3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter of the Draft Environmental Impact Statement (DEIS) for the Mars 2020 mission briefly discusses the local and global areas that could be affected by implementing the Proposed Action (Alternative 1), Alternative 2, Alternative 3, and the No Action Alternative as described in Chapter 2. This document is a Tier 2 mission-specific DEIS under NASA's *Final Programmatic Environmental Impact Statement for the Mars Exploration Program* (PEIS MEP) (NASA 2005a). The PEIS MEP addressed, in general, the regional area surrounding Cape Canaveral Air Force Station (CCAFS) and the Kennedy Space Center (KSC), Florida, and the global environment that could be affected if any of the alternatives in the PEIS were implemented. As a tiered document, the Mars 2020 DEIS supplements that discussion. Implementing the No Action Alternative (i.e., discontinue the Mars 2020 mission) would result in no impacts to the existing environment. Launch of the Mars 2020 mission would take place at CCAFS or KSC, Brevard County, Florida, during the summer of 2020 launch opportunity. The next launch opportunity for this mission would occur during the summer of 2022.

The PEIS MEP used other National Environmental Policy Act (NEPA) documentation such as the U.S. Air Force's (USAF) *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (USAF 1998), *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (USAF 2000), and institutional documents as principal sources of information to describe the affected environment. Where relevant, these documents are summarized in this chapter with the exception where updated documents are noted.

Section 3.1 describes the affected environment at CCAFS and KSC and includes consideration of the resource areas of Land Use, Air Quality, Noise, Geology and Soils, Water Quality, Biological and Natural Resources, Socioeconomics, Historical and Cultural Resources, Hazardous Materials and Hazardous Waste, Health and Safety, Environmental Justice and Aesthetics. Section 3.2 provides a general discussion of areas of the global environment that may be affected by the proposed action.

3.1 CAPE CANAVERAL AIR FORCE STATION AND KENNEDY SPACE CENTER LOCATION DESCRIPTION

CCAFS is located on the east coast of Florida in Brevard County on a barrier island called the Canaveral Peninsula. CCAFS is bounded on the west by the Banana River, on the north by KSC, on the east by the Atlantic Ocean, and on the south by Port Canaveral. CCAFS encompasses an area of approximately 15,800 acres (63.9 square kilometers, 24.7 square miles).

KSC is located on the east coast of Florida in Brevard County on the north end of Merritt Island adjacent to Cape Canaveral. KSC is bordered on the west by the Indian River and on the east by the Atlantic Ocean and CCAFS. The northernmost end of the Banana River 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 across Mosquito Lagoon in Volusia County. The Indian River, Banana River, and the Mosquito

Lagoon collectively make up the Indian River Lagoon system. The land and lagoon areas encompass approximately 139,400 acres (564.1 square kilometers, 217.8 square miles) (NASA 2010). The CCAFS and KSC area are illustrated in Figure 3-1.

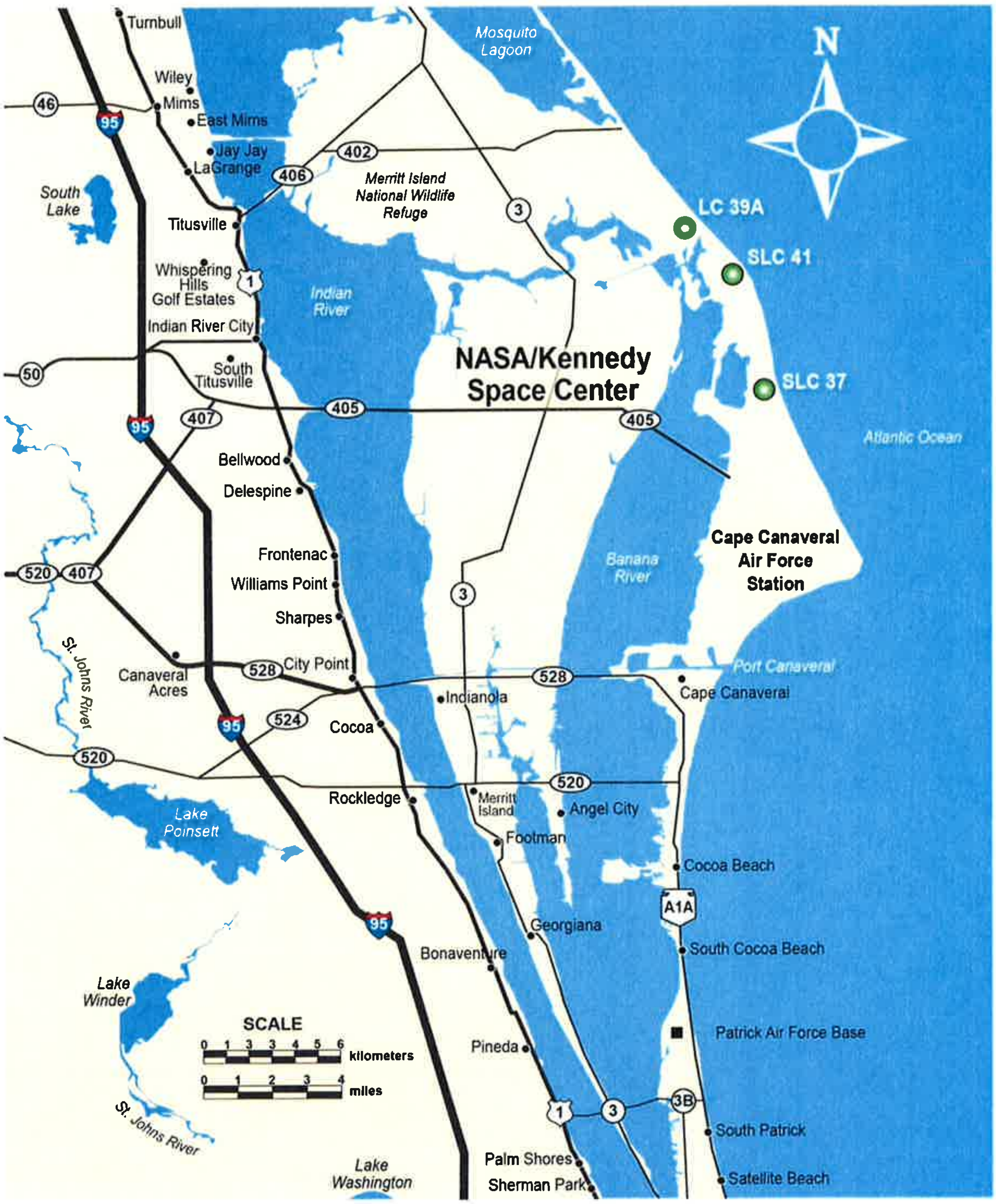

Figure 3-1. CCAFS and NASA/KSC Locations

3.1.1 Land Use

NASA has devised eleven land use categories to describe the regions within which various types of operational or support activities are conducted. These land use categories are Launch, Launch Support, Airfield Operations, Spaceport Management, Research and Development, Public Outreach, Seaport, Recreation, Conservation, Agriculture, and Open Space.

Only a very small part of the total acreage of KSC has been developed or designated for NASA operational and industrial use. Merritt Island consists of prime habitat for unique and endangered wildlife; therefore, in 1972 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 the Department of the Interior (DOI) was also entered into in 1975 due to the location of CNS within KSC boundaries (NASA 2010).

Land use is carefully planned and managed at KSC to provide required support for missions and to maximize protection of the environment. NASA maintains operational control of approximately 4,212 acres (17.0 square kilometers, 6.6 square miles) at KSC and this area comprises the functional area dedicated to NASA operations. NASA's two primary developed areas at KSC are Launch Complex (LC)-39 in the north and the centrally located Industrial Area. Approximately 70 percent of the NASA operational control area is developed land dedicated as facility sites, roads, lawns and right-of way. The remaining undeveloped areas are dedicated safety zones or are held in reserve for planned and future expansion (NASA 2010).

Land uses at CCAFS include launch operations, launch and range support, airfield, port operations, station support area, and open space. The launch operations land use category is present along the Atlantic Ocean shoreline and includes the active and inactive launch sites and support facilities. The launch and range support area is west of the launch operations area and is divided into two sections by the airfield. The airfield includes a single runway, taxiways, and apron, and is in the central part of the station. The port operations area is in the southern part of the station and includes facilities for commercial and industrial activities. The major industrial area is located in the center of the western portion of the station. This area also includes administration, recreation, and range-support facilities. Open space is dispersed throughout the station. There are no public beaches located on CCAFS. All land uses at CCAFS are under the operational control of the USAF 45th SW, located at Patrick Air Force Base (PAFB) (NASA 2011).

The proposed Mars 2020 mission would be launched either on a Delta IV launch vehicle from SLC-37 located on the northeastern section of CCAFS; an Atlas V launch vehicle from SLC-41 located in the northernmost section of CCAFS; or a Falcon Heavy launch vehicle from LC-39 located on the north end of Cape Canaveral at the Shuttle launch complex.

3.1.2 Air Resources

3.1.2.1. Climate

The climate of CCAFS and KSC is subtropical with short, mild winters and hot, humid summers, with no recognizable spring or fall seasons. Summer weather usually begins in April and prevails for about nine months of the year. During this period, dawns are normally 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. Thundershowers tend to lower the local temperatures, followed by an ocean breeze. The dominant weather pattern (May to October) is characterized by southeast winds, which travel clockwise around the Bermuda High. The southeast wind brings moisture and warm air, which helps produce almost daily thundershowers creating a wet season. Approximately 70 percent of the average annual rainfall occurs during this period. Occasional cool days occur in November, with winter weather starting in January and extending through February and March. These last two months are usually windy with temperatures ranging from about 40°F at night to 75°F during the day. 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 1979).

The main factors influencing climate at CCAFS and KSC are latitude and proximity to the Atlantic Ocean and the Indian and Banana Rivers, which moderate temperature fluctuations (NASA Technical Memorandum 1990). Results of the Cape Atmospheric Boundary Layer Experiment found that wind direction, especially the sea breeze front, is controlled by thermal differences between the Atlantic Ocean, Banana River, Indian River, and Cape Canaveral's 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 (1000 m) 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 (NASA 1979).

3.1.2.2. Air Quality

CCAFS and KSC are located in an area classified as in attainment for all the Federal and state criteria pollutants listed in Table 3-1.

Table 3-1. State and Federal Ambient Air Quality Standards

Pollutant	Average Time	State of Florida Standard	Federal Primary NAAQS	Federal Secondary NAAQS
Carbon Monoxide	8-hour[a] 1-hour[a]	9 ppm 35 ppm	9 ppm 35 ppm	N/A N/A
Lead	Quarterly 3-Month	1.5 µg/m3 1.5 µg/m3	1.5 µg/m3 0.15 µg/m3[b]	1.5 µg/m3 0.15 µg/m3
Nitrogen Dioxide	Annual 1-hour[d]	0.053 ppm 0.10 ppm	0.053 ppm 0.10 ppm	0.053 ppm 0.10 ppm
Ozone	8-hour[h] 1-hour[i]	0.075 ppm N/A	0.075 ppm 0.12 ppm	0.075 ppm 0.12 ppm
Particulate Matter (PM10)	24-hour[e]	15 µg/m3	150 µg/m3	150 µg/m3
Particulate Matter (PM2.5)	Annual[f] 24-hour[g]	15 µg/m3 N/A	15 µg/m3 35 µg/m3	15 µg/m3 35 µg/m3
Sulfur Dioxide	Annual 24-hour[a] 1-hour[j] 3-hour	0.02 ppm 0.10 ppm N/A 0.5 ppm	0.03 ppm 0.14 ppm 0.075 ppm N/A	0.5 ppm 0.14 ppm N/A 0.5 ppm

Source: NASA 2010, NASA 2011, KSC 2013.

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

3.1.2.3. Ozone Depleting Substances

The Clean Air Act amendments established a deadline of 2000 for the phase-out of the production of the Class I Ozone Depleting Substances (ODS) chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and 2002 for methyl chloroform. Under the Montreal Protocol, the U.S. must also phase-out its use of Class II ODS (hydrochlorofluorocarbons) by 2030.

In 1993, Executive Order 12843 directed Federal agencies to minimize the procurement of products containing ODS. The NASA policy requires that NASA minimize the procurement of ODS in anticipation of the phase-out of ODS production.

3.1.2.4. Risk Management Program 40 CFR 68

At KSC, monomethyl hydrazine (MMH) is the only listed regulated substance for accidental release prevention under its Risk Management Program (NASA 2010).

3.1.3 Noise

Ambient noise levels at CCAFS and KSC range from quiet (40 dBA) in isolated areas to 75 dBA or more due to infrequent launch activities, aircraft movement, and other support-related activities (NASA 1998). Noise generated at CCAFS and KSC by day-to-day operations, space vehicle launches, and Orbiter landings can be attributed to six general sources: (1) Orbiter re-entry sonic booms, (2) launches, (3) aircraft movements, (4) industrial operations, (5) construction, and (6) traffic noise (NASA 2010). The closest residential areas to CCAFS are to the south, in the cities of Cape Canaveral and Cocoa Beach. The closest residential area to LC-39 at KSC is to the west, in the city of Titusville. Infrequent aircraft fly-over and rocket launches from CCAFS and KSC would be expected to increase noise levels for short periods of time. The highest recorded levels were produced by launches of the Space Shuttle, which in the launch vicinity could exceed 160 dBA. Sonic booms produced during vehicle ascent typically occur over the Atlantic Ocean and are directed in front of the vehicle and do not impact land areas (USAF 1998, NASA 2011).

3.1.4 Soils and Geology

3.1.4.1. Soils

The KSC and CCAFS soil pattern is complex and 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 influences soil nutrient levels, particularly calcium and magnesium, and pH.

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 elevation changes cause dramatic differences in the position of the water table that, in turn, affect leaching, accumulation of organic matter, and formation of soil horizons. In addition, proximity to the lagoon systems influences soil salinity.

Soils at CCAFS/KSC are highly permeable and allow water to quickly percolate into the ground and have a high buffering capacity (NASA 1998). No prime or unique farmland is present at CCAFS/KSC (USAF 1998).

3.1.4.2. Geology

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 represent successive stages in this growth. It is suggested that the geologic history of the Merritt Island-Cape Canaveral barrier island was complex. The western portion of

Merritt Island is substantially older than the east and erosion has reduced the western side to a nearly level plain (NASA 2010).

3.1.4.3. Seismology

Seismological investigations of the Cape Canaveral area include refraction surveys and well logs. Investigations, conducted by the Seismological Branch of the U.S. Coast and Geodetic Survey, showed that the Cape Canaveral underground structure is normal and free of voids or anomalies. The Florida Platform exhibits high seismologic stability with very few confirmed earthquakes (NASA 2010).

3.1.5 Water Quality

3.1.5.1. Surface Water Classification

The major water bodies surrounding KSC and CCAFS include the Atlantic Ocean and the inland estuary consisting of the Indian River, the Banana River, and the Mosquito Lagoon. The inland estuary has been designated as an Estuary of National Significance, and contains Outstanding Florida Waters (OFW) and Aquatic Preserves. Freshwater inputs to the estuary include direct precipitation, storm water runoff, discharges from impoundments, and groundwater seepage (NASA 2010).

Surface drainage within CCAFS launch areas is generally westward toward the Banana River. CCAFS/KSC launch areas do not lie within the 100-year floodplain and are not within a wetland (USAF 2002). LC-39A is also outside the 500-year floodplain (KSC 2013). There are no National or state-designated wild or scenic rivers on or near KSC or CCAFS (NPS 2005, FS 258.501).

3.1.5.2. Surface Water Quality

Surface water quality at CCAFS/KSC is considered to be generally good. Historically, the best areas of water quality are adjacent to the undeveloped areas of the lagoon, such as the north Banana River, Mosquito Lagoon, and the northernmost portion of the Indian River. However, since 2011, the overall water quality of the waters surrounding KSC has been markedly impacted. The likely cause for these impacts is related to the presence of two large and persistent algal blooms in the area. The first bloom occurred from early spring through late fall of 2011. This bloom covered a large portion of the northern Indian River Lagoon basin, mainly the Indian River lagoon proper and Banana River, and included the waters surrounding KSC. The second large bloom occurred during the summer of 2012. Unlike the bloom of 2011, which began in the Banana River Lagoon before spreading to the northern Indian River Lagoon and Mosquito Lagoon, the 2012 bloom started in the southern Mosquito Lagoon in July, then spread into the northern Indian River Lagoon. These blooms decreased water clarity and overall quality, which negatively impacted seagrass growth and distribution. The marked decline of seagrass (approximately 90%) during this bloom has been documented for much of the central Indian River and the majority of the Banana River, including the KSC long-term monitoring sites and the St John's River Water Management District long-term seagrass sites (KSC 2013).

The Florida Department of Environmental Protection (FDEP), in compliance with the

Environmental Protection Agency (EPA) Numeric Criteria Standards for pollutants, has set total maximum daily loadings (TMDLs) for many impaired waters in the State. The following waters within the boundary or adjoining KSC are identified as impaired:

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

Basin Management Action Plans (BMAPs) addressing the first five years of a 15 year restoration period, for the Banana River Lagoon, and the North Indian River Lagoon have been developed and adopted. These BMAPs address nutrient and dissolved oxygen impairment (KSC 2013). In addition, a statewide TMDL for mercury has been adopted by the state of Florida and approved by the U.S. EPA (Gao 2014).

3.1.5.3. Groundwater Sources

There are three aquifer systems underlying CCAFS and KSC: the surficial aquifer system, the intermediate aquifer system, and the Floridan aquifer system. The surficial aquifer system, which is generally comprised of sand and marl, is under unconfined conditions and is approximately 21 m (68.9 ft) thick. The water table in the aquifer is generally 1 m (3.3 ft) or less below the ground surface. A confining unit composed of clays, sands, and limestone separates the surface aquifer from the underlying Floridan aquifer. The Floridan aquifer is the primary source of potable water in central Florida. These two main aquifers are separated by nearly impermeable confining units and contain three shallow aquifers referred to as the intermediate aquifer system. Groundwater in the Floridan aquifer at CCAFS and KSC is highly mineralized. CCAFS and KSC receive their potable water from the city of Cocoa, which utilizes water from the Floridan aquifer (USAF 1998).

3.1.5.4. Coastal Zone Management

NASA is responsible for making consistency determinations and obtaining concurrence from the respective state coastal zone management agency for NASA-approved or funded actions within the coastal zone. The USAF is responsible for making the coastal zone consistency determinations for its activities within the state. The Florida Department of Community Affairs reviews the coastal zone consistency determination (USAF 1998). The state of Florida's coastal zone includes the area encompassed by all of the state's 67 counties and its territorial seas.

Activities at CCAFS/KSC, which are likely to require consistency determinations with the state's Coastal Zone Management Program include: any project subject to state or Federal dredge and fill permitting review; any point or new non-point source discharge to surface waters; and major industrial expansion or development projects. Consistency review is typically addressed in NEPA documentation and submitted to the Governor's

Office for review via the Intergovernmental Coordination and Review Process (NASA 2010).

3.1.6 Biological and Natural Resources

Biological resources include native and introduced plants and animals within an area potentially affected by the proposed activity. These are divided into vegetation, wildlife, threatened or endangered species, and sensitive habitats. Sensitive habitats include, but are not limited to, wetlands, plant communities that are unusual or of limited distribution, and important seasonal use areas for wildlife. They also include critical habitat as protected by the Endangered Species Act and sensitive ecological areas as designated by state or federal rulings.

Because CCAFS and KSC are located near the coastline, the Marine Mammal Protection Act (MMPA) applies. The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and importation of marine mammals and marine mammal products into the United States. The term "take" means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (NASA 2011).

CCAFS and KSC occupy a combined total of about 62,753 hectares (ha) (155,066 ac) of coastal habitat on a barrier island complex that parallels Florida's mid-Atlantic coast. The area of interest for biological resources consists of CCAFS and KSC, the adjacent Atlantic Ocean, and three major inland water bodies including the Banana and Indian Rivers and Mosquito Lagoon. The region has several terrestrial and aquatic conservation and special designation areas (e.g., wildlife management areas and aquatic preserves). These areas serve as wildlife habitat and occupy about 25 percent (about 405,000 ha (1,000,000 ac)) of the total land and water area within the region.

3.1.6.1. Vegetation, Wetland, and Wildlife Resources

At CCAFS/KSC, coastal scrub and associated woodlands provide habitat for mammals, including the white-tailed deer, armadillo, bobcat, feral hog, raccoon, long-tailed weasel, round-tailed muskrat, and the Florida mouse (a state species of special concern). Resident and migrating bird species include numerous common land and shore birds.

The most common types of wetlands and open water areas at CCAFS/KSC are mangrove wetlands, salt marshes, freshwater wetlands, brackish water impoundments, borrow pits, and drainage canal systems (USAF 2008).

Amphibians observed at CCAFS and KSC include the spade-foot and eastern narrow-mouth toads, squirrel and southern leopard frogs, and green tree frogs. Reptiles observed include the American alligator, the Florida box turtle, the gopher tortoise, the Florida softshell turtle, the green anole lizard, the six-lined racerunner lizard, the broadhead skink lizard, the southern ringneck snake, the everglades racer snake, the eastern coachwhip snake, and the mangrove salt marsh snake (NASA 2011).

3.1.6.2. Aquatic Resources

The aquatic environment surrounding CCAFS and KSC provides diverse fish habitat, which supports many shore bird species, and sport, commercial, and recreational fishing. The Atlantic beaches at CCAFS, KSC, and the CNS are important to nesting sea turtles. The Mosquito Lagoon is considered one of the best oyster and clam harvesting areas on the east coast.

Marine mammals populate the coastal and lagoon waters, including the bottlenose dolphin, the spotted dolphin, and the manatee. The seagrass beds in the northern Indian River system provide important nursery areas, shelter, and foraging habitat for a wide variety of fish, invertebrates, and manatees. The inland rivers and lagoons provide habitat for marine worms, mollusks, and crustaceans. The Mosquito Lagoon is an important shrimp nursery area.

A number of saltwater fish species can be found within the Indian and Banana River systems, including the bay anchovy, pipefish, goby, silver perch, lined sole, spotted sea trout, and oyster toadfish. The small freshwater habitats found on CCAFS and KSC contain bluegill, garfish, largemouth bass, killifishes, sailfin molly, and top minnow (USAF 1998).

The Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended, mandates the conservation of essential fish habitat (EFH). Ocean waters off KSC have several areas designated as EFH that are of particular importance to sharks and other game fish, as well as several species of lobsters, shrimp, and crabs. These habitats include: sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone and from the Gulf Stream shoreward, including areas containing Sargassum plant species. In addition, the northern boundary of Oculina Bank, a unique strip of coral reefs not duplicated elsewhere on Earth, is located approximately 37 km (23 mi) off of Cape Canaveral. The entire reef is 145 km (90 mi) long. There are restrictions on many types of fishing in most of the area and fishing for snapper and grouper species is prohibited in part of the area (KSC 2013).

Regional Fishery Management Officials (FMOs) are responsible for designating EFH in their management plans for all managed species within the Exclusive Economic Zone (EEZ), which is a managed fisheries area that extends from the shoreline to 200 miles offshore along the coastline of U.S. waters. For the marine area surrounding CCAFS and PAFB, the South Atlantic Fishery Management Council (SAFMC) is the managing body. The SAFMC currently manages several types of organisms in the vicinity of Cape Canaveral and PAFB: the South Atlantic Snapper-Grouper complex, South Atlantic shrimps, Coastal Migratory Pelagic species, Highly Migratory species, Red Drum, Spiny Lobster, Golden Crab, Calico Scallop, and Sargassum. The National Marine Fisheries Service (NMFS) defines EFH for highly migratory species under its jurisdiction. Habitat Areas of Particular Concern (HAPCs) have also been designated within EFH areas; these are localized areas that are vulnerable to degradation or are especially important ecologically. HAPCs are located within the estuary systems of PAFB and CCAFS for penaid shrimp. The Oculina Bank near Cape Canaveral also serves as a HAPC for nursery habitat and refuge for rock shrimp (USAF 2008).

The USAF has a programmatic consultation in place with the NMFS on EFH regarding Atlas V and Delta IV launches from CCAFS (USAF 2000). Similar consultations for commercial Falcon Heavy launches would be expected to be in place before a possible Mars 2020 launch.

3.1.6.3. Threatened and Endangered Species

The USFWS currently recognizes 112 endangered or threatened and 22 candidate animal and plant species in the state of Florida (FWS 2014). The state of Florida considers 118 animal species as threatened, endangered, or of special concern (FFWCC 2014) and 55 plant species as threatened or endangered (FDACS 2014) for the state. Table 3-2 provides a list of Threatened, Endangered and Candidate Species Occurring on or Around CCAFS and KSC.

CCAFS and KSC have management plans in place for conservation of threatened or endangered species (e.g., Scrub Jay Operational Management Plan, Sea Turtle Operational Management Plan, exterior lighting management plans to minimize impacts from nighttime lights on sea turtle nesting beaches, designated manatee refuges, and sanctuaries in selected inland waterways) (USAF 2001, USAF 2008). In addition to protection under the Endangered Species Act, the wood stork, piping plover, roseate tern, and Florida scrub jay receive protection under the Migratory Bird Treaty Act (MBTA) (NASA 2010).

Table 3-2. Threatened, Endangered, and Candidate Species Occurring or Potentially Occurring on or Around CCAFS and KSC, Florida

Common Name	Scientific Name	Federal Status	State Status
Plants			
Beach-star[a]	*Remirea maritima*	–	E
Coastal mock vervain[a]	*Glandulareia maritima*	–	E
Curtiss' milkweed[a]	*Asclepias curtissii*	–	E
Florida lantana[a]	*Lantana depressa var. floridana*	–	E
Hand fern[a]	*Ophioglossum palmatum*	–	E
Scaevola Inkberry[a]	*Scaevola plumieri*	–	T
Nakedwood, Simpson's Stopper[a]	*Myrcianthes fragrans*	–	T
Nodding pinweed[a]	*Lechea cernua*	–	T
Sand dune spurge[a]	*Chamaesyce cumulicola*	–	E
Satin-leaf[a]	*Chrysophyllum oliviforme*	–	E
Sea lavender[a]	*Argusia gnaphalodes*	–	E
Shell mound prickly-pear cactus[a]	*Opuntia stricta*	–	T
Reptiles and Amphibians			
American alligator	*Alligator mississippiensis*	T(S/A)	T(S/A)
Atlantic (Kemp's) Ridley sea turtle[*]	*Lepidochelys kempi*	E	E
Atlantic green turtle	*Chelonia mydas*	E	E
Atlantic saltmarsh snake[b]	*Nerodia clarkia taeniata*		T
Eastern indigo snake	*Drymarchon corais couperi*	T	T
Florida gopher frog	*Lithobates capito aesopus*	–	SSC
Florida pine snake	*Pituophis melanoleucus mugitus*	–	SSC
Gopher tortoise	*Gopherus polyphemus*	C	T

Common Name	Scientific Name	Federal Status	State Status
Hawksbill sea turtle*	*Eretmochelys imbricata*	E	E
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Atlantic loggerhead sea turtle	*Caretta caretta*	T	T
Alligator Snapping Turtle[a]	*Macrochelys temminckii*		SSC
Birds			
American oystercatcher[a]	*Haematopus palliatus*	–	SSC
Black skimmer	*Rynchops niger*	–	SSC
Brown pelican	*Pelecanus occidentalis*	–	SSC
Florida scrub jay	*Aphelocoma coerulescens*	T	T
Least tern	*Sterna antillarum*	–	T
Little blue heron	*Egretta caerulea*	–	SSC
Piping plover	*Charadrius melodus*	T	T
Reddish egret	*Egretta rufescens*	–	SSC
Roseate spoonbill	*Ajaia ajaja*	–	SSC
Roseate tern[a]	*Sterna dougallii dougallii*	T	T
Snowy egret	*Egretta thula*	–	SSC
Southeastern American kestrel	*Falco sparverius paulus*	–	T
Tricolored heron	*Egretta tricolor*	–	SSC
White ibis	*Eudocimus albus*	–	SSC
Wood stork	*Mycteria americana*	E	E
Audubon's Crested Caracara[a]	*Poyborus plancus audubonii*		T
Snowy Plover[a]	*Charadrius alexandrinus*		T
Bald Eagle[b]	*Haliaeetus leucocephalus*	P	
Mammals			
Florida mouse	*Podomys floridanus*	–	SSC
Northern right whale*	*Eubalaena glacialis*	E	E
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	T	T
West Indian manatee	*Trichechus manatus latirostris*	E	E
Fish			
Smalltooth Sawfish*	*Pristis pectinata*	E	E

Sources: NASA 2010; USAF 2007, Dankert 2014a

a. Only found at CCAFS.

b Not observed at CCAFS.

c Not observed at CCAFS, but known to occur in vicinity.

* Does not occur on CCAFS property but occurs in waters adjacent to and required to consult for potential impacts to these species from CCAFS actions.

Key: C = candidate for Federal listing; CCAFS = Cape Canaveral Air Force Station; E = endangered; SSC = State species of special concern; (S/A) = similarity of appearance to a listed species; T = threatened; P = Protected under the Bald and Golden Eagle Protection Act.

3.1.6.4. Sensitive Habitats

Sensitive habitats on CCAFS and KSC include wetlands, critical habitats for threatened and endangered species as defined by the Endangered Species Act, and the nearby CNS and MINWR. The MINWR contains a large number of manatees. Manatee critical habitat, located in the Banana River system, includes the entire inland sections of the Indian and Banana rivers, and most of the waterways between the two rivers.

Legally designated critical habitat for the northern right whale (*Eubalaena glacialis*) is located along the CCAFS/KSC coast and extends east for 9.3 km (5.8 mi); right whales are occasionally observed between December and March (KSC 2013).

Threatened or endangered species that inhabit the scrubby flatwoods of Merritt Island include the Florida scrub jay and the eastern indigo snake. The southern bald eagle, a federally protected species under the MBTA, the Bald and Golden Eagle Protection Act and the Lacey Act, is also known to occur in this area (KSC 2013).

The Indian River Lagoon area (Indian River, Banana River, and Mosquito Lagoon) is home to more than 5,300 kinds of plants and animals. The lagoon has a gradation of brackish water to salt water where it opens to the ocean. It is listed as an Estuary of National Significance and contains more species than any other estuary in North America (2,965 animals, 1,350 plants, 700 fish, and 310 birds). It also provides important migratory bird habitat. The lagoon contains one of the highest densities of nesting turtles in the western hemisphere, is a rich fishery, and is used by up to one third of the United States' manatee population (USAF 1998).

The Atlantic beaches are important to nesting sea turtles. Disorientation of marine turtles related to lighting from nighttime space operations has occurred at CCAFS and KSC in the past; however, CCAFS and KSC both have a light management plan that addresses mitigation of impacts to nesting sea turtles during nighttime launches (USAF 2001, KSC 2013).

3.1.7 Socioeconomics and Children's Environmental Health and Safety

The surrounding counties of CCAFS and KSC include Brevard County, Flagler County, Indian River County, Lake County, Orange County, Osceola County, Polk Seminole County, and Volusia County. The socioeconomic resources in this region include the population, economy, transportation system, public and emergency services, and recreational opportunities. Under EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, dated April 21, 1997, federal agencies are encouraged to consider potential impacts of proposed actions on the safety or environmental health of children. Socioeconomic resources and EO 13045 are discussed below.

3.1.7.1. Population

The census population in 2010 and projected populations for 2012 and 2020 for the nine-county region are presented in Table 3-3 (USBC 2013a). The city of Cape Canaveral is the nearest community to CCAFS and KSC, has a population of roughly 9,912 (2010), and is located on the south side of Port Canaveral. Titusville with 43,761 (2010) residents and Merritt Island with 34,763 (2010) residents are located to the west of CCAFS and KSC. In addition, Palm Bay and the Melbourne area, which are communities to the south of CCAFS, have populations between 80,000 and 100,000 (USBC 2013a).

People belonging to the following population groups reside within this region: white, black or African American, American Indian, Alaska native, Asian, native Hawaiian and other Pacific Islander, some other race, two or more races, and Hispanic or Latino (of any race) (USBC 2013c).

Table 3-3 presents the total population in 2010 and the projected total populations for 2012 and 2020 for each of the counties in the nine-county region. Table 3-4 presents the minority population in 2010 and the projected minority population for 2020 for the respective counties.

Table 3-3. Population of the Nine-County Region

Geographic Area	Census Population 2010	Projected Population 2012	Projected Population 2020
Florida	18,801,310	19,317,568	21,528,304
County			
Brevard	543,376	547,307	563,317
Flagler	95,696	98,359	109,773
Indian River	138,028	140,567	151,199
Lake	297,052	303,186	329,015
Orange	1,145,956	1,202,234	1,456,375
Osceola	268,685	287,416	376,341
Polk	602,095	616,158	675,772
Seminole	422,718	430,838	464,908
Volusia	494,593	496,950	506,491
Nine-County Region	4,008,119	4,123,015	4,633,191

Source: Adapted from USBC 2013a, c

Note: Projected population values do not represent absolute limits to growth. For any county, the future population may be above or below the projected value.

Table 3-4. Minority Population of the Nine-County Region

Geographic Area	Minority Population 2010	Percent Minority 2010	Projected Minority Population 2012	Projected Percent Minority 2012	Projected Minority Population 2020	Projected Percent Minority 2020
Florida	4,692,148	25.0%	4,575,052	23.7%	5,098,629	23.7%
County						
Brevard	92,449	17.0%	90,401	16.5%	93,046	16.5%
Flagler	16,986	17.7%	20,485	20.8%	22,862	20.8%
Indian River	21,682	15.7%	19,898	14.2%	21,403	14.2%
Lake	53,428	18.0%	49,126	16.2%	53,311	16.2%
Orange	417,161	36.4%	424,732	35.3%	514,516	35.3%
Osceola	78,044	29.0%	72,216	25.1%	94,559	25.1%
Polk	149,241	24.8%	129,743	21.1%	142,296	21.1%
Seminole	92,054	21.8%	82,176	19.1%	88,674	19.1%
Volusia	86,337	17.5%	83,324	16.8%	84,924	16.8%
Nine-County Region	1,007,382	25.1%	972,101	23.6%	1,115,591	24.1%

Source: Adapted from USBC 2013a, c

Note: Projected population values do not represent absolute limits to growth. For any county, the future population may be above or below the projected value.

According to the Council on Environmental Quality (CEQ 1997), people whose incomes are less than the poverty threshold are defined as low-income. Data from Census 2010 (USBC 2013a) shows that 13.7 percent of the population living within the nine counties reported incomes below the poverty threshold; percentages lower than reported by Florida (14.7 percent) and the United States (14.3 percent).

3.1.7.2. Economy

An estimated 1,858,000 people were employed in the nine-county region in 2012 with an estimated unemployment rate of 8.8 percent (BEBR 2014).

The region's economic base is tourism and manufacturing, with tourism attracting more than 20 million visitors annually. Multiple theme parks, along with KSC, are among the most popular tourist attractions in the state. In 2010, 1.5 million out-of-state tourists visited the KSC Visitor Complex (NASA 2010c). In addition, the cruise and cargo industries at Port Canaveral contribute to the central Florida economy.

Industrial sectors in the region that provided significant employment in 2000 included: education, health and social services; arts, entertainment, recreation, accommodation and food services; retail trade; and professional, scientific, management, administrative, and waste management services (USBC 2000c).

The employment pool at CCAFS includes about 10,000 military and civilian personnel, all associated with the USAF (USAF 2013). Military personnel are attached to the 45th Space Wing at Patrick Air Force Base (PAFB), which is approximately 32 km (20 mi) south of CCAFS. A majority of the employed are contractor personnel from companies associated with missile testing and launch vehicle operations.

In FY 2012, of the $17.8 billion NASA budget, $1.3 billion in wages and purchases within the state of Florida were made by KSC and other NASA centers. For every dollar spent directly by NASA, about an additional dollar was added to the Florida economy, resulting in a total economic impact of $2.15 billion for the state. In addition to the jobs directly associated with KSC (2,100 government workers and 4,900 contractor employees) an additional 16,500 jobs are supported. While the overall NASA impact was significantly lower in FY 2012 from its FY 2009 peak, KSC remains the major economic driver in Brevard County (NASA 2012b). The gross state product of the overall economic activity of Florida for 2012 is estimated to be over $777 billion (BEA 2013).

3.1.7.3. Transportation Systems

The nine-county region is supported by a network of Federal, state and county roads; rail service; three major airports; and a sea port with cargo and cruise terminals (USAF 2002). CCAFS has a runway for government aircraft, delivery of launch vehicle components, and air freight associated with the operation of CCAFS launch complexes.

3.1.7.4. Public and Emergency Services

Emergency medical services for CCAFS and KSC personnel are provided at the Occupational Health Facility and Emergency Aid Clinic at KSC. These facilities are staffed by medical personnel specially trained in the treatment of hazards associated with the facilities and operations at CCAFS and KSC. A Memorandum of Understanding for emergency treatment has been established with a network of hospitals in the region (NASA 2010).

Fire protection at KSC/CCAFS includes a comprehensive program of fire protection engineering, fire prevention, fire suppression and emergency response operations. Specialized equipment and training, suited to the potential fire and emergency hazards of operations, are provided. Three fire stations, one located in the Shuttle Landing Facility/Vehicle Assembly Building Area, one at Pads 39A and 39B, and the other located in the Industrial Area, provide effective coverage for all of KSC/CCAFS. Coordination support agreements between KSC/CCAFS and local municipalities provide for reciprocal support in the event of an emergency or disaster (NASA 2010).

Security forces maintain road access control gates and patrol the KSC/CCAFS perimeter boundary and have coordination agreements to support local municipalities in the event of an emergency or disaster. CCAFS and the Brevard County Office of Emergency Management have agreements for communications and early warning in the event of a launch accident (NASA 2010).

Range Safety at CCAFS monitors launch surveillance areas to ensure that risks to people, aircraft, and surface vessels are within acceptable limits. Control areas and airspace are closed to the public as required. The USAF is responsible for disseminating a "Notice to Aviators" through the Federal Aviation Administration (FAA); and air traffic in a FAA-designated area around the launch corridor is controlled. The USAF also ensures that a "Notice to Mariners" is disseminated within a predetermined impact debris corridor beginning 10 working days prior to a launch. The U.S. Coast Guard transmits marine radio broadcast warnings to inform vessels of the effective closure time for the sea impact debris corridor. Warning signs are posted in various Port Canaveral areas for vessels leaving port (USAF 2004). In addition, PAFB maintains an Internet website and toll-free telephone number with launch hazard area information for mariners and restricted airspace information for pilots.

CCAFS/KSC obtain their potable water from the city of Cocoa water system. The water distribution systems at CCAFS and KSC are sized to accommodate the short-term high-volume flows required for launches

3.1.7.5. Recreation

There is an abundance of public recreational opportunities in the Nine-County Region with beaches, waterways, lakes, open land, and parks. Within the confines of CCAFS, access to recreational areas and facilities is limited to CCAFS personnel.

3.1.7.6. Protection of Children from Environmental Health Risks and Safety Risks

The nearest location to the proposed launch areas containing a moderate concentration of children is the KSC Child Development Center located at least 9.6 km (6.0 miles) away. This is a childcare center with pre-school service available for children ages six weeks to five years old. There are no other schools, daycare facilities, playgrounds, or other places where children are concentrated within CCAFS/KSC.

3.1.8 Cultural and Historic Resources

Cultural resources include prehistoric and historic sites, archeological sites, structures/buildings, districts, historic landscapes, objects, artifacts, cemeteries, traditional cultural properties, sacred sites, monuments and memorials, or any other physical evidence of human activity considered important to a culture or community for scientific, traditional, religious, or any other reasons.

Eighty-eight archaeological sites have been identified on CCAFS and 24 have been determined eligible for listing in the National Register of Historic Places (NRHP) but have not currently been listed. There are numerous historic properties on CCAFS (over 100) including seven cemeteries/grave sites. In addition, there are six CCAFS contributing facilities listed as National Historic Landmarks (NHLs). Four are launch complexes and two are NASA property (LC-5/6 and part of LC-19) and, therefore, are not under the jurisdiction of CCAFS.

At CCAFS, a number of launch pads are listed on the NRHP and form a National Historic Landmark District. No NRHP-listed or eligible prehistoric or historic archaeological sites have been identified at either SLC-37 or SLC-41. However, the north and south area of SLC-41 is considered a “high” zone of archeological potential (Dankert 2014b).

In 1973, LC-39 became the first NASA site at KSC to be listed in the NRHP. The nomination highlighted the national significance of those principal facilities associated with the Apollo Manned Lunar Landing Program. LC-39, built between November 1962 and October 1968, was evaluated as significant in the areas of architecture, communications, engineering, industry, science, transportation, and space exploration (NASA 2010).

As of January 2014, a total of 103 historic properties have been identified within KSC, including 8 historic districts, 32 individually listed or eligible properties, and 69 resources that are contributing to a historic district, but not individually eligible (Dankert 2014b).

3.1.9 Hazardous Materials and Hazardous Wastes

3.1.9.1. Hazardous Materials Management

Numerous types of hazardous materials are used to support the missions and general maintenance operations at CCAFS and KSC. Management of hazardous materials, excluding hazardous fuels, is the responsibility of each individual or organization. Each organization has a supply organization and uses a “pharmacy” control approach to track hazardous materials and to minimize hazardous waste generation, thereby minimizing the use of hazardous materials. The PAFB supply system is the primary method of purchasing or obtaining hazardous materials. Resource Conservation and Recovery Act (RCRA) requirements are accomplished by the directives listed in the respective permits issued to KSC/CCAFS as per 45th SW Operation Plan (OPLAN) 32-3 and Kennedy NASA Procedural Requirement (KNPR 8500.1) (NASA 2010). Liquid propellants would be stored in tanks near the launch pad within appropriate cement containment basins and would be managed by a Launch Service Provider.

3.1.9.2. Hazardous Waste Management at CCAFS

Typical hazardous wastes at CCAFS include various solvents, paints and primers, sealants, photograph-developing solutions, adhesives, alcohol, oils, fuels, and various process chemicals (USAF 1998). Individual contractors and organizations maintain hazardous waste satellite accumulation points (SAPs) and 90-day hazardous waste accumulation areas. A maximum of 208 liters (55 gal) per waste stream of hazardous waste can be accumulated at a SAP. There is no limit to the volume of waste that can be stored at a 90-day accumulation area, but wastes must be taken to the permitted storage facility or disposed of offsite within 90 days. The permitted storage facility (RCRA Part B Permit, Number HO01-255040) is operated within Buildings 44200/44205. The facility is permitted to store hazardous wastes for up to 1 year under the current Florida Department of Environmental Protection (FDEP) permit and is operated by the launch base support contractor. However, the permit does not allow the waste storage site facility to store waste hydrazine, MMH, or nitrogen tetroxide (NTO) (NASA 2011). The 45th SW OPLAN 19-14, Petroleum Products and Hazardous Waste Management Plan, outlines specific measures for proper collection, and management and disposal of petroleum products/waste and hazardous/non-hazardous wastes. In the event of a spill, 45th SW OPLAN 10-2, Vol. 2, 45th SW Hazardous Material Response Plan provides for appropriate reporting and emergency response to mitigate environmental and human health impacts (USAF 2008).

3.1.9.3. Hazardous Waste Management at KSC

The main facility operating under the permitted KSC Transportation, Storage, and Disposal Facility (TSDF) is the Hazardous Waste Storage Facility (K7- 0164 and K7-0165) in the LC-39 area, which handles liquid and solid hazardous wastes. There are four cells at this facility each of which is designated and designed for the storage of specific hazardous wastes. Wastes permitted to be stored include the following: flammable, organic, toxic waste; caustic, toxic, reactive wastes; acidic waste; and solid hazardous and controlled wastes.

The quantity of hazardous and controlled waste generated at KSC depends on launch processing, construction and associated support activities. As part of KSC's waste management and pollution prevention programs, opportunities for waste prevention and reduction are continually assessed and implemented where cost-effective (NASA 2010).

3.1.9.4. Hazardous Waste Clean up

Solid Waste Management Unit (SWMU) 008

LC-39A has been designated as SWMU 008. RCRA Facility Investigation (RFI) activities were performed at LC-39A from early 1998 through mid-2000. In a portion of the site, groundwater impacts due to volatile organic compounds (VOCs) were observed and polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol, and 2, 4, and 6-trichlorophenol were detected above maximum contaminant levels and groundwater cleanup target levels (GCTLs) have been established. Surface water inside and outside of the perimeter fence contained PAHs and metals above surface water cleanup target levels (SWCTLs); some pesticides were also detected outside the fence line. An interim measure was conducted in 2000, which removed soils contaminated with polychlorinated biphenols (PCBs) and PAHs (KSC 2013).

Supplemental RFI activities were performed from mid-2000 through early 2003 to further evaluate the extent of contamination and potential ecological risks to the environment. As a result, groundwater at LC-39A will not be used as a future source of drinking water. Groundwater from the pad area discharges to surrounding surface waters, which are classified as OFW and, therefore, must not receive discharges of contaminants above background levels. A Corrective Measures Study (CMS) work plan has been developed to address groundwater contamination at LC-39A. Metals are present in the swale sediments and a CMS was recommended to evaluate means for controlling potential off-site migration of these contaminants. There are several contaminants in site soils that pose an unacceptable risk to future potential residents. Restrictions are in place for any site work to prevent soils from leaving the area from which they were excavated. An interim measure was completed in 2009 for trichloroethylene-contaminated soils in the area west of the LOx tank. This activity included excavation and disposal of 382 m^3 (500 cubic yards) of contaminated soil. A groundwater plume has been identified in the northwest portion of the pad and is under investigation (KSC 2013).

Sitewide soil and groundwater sampling at various intervals was conducted between December 2011 and October 2012 to determine current baseline conditions and further evaluate contamination resulting from former launch activities. The investigation confirmed the presence of VOCs in groundwater at concentrations greater than FDEP GCTLs. Soils were found to exceed the industrial soil cleanup target levels (SCTLs) for PAHs and PCBs. Additional soil areas have one or more chemicals of concern that exceed residential SCTLs. These contaminants include arsenic, barium, copper, nickel, thallium, PAHs, and PCBs (KSC 2013).

3.1.9.5. Pollution Prevention

CCAFS has a Pollution Prevention Program Guide (PPPG) and Pollution Prevention Management Action Plan. The PPPG establishes the overall strategy, delineates responsibilities, and specifies objectives for reducing pollution of the ground, air, surface water, and groundwater (USAF 1998).

KSC has established a Pollution Prevention Working Group to review all aspects of the KSC Pollution Prevention Program and to identify areas for additional pollution prevention activities. The team consists of KSC and contractor personnel. The NASA Acquisition Pollution Prevention Office assists KSC and other NASA centers in identifying, validating, and implementing less hazardous materials and processes (NASA 2011).

3.1.10 Health and Safety

The areas in and around CCAFS and KSC that could be affected by payload processing, transport, and launch are the subject of health and safety concerns. The objective of the Range Safety Program is to ensure that the general public, launch area personnel, foreign landmasses, and launch area resources are provided an acceptable level of safety, and that all aspects of prelaunch and launch operations adhere to public laws. Range Safety organizations review, approve, monitor, and impose safety holds, when necessary, on all prelaunch and launch operations.

Hazardous materials, such as propellant, ordnance, chemicals, and booster/payload components, are transported in accordance with U.S. Department of Transportation regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199). Hazardous materials, such as liquid rocket propellant, are transported in specially designed containers to reduce the potential risk of an unintentional release should an accident occur (USAF 1998).

3.1.10.1. Regional Safety

Prior to launch of a mission using MMRTGs or LWRHUs, a comprehensive set of plans would be developed by NASA to ensure that any launch accident could be met with a well-developed and tested response. NASA's plans would be developed in accordance with the National Response Framework (NRF) (DHS 2013) and the NRF Nuclear/Radiological Incident Annex (DHS 2008), combined with the efforts of the U.S. Department of Homeland Security (DHS), DHS's Federal Emergency Management Agency, DOE, the U.S. Department of Defense (DoD), the U.S. Department of State (DOS), the U.S. Environmental Protection Agency (EPA), the state of Florida, Brevard County, and local organizations. These organizations and other Federal agencies, as appropriate, could be involved in response to a radiological emergency. Future radiological contingency planning and implementation would be expected to be similar to the process used for the 2011 MSL mission launch (Scott 2012).

3.1.10.2. On-Station Safety

Launches are postponed if Range Safety models predict undue hazards for persons and property due to potential dispersion of hazardous materials or propagation of blast overpressure in the event of a launch vehicle flight termination. The 45th SW has prepared detailed procedures to be used to control toxic gas hazards. Atmospheric dispersion computer models are run to predict toxic hazard corridors (THCs) for both normal and aborted launches, as well as spills or releases of toxic materials from storage tanks, or during loading or unloading of tanks. Range Safety uses the THCs to reduce the risk of exposure of CCAFS and KSC personnel and the general public to toxic materials, including toxic gases.

For a NASA launch, the Launch Disaster Control Group is a joint NASA/USAF emergency response team formed prior to each launch and situated at a fallback location to coordinate emergency response (USAF1998).

The KSC Environmental Justice Plan (KSC 2010) was developed by the Environmental Office in 1997 and was updated in 2010. The purpose of the Environmental Justice Plan is to ensure KSC identifies and addresses activities which have disproportionately high adverse human health or environmental effects on minority or low-income populations in the surrounding Kennedy Space Center community and that the community participates in developing policies to prevent these effects.

KSC is committed to ensuring that the goals of Environmental Justice Strategy are met. Moreover, KSC will continue to communicate with and seek the input of local communities through public meetings, material distributions, information repositories, community events, open houses, press releases and public education campaigns. To ensure that members of the community are well informed of potential adverse environmental impacts from KSC activities, a mailing list with the names of local officials, community leaders, public interest groups, interested individuals, media, and community organizations was compiled. The mailing list is updated as changes are reported (NASA 2010).

3.1.11 Aesthetics

NASA considers the extent to which any lighting or other visual impacts associated with an action would create an annoyance among people in the vicinity or interfere with their normal activities. Visual and aesthetic resources refer to natural or developed landscapes that provide information for an individual to develop their perceptions of the area. Areas such as coastlines, national parks, and recreation or wilderness areas are usually considered to have high visual sensitivity. Heavily industrialized urban areas tend to be the areas of the lowest visual sensitivity. The existing conditions at KSC are characterized as having low visual sensitivity, because the site is currently an industrialized area that supports rocket launches. Notable visual structures include the lightning protection towers at LC-39B. Due to the flat topography and height of the lightning towers (approximately 161 m (528 ft)), the lightning protection towers can be seen several miles away. Existing light sources at KSC include nighttime security lighting at the launch complexes and buildings. NASA has guidelines to address the light impacts to wildlife species under the KSC Light Management Plan (NASA 2002, KSC 2013).

3.2 THE GLOBAL ENVIRONMENT

In accordance with Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*, this section provides a general overview of the global environment. Basic descriptions of the troposphere and stratosphere, global population distribution and density, distribution of land surface types, and a brief discussion of background radiation and the global atmospheric inventory of plutonium are included.

3.2.1 Troposphere

The troposphere is the atmospheric layer closest to the Earth's surface where all life exists and virtually all weather occurs. It extends from the Earth's surface to a height of about 6 to 10 km (20,000 to 33,000 ft) (the lower boundary of the stratosphere). The atmosphere above 900 m (3,000 ft) includes the free troposphere ranging from 900 m (3,000 ft) to between 2 and 10 km (6,600 to 33,000 ft) in altitude and the stratosphere extending from 10 km (33,000 ft) to 50 km (164,000 ft). These boundaries should be taken as approximate annual mean values as the actual level of the boundary between the troposphere and stratosphere (tropopause) is variable on a seasonal and day-to-day basis (NASA 2011).

In general, the troposphere is well mixed and aerosols are removed in a short period of time (ranging from a few days to a few weeks) as a result of both the mixing within this layer and scavenging by precipitation. Removal of most emissions from rocket exhaust products from the troposphere occurs over a period of less than one week, thereby preventing a buildup of these products on a global level (USAF 1998).

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

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

3.2.2 Stratosphere

The stratosphere extends from the tropopause up to an altitude of approximately 50 km (31 mi or 164,000 ft). In general, vertical mixing is limited within the stratosphere, providing little transport between the layers above (mesosphere) and below (troposphere). The lack of vertical mixing and exchange between these layers provides for extremely long residence times, on the order of months, causing the stratosphere to act as a reservoir for certain types of atmospheric pollution (USAF 1998).

The stratospheric ozone absorbs most of the most harmful ultraviolet (UV-B) radiation from the sun. Depletion of ozone following the introduction of man-made materials can result in an increase in solar UV on the ground, which can pose a serious ecological and health hazard. The importance and global nature of the ozone layer requires a careful consideration of all sources of disturbance (NASA 2011).

Solid and liquid rocket propulsion systems emit a variety of gases and particles directly into the stratosphere (WMO 1991). A large fraction of these emissions, carbon dioxide (CO_2) for example, is chemically inert and does not affect ozone levels directly. Other emissions, such as hydrogen chloride (HCl) and water, are not highly reactive, but have an impact on ozone since these gases participate in chemical reactions that help determine the concentrations of the ozone-destroying radical gases. A small fraction of rocket engine emissions are highly reactive radicals. Particulate emissions, such as aluminum oxide powder and carbon (soot), may mimic or enhance the role of natural stratospheric particles by enabling or enhancing ozone-related chemical reactions.

Greenhouse gases absorb the radiant energy from the Sun and Earth. Some of the greenhouse gases (e.g., CO_2, chlorofluorocarbons (CFCs), and water) are emitted during the processes of preparing for and launching spacecraft. Other gases (e.g., NOx and VOCs) emitted from these processes contribute indirectly by forming ozone and other reactive species that photochemically react with greenhouse gases and control the radiation's penetration to the troposphere. Greenhouse gases are thought to potentially have a negative effect on the ozone protective layer of the atmosphere. Research on greenhouse gas production (and possible effects of certain related pollutants, such as pollutants contributing to global warming) is ongoing by the EPA and some states.

The Montreal Protocol is designed to protect the stratospheric ozone layer by phasing out production and consumption of substances that deplete the ozone layer. Measurements have shown that atmospheric concentrations of ozone-depleting substances are decreasing, indicating that emissions have been greatly reduced (EPA 2003).

3.2.3 Orbital Re-entry Debris

Space debris can be classified as either natural or man-made objects. The measured amount of man-made debris equals or exceeds that of natural meteoroids at most low-Earth orbit altitudes (i.e., below 2,000 km (1,200 mi)). Man-made debris consists of material left in Earth orbit from the launch, deployment, deactivation, and fragmentation of spacecraft and launch vehicle components. It exists at all inclinations and has the greatest density at Low Earth Orbit altitudes of approximately 800 to 1,000 km (500 to 625 mi) (UN 1999). Orbital debris moves in many different orbits and directions, at velocities ranging from 3 to over 8 km/s (1.9 to over 5 mi/s) relative to Earth (NASA-HDBK 8719.14).

Reentry debris would include non-recoverable items from launch activities such as jettisoned vehicle stages, as well as recoverable items like solid rocket boosters and manned spacecraft. Impacts from recoverable and non-recoverable components from launch activities are typically planned to occur in broad ocean areas cleared of shipping or air traffic. Reentry is controlled by Range Safety and efforts would be coordinated to reduce the risk to shipping lanes and ensure vessel activity would be outside the launch and reentry zone (NASA 2013a).

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

There are four statutes relating to marine debris: 1) the Marine Plastic Pollution Research and Control Act; 2) the Marine Debris Research, Prevention, and Reduction Act (MDRPRA); 3) the Shore Protection Act; and 4) the Marine Protection, Research, and Sanctuaries Act which regulates the ocean disposal of hazardous waste. The most applicable law governing reentry boosters is the MDRPRA. This Act tasks NOAA and the U.S. Coast Guard to assess, reduce, and prevent marine debris and its adverse impacts on the marine environment and navigation safety (NASA 2013a).

Space programs managed by U.S. Government organizations are directed to follow the U.S. Government Orbital Debris Mitigation Standard Practices. Commercial operations are addressed in regulations by the Department of Transportation, the Department of Commerce, and the Federal Communications Commission.

3.2.4 Global Population Distribution

The distribution of the Earth's population is an important characteristic in considering the potential consequences of accident scenarios. For this purpose, global population statistics and other information are distributed among equal-sized areas (cells) of the Earth's surface. The cells are derived by first dividing the Earth from pole to pole into 20 latitude bands of equal area. Each latitude band is then segmented into 36 equal-sized cells, for a total of 720 cells. Each cell covers an area of 708,438 square kilometers (273,529 square miles) (HNUS 1992).

The total population of the Earth in 2020 is projected to be approximately 7.7 billion people (Lipinski 2014a). Table 3-5 lists the estimated global distribution of the projected population in 2020 across each of the 20 equal-area latitude bands. The greatest population densities occur in a relatively narrow grouping of the five northern bands between latitudes 44° north and 11° north (bands 4 through 8). Florida lies within latitude band 6. Due to launch azimuth angle constraints, launches from CCAFS/KSC to other solar system objects (e.g., planets such as Mars) would partially circle the Earth between 28° north and 28° south latitudes (bands 6 through 15) before departing for interplanetary space.

Table 3-5. Global Population and Surface Characteristics by Latitude Band

Latitude Band	Latitude Range, degrees	Band Population Estimate for 2020, millions	Band Surface Fractions			
			Water	Land	Land Rock Fraction	Land Soil Fraction
1	90N – 64N	5.5	0.7332	0.2668	1.0[a]	0.0[a]
2	64N – 53N	201	0.4085	0.5915	1.0[a]	0.0[a]
3	53N – 44N	597	0.4456	0.5544	0.251[a]	0.749[a]
4	44N – 36N	1020	0.5522	0.4478	0.251	0.749
5	36N – 30N	1250	0.5718	0.4282	0.153	0.847
6	30N – 23N	1490	0.6064	0.3936	0.088	0.912
7	23N – 17N	764	0.6710	0.3290	0.076	0.924
8	17N – 11N	618	0.7514	0.2486	0.058	0.924
9	11N – 5N	562	0.7592	0.2408	0.077	0.923
10	5N – 0	188	0.7854	0.2146	0.084	0.916
11	0 – 5S	217	0.7630	0.2370	0.044	0.956
12	5S – 11S	303	0.7815	0.2185	0.055	0.945
13	11S – 17S	113	0.7799	0.2201	0.085	0.915
14	17S – 23S	118	0.7574	0.2426	0.089	0.911
15	23S – 30S	136	0.7796	0.2204	0.092	0.980
16	30S – 36S	78	0.8646	0.1354	0.112	0.888
17	36S – 44S	20	0.9538	0.0462	0.296	0.704
18	44S – 53S	1.0	0.9784	0.0216	0.296[a]	0.704[a]
19	53S – 64S	0.3	0.9930	0.0070	1.0[a]	0.0[a]
20	64S – 90S	--	0.3863	0.6137	1.0[a]	0.0a

Sources: Population estimates from Lipinski 2014a; Surface characteristics adapted from HNUS 1992

(a) Assumed values

Note: N = North Latitude, S = South Latitude

3.2.5 Earth Surface Characteristics

The worldwide distribution of surface types is also an important characteristic in considering the potential consequences of accident scenarios. Table 3-5 also provides a breakdown of the total land fraction for each of the 20 latitude bands (HNUS 1992). The total land fraction was further subdivided by the fraction consisting of soil or rock cover. For the most densely populated bands (bands 4 through 8), the land fraction varies from about 25 percent in band 8 to about 45 percent in band 4, and is predominately soil (from about 75 percent in band 4 to about 92 percent in bands 7 and 8).

3.2.6 Background Radiation

3.2.6.1. Natural and Manmade Sources

The general population is exposed to various sources of natural and human-made radiation. These sources are divided into six broad categories: (1) cosmic radiation (from space), (2) external terrestrial radiation or groundshine (from naturally occurring radiation in rocks and soil), (3) internal radiation (from inhalation or ingestion), (4) consumer products (from smoke detectors, airport x-ray machines, televisions), (5) medical diagnosis and therapy (e.g., diagnostic x-rays, nuclear medical procedures), and (6) other sources (e.g., nuclear power plants, transportation).

Dose is the amount of ionizing radiation energy deposited in body tissues via various exposure pathways and is expressed in units of measurement called rem, (Roentgen equivalent in man). An average person in the United States receives a total dose of about 0.31 rem per year from all natural sources (see Table 3-6).

The average dose from man-made sources is also about 0.31rem. Exposure to radon, the largest component of natural background radiation, accounts for about 74 percent or 0.23 rem of the yearly total natural dose received. Exposure to cosmic and terrestrial radiation collectively is about 16 percent of the yearly total natural dose. The dominant contributor to the man-made dose is from medical uses, nuclear medicine, and medical procedures. The dose from these two sources has increased dramatically in recent years with the increase in the use of technologies such as computed tomography (commonly referred to as CT scans). A single CT scan can result in a dose of anywhere between 0.1 and 2 rem. For perspective, a simple chest x-ray results in a dose of about 0.002 rem, and about 0.065 rem is received from a diagnostic pelvic and hip x-ray. Not everyone is subject to exposure and subsequent dose from the medical sources; the dominant contributor to man-made background doses. There is a wide disparity in the background dose to people who receive medical doses and those that don't.

Table 3-6. Average Annual Effective Dose Equivalent of Ionizing Radiation to a Member of the U.S. Population

Source	Effective Dose Equivalent[a]	
	rem per year	percent of total
Natural		
Radon[b]	0.229	37
Cosmic	0.032	5
Terrestrial	0.019	5
Internal	0.031	5
Subtotal — Natural	0.310	50
Manmade		
Medical procedures	0.223	36
Nuclear medicine	0.074	12
Consumer products	0.012	2
Industrial	<0.6	0.1
Subtotal — Manmade	0.310	50
Total Natural and Manmade	**0.620**	**100**

Source: NRC 2011

(a) Effective dose equivalent is proportional to incremental risk in cancer.

(b) Dose equivalent to bronchi from radon decay products. The assumed weighting factor for the effective dose equivalent relative to whole-body exposure is 0.08.

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Due to its low elevation, Florida receives less exposure to cosmic radiation than most parts of the country (HPS 2014). Assessments performed by the U.S. Geological Survey and the U.S. Environmental Protection Agency indicate that KSC, CCAFS, and adjacent communities have a low potential for geologic radon (USGS 1995). In other categories of background radiation exposure, Florida is consistent with the national average.

3.2.6.2. Worldwide Plutonium Levels

Plutonium-238 (Pu-238) exists in the environment as a result of atmospheric testing of nuclear weapons and a 1964 launch accident. The following information provides a perspective against which to compare the scope of postulated incremental releases of plutonium from potential mission accidents.

Between 1945 and 1974, aboveground nuclear weapons tests released about 440,000 curies (Ci) of plutonium to the environment (AEC 1974). About 97 percent (approximately 430,000 Ci) of this plutonium was Pu-239 and Pu-240, essentially identical isotopes with respect to chemical behavior and radiological emission energies. The remainder consists primarily of Pu-238 (approximately 9,000 Ci), along with much smaller amounts of Pu-241 and Pu-242. (Some of the Pu-238 and Pu-241 have decayed since the time of release.) About 9,000 Ci of Pu-238 was released to the atmosphere from weapons tests.

The 1964 reentry and burn-up of a Systems for Nuclear Auxiliary Power (SNAP)-9A radioisotope thermoelectric generator (RTG) released 17,000 Ci of Pu-238 into the atmosphere. This release occurred because the RTG design philosophy of the time was to not contain the plutonium. Since 1964, essentially all of the Pu-238 released from SNAP-9A has been deposited on the Earth's surface (AEC 1974). About 25 percent (approximately 4,000 Ci) of that 1964 release was deposited in the northern hemisphere, with the remaining 75 percent settling in the southern hemisphere. In April 1986, approximately 369,000,000 Ci of various radioisotopes were released to the environment from the Chernobyl nuclear power station accident (IAEA 2005a). Approximately 400 Ci of the total Chernobyl release was Pu-238.

The total plutonium released to the ocean environment by overseas nuclear reprocessing plants between 1952 and 1992 was more than 100,000 Ci (Gray et al. 1995), of which approximately 3,400 Ci was Pu-238 (Gray et al. 1995; IAEA 2005b; OSPAR 2005), bringing the total amount of Pu-238 dispersed into the environment to about 38,800 Ci.

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