, especially as they relate to the Mosquito and Indian River Lagoons. One commenter recommended that the sandbar accessing the Indian River via the NASA Causeway and U.S. Route 1 be designated for non-motorized boating.

5.4.8 NEPA Process/PEIS

Fourteen (14) comments from seven (7) unique commenters regarding the NEPA Process and the PEIS were received. Space Florida requested a clear definition as to what its further participation may be in the PEIS preparation; members of the public were confused on how to comment without a better defined Proposed Action.

Other comments addressed the CMP, Future Land Use Plan, and PEIS, including:

- CMP-proposed land use developments, affected areas, and project definitions are too vague to enable meaningful environmental analysis, even at the PEIS conceptual level.
- PEIS should capture all of the future development plans for the SLF area that have been prepared by both NASA and Space Florida to minimize the need for additional NEPA analysis.
- At its current level of future development definition, the CMP is inadequately detailed to attract broad and meaningful stakeholder scoping input, or support the subsequent analysis of potential impacts required for a PEIS.

Recommendations for inclusion or analysis in the PEIS include:

- Incorporate information obtained from Request for Information (RFI) on May 27, 2014 to identify potential partners interested in developing vacant land consistent with the land use requirements outlined in the KSC Master Plan.
- Space Florida's concept of a state-managed control complex that can compete with other launch sites unencumbered by federal installation regulations and priorities.
- Direct, indirect, and cumulative adverse impacts on recreational, commercial, and economically beneficial uses; public use; T&E species, wildlife, and wetlands near CNS and MINWR; water quality of the Indian River Lagoon; nationally significant wetlands; and historic sites and landmarks.
- Potential impact of worst-case scenarios.
- The degree of impact that Launch Pads 39C and D would have on public access.
- The increased protection of habitat, listed species, and historic resources that would result from Proposed Action.

5.4.9 Noise

One (1) commenter expressed concerns regarding how noise will affect wildlife; as well as the impact to residential homes bordering KSC property along North Merritt Island.

5.4.10 Proposed Action

Sixty-eight (68) comments specific to the Proposed Action were received from thirty eight (38) unique commenters – the largest number of comments and commenters for any one category.

The majority of commenters supported future land use designation of the area north of SR 402 as an "Operational/Buffer Public Use Zone" and continued active management by the USFWS and NPS for habitat conservation, historic preservation, and public enjoyment. Many noted that this designation would protect natural resources, jobs, and recreation-based activities.

General support was expressed for the strategies discussed in the Future Development Concept, including re-development and in-fill of areas currently developed; avoid development in areas prone to inundation by storm events; enable greater on-site production of renewable energy to reduce net impact on greenhouse gases (GHG). Commenters also generally supported core values stated for the master plan, including evolution to a multi-user spaceport; leaner and greener; promotion of compatible relationships between adjacent land uses; recognition of wetlands at KSC and need for mitigation and development costs; preservation of Florida scrub jay habitat; recognition that future planning must recognize sea level rise. Many also supported the underlying justification of the master plan to accommodate non-governmental users of launch facilities within KSC as a reasonable and practicable alternative to the proposed Shiloh Project.

Others were concerned that mixing private enterprises with a government entity on government property for leased land will cause problems in the future; and that NASA should stay out of commercial launches. Some instead support Space Florida's concept of a state-managed complex that can compete with other launch sites unencumbered by federal installation regulations and priorities.

Several comments concerned the location of proposed launch facilities, including:

- Working cooperatively with the Air Force could obviate the need to build new launch facilities given underutilized launch facilities located at CCAFS.
- Two new launch operation and support facilities (34C and 34D) [sic], as well as potentially storing propellants and munitions to support launch operations, would cumulatively impact Mosquito and Indian River Lagoons.
- Eliminate the two proposed seaports site due to potential significant damage to natural resources in MINWR; impacts to a no-motor zone and a manatee protection area; and contradictions with environmental stewardship objectives described in CMP.

Specific issues with the CMP, Future Land Use Plan, and Proposed Action include:

- Future vertical launch facilities at Pads 39C and 39D in Future Land Use Plan are inconsistent with environmental stewardship objectives described in CMP.
- Identify the type of launch vehicles this plan intends to support in CMP and PEIS.

- Quantify acreage size depicted on the CMP future development; explain and define configuration of the conceptual site; define extent of wharves, dock, and support facilities construction.
- CMP describes a "business-focused implementation and operating framework" but does not discuss governance, regulatory, and operating environmental changes to facilitate institutional footprint reduction and realignment with current and future NASA mission needs.
- Pads 39C and 39D would not accommodate a medium-class or heavy-class liquid fueled launch vehicle with supporting launch integration and support capabilities.
- CMP does not sufficiently describe how KSC's existing physical assets would align with NASA requirements or reduce its institutional footprint and long-term recapitalization liability.

5.4.11 Public Involvement

A total of twelve (12) comments from nine (9) commenters were submitted regarding Public Involvement. Comments stated that a more collaborative planning process should have been used to develop its new CMP, and recommended more dialogue and collaboration between KSC and its stakeholders before proceeding with a PEIS, even if it requires modification of the CMP.

Several attendees noted that while notification for the Public Scoping Meetings was legally adequate, larger and earlier distribution would have resulted in more attendees. One commenter expressed frustration that NASA representatives would not answer questions at the meetings. Others appreciated the NASA-sponsored meetings about the future of the space program, as well as the opportunity for one-on-one discussions with NASA representatives during the open house.

5.4.12 Purpose and Need

Seven (7) comments were received from three (3) unique commenters revolving around whether the Proposed Action would meet the Purpose and Need, and whether it is appropriate for NASA’s current and future mission. Another commenter supported all efforts to use KSC for its intended primary purpose, a National Space Center.

In light of the unused and unavailable launch pads at the CCAFS, another addressed whether the Purpose and Need for this project could address the divergent missions and priorities of both NASA and the U.S. Air Force (USAF).

5.4.13 Recreation

Thirty-nine (39) comments were submitted from twenty-seven (27) unique commenters regarding recreation. A large majority of commenters were concerned with impacts to hiking, fishing, bird watching, wildlife viewing, enjoyment of cultural and historic resources, visual resources, boating, guided fishing/angling, and limited public access at Playalinda Beach, CNS, MINWR, and Mosquito and Indian River Lagoons. This same majority tended to support the designation north of SR 402 and Beach Access Road as Operational Buffer/Public Use for habitat conservation, preservation of historic properties, and public enjoyment.

As discussed in the Section 5.4.4 (Cumulative Effects), commenters noted that Launch Pads 39C and D would undo appropriations by Congress in the 1980s to move the beach access road to reduce instances of closure for shuttle launches; and result in recurring loss of public access to CNS and MINWR east of SR 3.

Several were concerned with how recreational activities would impact revenue and jobs due to limited visitation at CNS and MINWR.

Specific requests for clarification or analyses in the PEIS included:

- Discuss potential impacts on public access from proposed facilities adjacent SR 402 (Launch Pads 39C and D, rail gun strip), including the worst-case scenario and the degree of impact.
- Study and predict the frequency of closure of the southern entrance to CNS from Launch Pads 39C and D, and impacts from limited public access.
- Study impacts of restrictions on public use of CNS for access to beaches, boating (Mosquito Lagoon at Eddy Creek), and wildlife viewing opportunities along Beach Road from Launch Pads 34C and D [sic].
- Study the direct, indirect, and cumulative adverse impacts on recreational, commercial, and economically beneficial uses near CNS and MINWR.

5.4.14 Regulatory Compliance

Seven (7) comments were received from three (3) commenters regarding Regulatory Compliance. Commenters stressed the importance for the Proposed Action to comply with all current regulations and permitting requirements, specifically citing Section 106 of the National Historic Preservation Act (NHPA); the Endangered Species Act (ESA); Section 404 of the Clean Water Act; as well as the 2010 National Space Policy and the 2013 National Space Transportation Policy.

The Florida Trust requested the opportunity to participate as a consulting party in the Section 106 consultation process, pursuant to 36 CFR 800.2(c)(5) and 800.3(f)(3).

5.4.15 Socioeconomics

Forty-four (44) comments were received from twenty-seven (27) unique commenters regarding impacts to tax revenue, jobs, social fabric, commercial viability of the Proposed Action, lost revenue associated with limited access at CNS and MINWR. Comments requested that the PEIS examine the potential direct, indirect, and cumulative, social and economic impacts from the Proposed Action and clarify the total projected Capital Improvement Program (CIP) funding requirements envisioned during the 20-year planning horizon.

Many argued that Florida's aerospace sector economy and competitive position in the commercial space industry are increasingly disadvantaged by reliance on federal spaceport infrastructure, land use policies, and a heritage operating environment tied to the past. Commenters expressed concern that Brevard and Volusia counties and KSC's neighboring municipalities have suffered significant business and tax revenue disruption already from federal space program employment and funding reductions. Many argued that the proposed launch sites would not be commercially viable, since an investor might not be able to comply with contracts if NASA will always have priority.

Others generally supported the Proposed Action as it would guarantee that there will be no commercial space facility at Shiloh and provide Volusia County with needed development and associated jobs. One commenter urged that we work together to re-prosper and re-grow the area instead of each county competing for its own jobs.

As discussed in Section 4.5.13 (Recreation), many were concerned with how recreational activities would impact revenue and jobs due to limited visitation at CNS and MINWR. Several requested that the PEIS include discussion of the direct, indirect, and cumulative adverse impacts on recreational, commercial, and economically beneficial uses near CNS and MINWR. Commenters urged NASA to hold firm to public interests and protect MINWR, Mosquito and Indian River Lagoons; and maintain beach access. A few commenters were also concerned with potential impacts to utilities, infrastructure, roads, and property values.

Commenters expressed concern that with uncontrolled development, small coastal towns would lose their sense of community and identity. One commenter added that the simultaneous growth of industry and population growth is already exacerbating the water quality, air quality, and basic quality of life in Florida.

Specific requests for clarification in the CMP and/or inclusion in the PEIS include:

- CMP does not sufficiently describe how KSC's existing physical assets would align with NASA requirements or reduce its institutional footprint and long-term recapitalization liability, measured by the Current Replacement Value (CRV) of agency facilities assets.
- CMP and PEIS should clearly identify the total projected CIP funding requirements envisioned during the 20-year planning horizon.
- Reliance upon non-NASA funding sources for critical and non-critical horizontal infrastructure should be identified to highlight the risks to NASA and to the prospective commercial and non-NASA stakeholders in the overall CIP.
- Distinguish the CIP projects required to support NASA mission and the CIP projects which are deemed to enhance overall spaceport infrastructure and capabilities, along with individual project cost estimates and total CIP rollup values.
- NASA-centric CMP that fails to recognize the needs of its Florida stakeholders puts Florida at high risk of becoming irrelevant in the dynamic commercial space industry.
- Consider potential failure to attract the envisioned private-sector investment and state involvement in funding critical spaceport infrastructure.

5.4.16 Threatened and Endangered Species

Eighteen (18) comments were received from eleven (11) unique commenters regarding Threatened and Endangered (T&E) Species as well as state-listed species of special concern and species of management concern.

The majority commented that many of the 16 federally-listed species at MINWR would be adversely impacted by construction and operation of the proposed launch site. Some noted that the MINWR and CNS are located along the Atlantic Flyway and serve as an important migration and wintering site for a variety of waterfowl, shorebirds, and Neotropical migrants. One commenter pointed out that significant funds have been mobilized for restoration of the Indian River Lagoon in light of recent deaths of manatees, dolphins, pelicans, and the loss of sea grass.

Commenters urged the PEIS to consider impacts to listed species and migratory birds from the volume of water used to cool launch facilities during a launch and the proposed source of cooling water for new vertical launch operations and support facilities (34C and D) [sic].

Several comments were specific to the Florida scrub jay, noting that the construction of new launch facilities further north would prevent/interfere with prescribed burning necessary to restore and maintain its habitat.

5.4.17 Transportation

Nine (9) comments from three (3) unique commenters addressed transportation, specifically as it relates to access roads and the impact on public access to surrounding beaches. Commenters expressed the need to analyze the utilization and/or expansion of current existing seaport facilities on and off KSC to meet future transportation requirements; to analyze impacts of access roads through wetlands to service these sites; and identify what level of utilities would be extended from existing KSC service areas to provide required power and deluge water. Commenters were also concerned with the route and details of the proposed rail system and bridge.

5.4.18 Water Resources

A total of thirty-one (31) comments were received from nineteen (19) unique commenters regarding water resources, focusing on the Proposed Action’s effects to water quality, wetlands, and the seashore as they relate to recreational opportunities and wildlife.

The majority of comments regarded the direct, indirect, and cumulative adverse impacts of Launch Pads 39C and 39C on wetlands and water quality near, in, or on the MINWR, CSN, Mosquito and Indian River Lagoons, and the seashore environment. Several commenters stated that siting new facilities further north than the current launch pads would increase the debris and pollutants from the space vehicle fuel mix, which are a major concern at the Mosquito Lagoon and adjacent Indian River system. Several were also concerned that construction of the one of the proposed seaports would necessitate Banana Creek to be dredged, deepened, and filled.

Commenters specifically requested that the total amount of impacted wetlands and surface waters be identified in PEIS; impacts to water resources be minimized per Section 404 of the Clean Water Act; and that mitigation address any damage that cannot be avoided.

5.4.19 Wildlife

Twenty-three (23) comments were received from sixteen (16) unique commenters regarding the direct, indirect, and cumulative adverse impacts to wildlife and wildlife habitats for common species in the area.

In addition to those concerns discussed in Section 5.4.16 (Threatened and Endangered Species), many were concerned that implementation of the Master Plan could result in potential negative effects from loss and/or fragmentation of habitat, especially in MINWR and CNS, and the waters and sea grass nurseries of the Indian River and Mosquito Lagoon that support a varied and plentiful fish population. One commenter was also concerned about the potential impacts to birds in Bald Paint Pond.

Table 3. KSC Center-wide Operations PEIS Scoping Comments by Commenter and Category (Scoping Period June 4– July 7, 2014)

Commenter	Alternatives	Cooperating Agencies	Cultural and Historic	Cumulative Effects	Health and Safety	Land Use	Mitigation	NEPA Process/PEIS	Noise	Proposed Action	Public Involvement	Purpose and Need	Recreation	Regulatory Compliance	Socioeconomics	T&E Species	Transportation	Water Resources	Wildlife
Agency (A)																			
A1	X				X								X			X			
A2		X				X	X						X			X		X	X
A3	X	X		X	X	X		X		X	X	X	X		X		X	X	
Non-Governmental Organization (NGO)																			
NGO1										X	X		X			X			
NGO2	X	X		X		X	X			X			X						
NGO3	X	X				X	X	X		X			X		X		X		
NGO4		X		X						X					X			X	
NGO5				X				X		X	X		X			X		X	
NGO6			X		X					X				X					
NGO7	X		X		X		X	X		X			X		X	X		X	X
NGO8			X		X					X			X						
NGO9										X								X	X
NGO10		X					X			X			X		X	X		X	X

Commenter	Alternatives	Cooperating Agencies	Cultural and Historic	Cumulative Effects	Health and Safety	Land Use	Mitigation	NEPA Process/PEIS	Noise	Proposed Action	Public Involvement	Purpose and Need	Recreation	Regulatory Compliance	Socioeconomics	T&E Species	Transportation	Water Resources	Wildlife
NGO11		X		X		X	X			X		X	X		X			X	X
NGO12				X						X					X				
NGO13								X					X		X	X		X	X
Public (P)																			
P1														X		X		X	X
P2				X		X				X									
P3								X			X								
P4						X				X	X		X						
P5				X			X												
P6							X								X				
P7										X									
P8		X				X				X			X						
P9						X				X									
P10		X				X	X			X									
P11		X											X						
P12				X						X			X		X				X
P13										X				X					

Commenter	Alternatives	Cooperating Agencies	Cultural and Historic	Cumulative Effects	Health and Safety	Land Use	Mitigation	NEPA Process/PEIS	Noise	Proposed Action	Public Involvement	Purpose and Need	Recreation	Regulatory Compliance	Socioeconomics	T&E Species	Transportation	Water Resources	Wildlife
P14										X					X				
P15				X						X					X				
P16				X						X					X				
P17				X															
P18															X				
P19										X					X				
P20				X						X					X			X	
P21				X											X				
P22											X								
P23										X					X				
P24				X						X									
P25																	X		
P26											X								
P27		X											X					X	X
P28				X											X			X	
P29				X											X				X
P30											X								

Commenter	Alternatives	Cooperating Agencies	Cultural and Historic	Cumulative Effects	Health and Safety	Land Use	Mitigation	NEPA Process/PEIS	Noise	Proposed Action	Public Involvement	Purpose and Need	Recreation	Regulatory Compliance	Socioeconomics	T&E Species	Transportation	Water Resources	Wildlife
P31										X				X					
P32		X				X		X		X		X			X				
P33		X				X				X								X	X
P34						X				X						X		X	X
P35													X						
P36										X									X
P37										X					X				
P38		X		X		X	X			X			X	X	X	X		X	
P39					X	X				X			X		X			X	
P40	X				X				X	X	X		X	X	X		X	X	X
P41				X		X				X			X						
P42													X						X
P43						X							X						
P44										X			X					X	X

6.0 CONCLUSION

The overall tenor of scoping feedback from participating stakeholders – including agency, NGOs, and members of the public – was broad, qualified support for the basic concepts behind the KSC CMP. This was tempered by widely shared concerns about specific elements of the land use plan, such as impacts from the siting of the proposed Launch Pads 39C and 39D, restricted access to and closures at Playalinda Beach, impacts from proposed seaport siting, and others.

General concerns were expressed about cumulative impacts to resources and recreationists at MINWR and CNS, as well as to water quality and wildlife in the surrounding water bodies. These water bodies (i.e., Indian River, Mosquito Lagoon) are critical to the environmental health and quality of life of the region and are showing signs of acute stress even now as a result of cumulative population growth and development in the region and the loadings of pollutants these entail.

Several concerns expressed repeatedly by certain stakeholders during the scoping process were not environmental per se, but more oriented toward the commercial viability of the "business model" of the proposed future management of KSC as expressed in the CMP. These commenters expressed doubt as to whether NASA's goal of KSC evolving toward a multi-user spaceport was feasible. There is concern that the CMP is not sufficiently responsive to the dynamic, evolving commercial space market, and that as a result, KSC and Florida will miss out on emerging opportunities in this market.

Commenters suggested a number of issues and alternatives that should be assessed in the PEIS.

7.0 LIST OF PREPARERS

NASA prepared the various Scoping Materials and the Scoping Report with contractual assistance from Solv, LLC. The following individuals were primarily responsible for the development, drafting, and review of the scoping materials and Scoping Report:

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