**National Aeronautics and Space Administration**

**January 2008**

# Final Constellation Programmatic Environmental Impact Statement

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# FINAL CONSTELLATION PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

**LEAD AGENCY:** National Aeronautics and Space Administration (NASA), Washington, DC 20546

**PROPOSED ACTION:** NASA proposes to continue preparations for and to implement the Constellation Program, a coordinated effort to provide the necessary flight systems and Earth-based ground infrastructure required to enable continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond.

**FOR FURTHER INFORMATION:**
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**LOCATION:** Principal locations include Brevard and Volusia Counties, Florida; Hancock County, Mississippi; Orleans Parish, Louisiana; Harris County, Texas; Madison County, Alabama; Cuyahoga and Erie Counties, Ohio; Hampton, Virginia; Santa Clara County, California; Doña Ana and Otero Counties, New Mexico; and Box Elder and Davis Counties, Utah

**DATE:** January 2008

**ABSTRACT:** NASA's *Final Constellation Programmatic Environmental Impact Statement* (PEIS) addresses the environmental impacts associated with the Proposed Action (Preferred Alternative) and the No Action Alternative. The purpose of the Constellation Program is to develop the flight systems and Earth-based ground infrastructure required to enable continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond. The Constellation Program would be responsible for development and testing of flight hardware, and for performing mission operations once the infrastructure is sufficiently developed. The environmental impacts of principal concern are those that would result from fabrication, testing, and launching of the Orion spacecraft and the Ares I and Ares V launch vehicles. Under the No Action Alternative, NASA would not implement the Constellation Program and would not build the necessary flight systems and ground infrastructure for human space missions following retirement of the Space Shuttle fleet by 2010.

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# ABBREVIATIONS AND ACRONYMS

## A

| | |
|---|---|
| ac | acre(s) |
| ACHP | Advisory Council on Historic Preservation |
| AIHA | American Industrial Hygiene Association |
| $Al_2O_3$ | aluminum oxide |
| ARC | Ames Research Center |
| ARF | Assembly and Refurbishment Facility |
| ASTF | Aft Skirt Test Facility |
| ATK | Alliant Techsystems-Launch Systems Group |

## C

| | |
|---|---|
| °C | degree(s) Celsius |
| CAA | Clean Air Act |
| CAIB | Columbia Accident Investigation Board |
| CAIL | CEV Avionics Integration Laboratory |
| CaLV | Cargo Launch Vehicle |
| CAT | Computer-Aided Tomography |
| CCAFS | Cape Canaveral Air Force Station |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CEV | Crew Exploration Vehicle |
| CFC | chlorofluorocarbon |
| CFR | Code of Federal Regulations |
| Cl | Chlorine (element) |
| $Cl_2$ | Chlorine (gas) |
| CLV | Crew Launch Vehicle |
| cm | centimeter(s) |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| CONUS | Continental U.S. |
| CRC | Clearfield Refurbishment Center |
| CRMP | Cultural Resources Management Plan |
| CWA | Clean Water Act |

## D

| | |
|---|---|
| dB | decibel(s) |
| dBA | decibel(s) (A-weighted) |
| DCE | Dichloroethene |
| DFRC | Dryden Flight Research Center |
| DOD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| DOI | U.S. Department of the Interior |
| DOT | U.S. Department of Transportation |

## E

| | |
|---|---|
| EA | Environmental Assessment |
| EDS | Earth Departure Stage |
| EIS | Environmental Impact Statement |
| EO | Executive Order |
| EPA | U.S. Environmental Protection Agency |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| EPRG | Emergency Planning Response Guide(s) |
| ERD | Environmental Resources Document |
| ESA | Endangered Species Act |
| ESAS | Exploration Systems Architecture Study |
| ESMD | Exploration Systems Mission Directorate |
| EVA | Extravehicular Activity(ies) |

## F

| | |
|---|---|
| °F | degree(s) Fahrenheit |
| FAC | Florida Administrative Code |
| FEIS | Final Environmental Impact Statement |
| FEMA | Federal Emergency Management Agency |
| FONSI | Finding of No Significant Impact |
| FR | Federal Register |
| ft | foot (feet) |
| $ft^2$ | square foot (feet) |
| $ft^3$ | cubic foot (feet) |

## G

| | |
|---|---|
| g | gram(s) |
| gal | gallon(s) |
| GRC | John H. Glenn Research Center |
| GSFC | Goddard Space Flight Center |

## ABBREVIATIONS AND ACRONYMS (Cont.)

**H**

| | |
|---|---|
| ha | hectare(s) |
| HAP | hazardous air pollutant(s) |
| HCFC | hydrochlorofluorocarbon |
| HCl | hydrogen chloride or hydrochloric acid |
| HMTA | Hazardous Materials Transportation Act |
| $HNO_3$ | Nitric acid |
| HTPB | hydroxyl terminated polybutadiene |

**I**

| | |
|---|---|
| in | inch(es) |
| Isp | specific impulse |

**J**

| | |
|---|---|
| JPL | Jet Propulsion Laboratory |
| JSC | Lyndon B. Johnson Space Center |

**K**

| | |
|---|---|
| kg | kilogram(s) |
| kl | kilolitre(s) |
| km | kilometer(s) |
| kPa | kilopascal(s) |
| KSC | John F. Kennedy Space Center |

**L**

| | |
|---|---|
| l | liter(s) |
| LAFB | Langley Air Force Base |
| LaRC | Langley Research Center |
| lb | pound(s) |
| lbf | pound(s) force |
| LC | Launch Complex |
| LCC | Launch Control Center |
| LEO | low Earth orbit |
| LH | liquid hydrogen |
| LLO | low lunar orbit |
| LOX | liquid oxygen |
| LSAM | Lunar Surface Access Module |

**M**

| | |
|---|---|
| $\mu g/m^3$ | microgram(s) per cubic meter |
| m | meter(s) |
| $m^2$ | square meter(s) |
| $m^3$ | cubic meter(s) |
| MAF | Michoud Assembly Facility |
| MARPOL | marine pollution (treaty abbreviation) |
| $mg/m^3$ | milligram(s) per cubic meter |
| mgd | million gallons per day |
| mi | mile(s) |
| min | minute(s) |
| MINWR | Merritt Island National Wildlife Refuge |
| ML | Mobile Launcher |
| Mlb | million pounds |
| MLP | Mobile Launch Platform |
| MPPF | Multi-Payload Processing Facility |
| MRI | Magnetic Resonance Imaging |
| MSFC | George C. Marshall Space Flight Center |
| mt, mT | metric ton |
| MTV | Mars Transfer Vehicle |

**N**

| | |
|---|---|
| N | Newton(s) |
| $N/m^2$ | Newton(s) per square meter |
| $N_2H_4$ | hydrazine |
| $N_2O_4$ | nitrogen tetroxide |
| NAAQS | National Ambient Air Quality Standards |
| NASA | National Aeronautics and Space Administration |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NIOSH | National Institute of Occupational Safety and Health |
| nm, nmi | nautical mile(s) |
| NO | nitrogen oxide |
| $NO_2$ | nitrogen dioxide |
| NOI | Notice of Intent |
| NOTAM | Notices to Airmen |
| $NO_x$ | nitrogen oxides |
| NPD | NASA Policy Directive |
| NPDES | National Pollutant Discharge Elimination System |
| NPR | NASA Procedural Requirements |
| NRHP | National Register of Historic Places |
| NTP | Nuclear Thermal Propulsion |

## ABBREVIATIONS AND ACRONYMS (Cont.)

**O**

| | |
|---|---|
| O&C | Operations and Checkout (building) |
| $O_3$ | ozone |
| ODS | Ozone Depleting Substances |
| OSF | Ordnance Storage Facility |
| OSHA | Occupational Safety and Health Administration |
| oz | ounce(s) |

**P**

| | |
|---|---|
| 1,1,2,2-PCA | 1,1,2,2-tetrachloroethane |
| Pb | lead (metal) |
| PBAN | polybutadiene acrylonitrile |
| PBS | Plum Brook Station |
| PCB | polychlorinated biphenyl |
| PCE | tetrachloroethene |
| PCT | Polychlorinated terphenyl |
| PEIS | Programmatic Environmental Impact Statement |
| pH | measure of acidity (log of hydrogen ions) |
| PICA | Phenolic Impregnated Carbon Ablator |
| PM | particulate matter |
| PPA | Pollution Prevention Act |
| ppm | parts per million |
| PRF | Parachute Refurbishment Facility |
| PSD | Prevention of Significant Deterioration |
| psf | pounds per square foot |

**R**

| | |
|---|---|
| RCRA | Resource Conservation and Recovery Act |
| REL | Recommended Exposure Limit |
| ROD | Record of Decision |
| RPSF | Rotation, Processing, and Surge Facility |
| RSRB | Reusable Solid Rocket Booster |

**S**

| | |
|---|---|
| sec | second(s) |
| scf | standard cubic feet |
| SHPO | State Historic Preservation Officer |
| SIP | State Implementation Plan |
| SM | Service Module |
| $SO_2$ | sulfur dioxide |
| $SO_x$ | sulfur oxides |
| SRB | Solid Rocket Booster |
| SRM | Solid Rocket Motor |
| SSC | John C. Stennis Space Center |
| SSPF | Space Station Processing Facility |

**T**

| | |
|---|---|
| 1,1,1-TCA | 1,1,1-Trichloroethane |
| t | ton |
| TCA | trichloroethane |
| TCE | trichloroethene |
| TMDL | total maximum daily load |
| TNT | trinitrotoluene |
| TRI | Toxic Release Inventory |
| TSCA | Toxic Substances Control Act |
| TSP | Total Suspended Particulates |

**U**

| | |
|---|---|
| U.S. | United States |
| U.S.C. | United States Code |
| UNCLOS | United Nations Convention on the Law of the Sea |
| USAF | U.S. Air Force |
| USFWS | U.S. Fish and Wildlife Service |

**V**

| | |
|---|---|
| VAB | Vehicle Assembly Building |
| VOC | volatile organic compound(s) |
| VPF | Vertical Processing Facility |

**W**

| | |
|---|---|
| WSMR | White Sands Missile Range |
| WSTF | White Sands Test Facility |

## COMMON METRIC/BRITISH SYSTEM EQUIVALENTS

### Length

| | |
|---|---|
| 1 centimeter (cm) = 0.3937 inch (in.) | 1 in = 2.54 cm |
| 1 centimeter = 0.0328 foot (ft) | 1 ft = 30.48 cm |
| 1 meter (m) = 3.2808 feet | 1 ft = 0.3048 m |
| 1 meter = 0.0006 mile (mi) | 1 mi = 1609.3440 m |
| 1 kilometer (km) = 0.6214 mile | 1 mi = 1.6093 km |
| 1 kilometer = 0.53996 nautical mile (nmi or nm) | 1 nmi = 1.8520 km |
| 1 mile = 0.87 nautical miles | 1 nmi = 1.15 mi |

### Area

| | |
|---|---|
| 1 square centimeter ($cm^2$) = 0.1550 square inch ($in^2$) | 1 $in^2$ = 6.4516 $cm^2$ |
| 1 square meter ($m^2$) = 10.7639 square feet ($ft^2$) | 1 $ft^2$ = 0.09290 $m^2$ |
| 1 square kilometer ($km^2$) = 0.3861 square mile ($mi^2$) | 1 $mi^2$= 2.5900 $km^2$ |
| 1 hectare (ha) = 2.4710 acres (ac) | 1 ac = 0.4047 ha |
| 1 hectare = 10,000 square meters ($m^2$) | 1 $m^2$ = 0.0001 ha |

### Volume

| | |
|---|---|
| 1 cubic centimeter ($cm^3$) = 0.0610 cubic inch ($in^3$) | 1 $in^3$ = 16.3871 $cm^3$ |
| 1 cubic meter ($m^3$) = 35.3147 cubic feet ($ft^3$) | 1 $ft^3$ = 0.0283 $m^3$ |
| 1 cubic meter = 1.308 cubic yards ($yd^3$) | 1 $yd^3$ = 0.76455 $m^3$ |
| 1 liter (l) = 1.0567 quarts (qt) | 1 qt = 0.9463264 l |
| 1 liter = 0.2642 gallon (gal) | 1 gal = 3.7845 l |
| 1 kiloliter (kl) = 264.2 gallon | 1 gal = 0.0038 kl |

### Mass

| | |
|---|---|
| 1 gram (g) = 0.0353 ounce (oz) | 1 oz = 28.3495 g |
| 1 kilogram (kg) = 2.2046 pounds (lb) | 1 lb = 0.4536 kg |
| 1 metric ton (mt) = 1.1023 tons | 1 ton = 0.9072 mt |

### Pressure

| | |
|---|---|
| 1 newton/square meter ($N/m^2$) = 0.0208 pound/square foot (psf) | 1 psf = 48 $N/m^2$ |
| 1 kilopascal (kPa) = 20.885 pounds/square foot (psf) | 1 psf = 0.04788 kPa |

### Force

| | |
|---|---|
| 1 newton (N) = 0.2248 pound-force (lb-f) | 1 lb-f = 4.4478 N |

### Energy

| | |
|---|---|
| 1 Joule (J) = $9.478 \times 10^{-4}$ British thermal units (Btu) | 1 Btu = 1,055.05 J |

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# EXECUTIVE SUMMARY

This *Final Constellation Programmatic Environmental Impact Statement* has been prepared by the National Aeronautics and Space Administration (NASA) to assist in the decision-making process as required by the National Environmental Policy Act of 1969, as amended (NEPA) (42 United States Code [U.S.C.] 4321 *et seq*.); Council on Environmental Quality regulations for implementing the procedural provisions of NEPA (40 Code of Federal Regulations [CFR] parts 1500-1508); NASA policies and procedures at 14 CFR subpart 1216.3; and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*.

**CONSTELLATION PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT ROADMAP**

**Chapter 1: Purpose and Need for Action**

- Describes the purpose and need for the Constellation Program

**Chapter 2: Description and Comparison of Alternatives**

- Describes the Proposed Action (Preferred Alternative), the Constellation Program and its constituent Projects
- Describes the No Action Alternative
- Briefly describes alternatives considered but eliminated from further evaluation
- Summarizes and contrasts the environmental impacts of the Proposed Action and the No Action Alternative

**Chapter 3: Description of the Affected Environment**

- Describes the existing environmental resources (*e.g.*, land, air, and water) at the primary NASA, other government, and commercial facilities where potentially significant impacts from implementing the Constellation Program work could occur.
- Describes the global environment

**Chapter 4: Environment Consequences of Alternatives**

- Describes environmental impacts of implementing the Proposed Action and the No Action Alternative relevant to each environmental resource
- Identifies incomplete and unavailable information
- Lists Federal, state, or local permits, licenses, or consultations required for implementing the Proposed Action

**Chapter 5: Mitigation Measures**

- Describes mitigation measures to reduce or avoid potential environmental impacts

## ES.1 BACKGROUND

In 2004, President George W. Bush announced a new exploration initiative (the *Vision for Space Exploration*) to return humans to the Moon by 2020 in preparation for human exploration of Mars and beyond. As part of this initiative, NASA will continue to use the Space Shuttle fleet to fulfill its obligation to complete assembly of the International Space Station and then retire the fleet by 2010. As the first step toward developing the vehicles to explore the Moon, Mars, and beyond, the President directed NASA to build and fly a new Crew Exploration Vehicle (CEV [since named Orion]) by 2014. The Orion spacecraft would be capable of transporting humans to the International Space Station, the Moon, and would be used on future missions to Mars and beyond.

Congress expressly endorsed the President's exploration initiative and provided additional direction for the initiative in the NASA Authorization Act of 2005, authorizing NASA to "…establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations" (Pub. L. 109-155).

In response to the President's exploration initiative, NASA Administrator Michael Griffin commissioned the Exploration Systems Architecture Study (ESAS) to perform four specific tasks:

1. Complete assessment of the top-level CEV requirements and plans to enable the CEV to provide crew transport to the International Space Station and to accelerate the development of the CEV and crew launch system to reduce the gap between Space Shuttle retirement and CEV initial operational capability
2. Provide definition of top-level requirements and configurations for crew and cargo launch systems to support the lunar and Mars exploration programs
3. Develop a reference lunar exploration architecture concept to support sustained human and robotic lunar exploration operations
4. Identify key technologies required to enable and significantly enhance these reference exploration systems and reprioritize near- and far-term technology investments.

The ESAS Team examined multiple combinations of launch elements for crew and cargo missions, including launch vehicles derived from the Space Shuttle and from current and proposed U.S. heavy-lift launch vehicles (*e.g.*, Delta IV and Atlas V launch vehicles). The ESAS Team also developed new architecture-level requirements and an overall approach to meet the human exploration goals of the exploration initiative.

In order to meet the goals of the exploration initiative and to accomplish the specific directives given to NASA by the President and Congress, NASA initiated and is in the early planning stages of the proposed Constellation Program. The Constellation Program used the ESAS Team's recommendations and the underlying Presidential and Congressional directives as a starting point and has continued to refine the mission requirements, evaluate capabilities for the technologies studied by the ESAS Team, and perform more detailed examination of the developmental requirements. The Constellation Program would develop the flight systems and Earth-based ground infrastructure necessary to enable continued human access to space.

As envisioned by NASA, an incremental buildup would begin with up to four person crews making several short-duration trips of up to 14 days to the Moon until power supplies, rovers, and living quarters would become operational. These would be followed by long-duration human lunar missions increasing up to 180 days.

## ES.2 PURPOSE AND NEED OF THE ACTION

The 2004 announcement by President Bush set the long-term goals and objectives for the Nation's space exploration efforts. The underlying goals, and hence the need for NASA action, are to advance the Nation's scientific, security, and economic interests through a robust space exploration program. In achieving this goal, the U.S. will pursue the following initiatives:

- Implement a sustained and affordable human and robotic program to explore the Solar System and beyond
- Extend human presence across the Solar System, starting with a return of humans to the Moon by 2020 in preparation for human exploration of Mars and other Solar System destinations
- Develop innovative technologies, knowledge, and infrastructure both to explore and to support decisions about the destinations for human exploration
- Promote international and commercial participation in this new space exploration program.

As the lead agency, NASA was tasked with development of the plans, programs, and activities required to implement the Nation's space exploration efforts. The following directives were among those given to NASA in the NASA Authorization Act of 2005 and/or the President's announcement of the *Vision for Space Exploration*:

- Develop a crew exploration vehicle to replace the Space Shuttle fleet by 2014, and as close to 2010 as possible
- To the fullest extent possible consistent with a successful development program, use the personnel, capabilities, assets, and infrastructure of the Space Shuttle Program in developing the Crew Exploration Vehicle, Crew Launch Vehicle, and a heavy-lift launch vehicle
- Undertake lunar exploration activities directed at enabling robotic and human exploration of Mars and beyond
- Conduct the first extended human exploration mission to the lunar surface by the end of the next decade
- Use the knowledge gained from successful sustained human exploration of the Moon and robotic exploration of Mars, conduct human exploration expeditions to Mars and, ultimately, other destinations in our Solar System.

The purpose of NASA's Proposed Action (Preferred Alternative) is to undertake the activities necessary to pursue the human exploration elements of these directives, including developing the flight systems and ground infrastructure required to enable continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond. Robotic exploration activities are the responsibility of other NASA programs and are subject to separate NEPA review and documentation, as appropriate.

NASA's current human space flight system, the Space Shuttle, is not suited for human travel beyond low Earth orbit. To fulfill the purpose outlined in the President's exploration initiative, and to accomplish the specific directives given to NASA by the President and Congress, NASA proposes to continue preparations for and to implement the Constellation Program and develop a new class of exploration vehicles and the infrastructure necessary to support their development and use in space exploration.

The vehicles to be developed include the Orion spacecraft (see Figure ES-1) and two launch vehicles, the Crew Launch Vehicle (CLV [since named Ares I]) (see Figure ES-2) and a Cargo Launch Vehicle (CaLV [since named Ares V]) (see Figure ES-3). The Orion spacecraft, launched atop the Ares I, would be capable of docking with the International Space Station or docking with cargo launched to low Earth orbit by the Ares V for transit to the Moon or future missions to Mars.

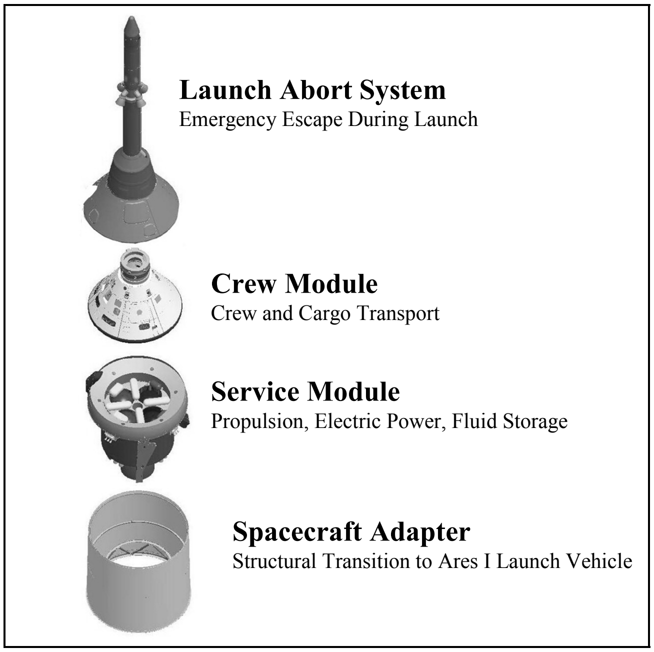


**Figure ES-1. Orion Spacecraft Modules**

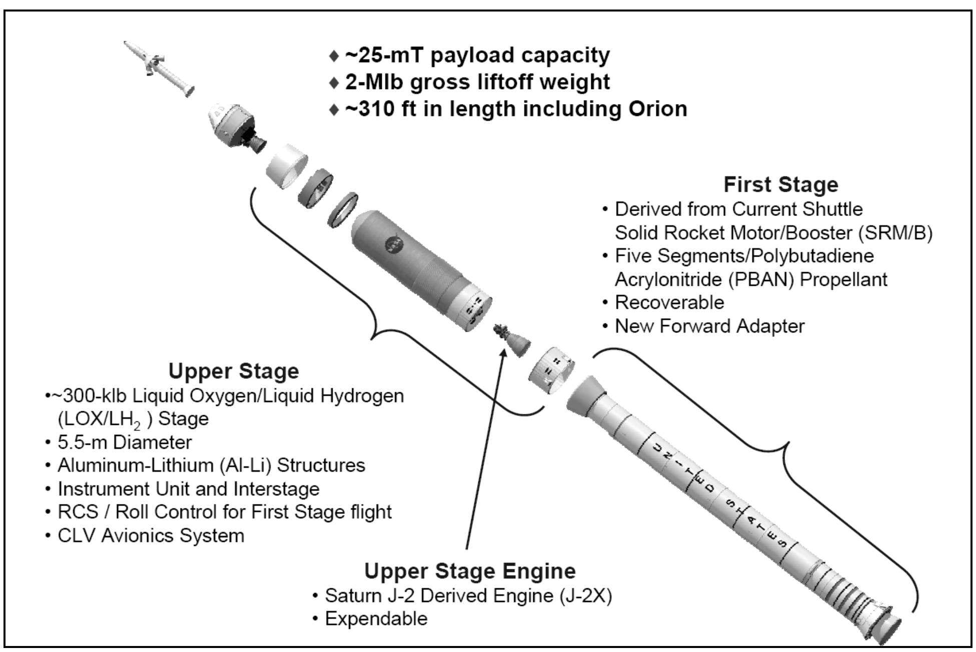


**Figure ES-2. Ares I Launch Vehicle**

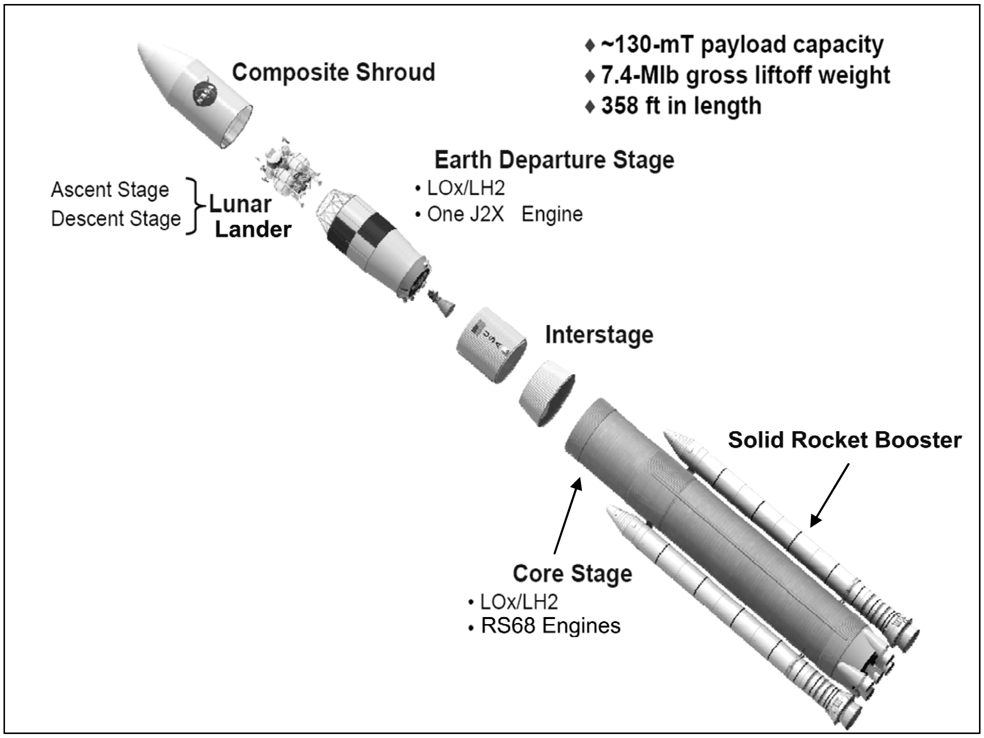


**Figure ES-3. Ares V Launch Vehicle**

Beyond meeting the needs of future human space flight, the Constellation Program would greatly enhance NASA's ability to meet other broad goals set for the U.S. Space Program. Historically, the U.S. Space Program has produced technological advances that have tangible, global benefits. For example, advances in weather forecasting, communications, computing, search and rescue technology, robotics, and electronics are direct results of the U.S. Space Program. Medical technologies, such as computer-aided tomography (CAT) scanners and magnetic resonance imaging (MRI) machines, are also derived from technologies developed for the use in space. These benefits have come directly from activities at NASA and from activities inspired by the discoveries and advancements made through NASA programs. The Constellation Program would continue to provide the opportunity for such advancements by contributing to:

- The extension of human presence beyond Earth orbit
- The pursuit of scientific activities that address fundamental questions about the history of Earth, the Solar System, and the Universe
- A challenging, shared peaceful experience that unites nations in pursuit of common objectives
- The expansion of Earth's economic sphere and conducting activities with benefits to life on Earth
- A vibrant space exploration program to engage the public, encourage students, and help develop the high-tech workforce that will be required to address the challenges of tomorrow.

As directed by the President, retirement of the Space Shuttle fleet is expected to occur by 2010 and is a separate action from the Constellation Program. The environmental impacts associated with retiring the Space Shuttle fleet will be addressed in the *Draft Programmatic Environmental Assessment for Space Shuttle Program Transition and Retirement*, which is scheduled to be released by NASA for public review and comment in early 2008.

## ES.3 NEPA ACTIVITIES FOR THE CONSTELLATION PROGRAM

### ES.3.1 NEPA Planning and Scoping Activities

On September 26, 2006, NASA published a Notice of Intent (NOI) in the *Federal Register* (*FR*) (71 *FR* 56183) to prepare a Draft Programmatic Environmental Impact Statement (PEIS) and conduct scoping for the Constellation Program. Scoping meetings to solicit public input on environmental concerns and alternatives to be considered in the PEIS were held on October 18, 2006 in Cocoa, Florida; on October 20, 2006 in Washington, DC; and on October 24, 2006 in Salt Lake City, Utah. Comments were solicited from Federal, state, and local agencies and other interested parties on the scope of the Constellation Program. Scoping comments were received from private organizations and individuals in the form of letters, electronic mail, telephone messages, and oral and written comments provided at the public scoping meetings. The scoping period ended on November 13, 2006. The scoping comments expressed concerns or questions about both technological and environmental issues.

The following issues were identified through the public scoping process and are addressed briefly in Section ES.7 and in detail in Chapter 4 of this Final PEIS:

- The economic impact of the Constellation Program, locally and nationally, with an emphasis on the impact of the Program on jobs near NASA Centers
- Risks to the public associated with launch and Earth atmospheric entry
- Environmental impacts of the use of solid rocket fuels on the ozone layer and impacts associated with the deposition of combustion products near the launch area
- Impacts on local animal species (*e.g.*, sea turtles and manatees) associated with construction and launch activities in the John F. Kennedy Space Center (KSC) area
- Noise impacts associated with launch events
- The relationship between the Constellation Program and the Space Shuttle Program, including how the socioeconomic impacts of the Space Shuttle retirement and the Constellation Program overlap.

Additional technology-related issues that were identified and are addressed in detail in Chapter 2, Section 2.3 of this Final PEIS include:

- Alternative technologies to be used for the launch vehicles, including the possibility of using Evolved Expendable Launch Vehicles (*i.e.*, Atlas V and Delta IV launch vehicles) developed by the U.S. Air Force (USAF) instead of developing new launch vehicles
- Involvement of entities other than NASA in the development of the launch systems, in particular potential international partnerships and partnerships with private industry.

Issues raised that are outside the scope of this Final PEIS include the following:

- Possible military applications associated with the Constellation Program
- Legal issues associated with the use of the Moon and its raw materials
- Environmental impacts in outer space, including impacts on the Moon
- Use of nuclear systems in support of the Constellation Program (Future program activities may benefit from use of nuclear systems in areas such as planetary electrical power generation or interplanetary propulsion. Technical studies will be conducted to determine whether nuclear-based systems can safely and affordably enhance future mission capabilities. Any future activities associated with development and use of nuclear systems for the Constellation Program would be subject to separate NEPA review and documentation, as appropriate)
- Maintaining funding for the Constellation Program for the extended period required to meet the Program's goals
- The possible gap in the ability of the U.S. to provide crew transport to the International Space Station
- Supply of crew and/or cargo to the International Space Station by commercial entities (which would be subject to separate NEPA review and documentation, as appropriate, by NASA independently or in connection with the Federal Aviation Administration commercial licensing process).

An additional issue that was raised which is relevant to the Constellation Program, but not addressed fully in this Final PEIS, involves traffic impacts (*e.g.*, congestion and emissions) associated with landing events at a terrestrial landing site. Impacts associated with terrestrial landing sites would be addressed in separate NEPA documentation, as appropriate.

### ES.3.2 Results of Public Review of the Draft PEIS

NASA published a Notice of Availability (NOA) of the *Draft Constellation Programmatic Environmental Impact Statement* on August 17, 2007 (72 *FR* 46218). NASA mailed over 300 hard copies and/or compact disks (CDs) of the Draft PEIS to potentially interested Federal, state, and local agencies; organizations; and individuals. In addition, the Draft PEIS was made publicly available in electronic format on NASA's web site. NASA also sent electronic mail (e-mail) notifications to potentially interested individuals who had submitted scoping comments via e-mail but who had not provided a mailing address.

The public review and comment period for the Draft PEIS closed on September 30, 2007. NASA received a total of 21 submissions (letters and e-mails) from Federal, state, and local agencies; organizations; and individuals, of which, 14 submissions contained comments regarding the Constellation Program. Seven submissions only requested to be added to the mailing list to receive a copy of the Final PEIS. The comment submissions included concerns regarding:

- Establishing a light management plan at KSC
- Establishing a monitoring program for bird strikes at KSC

- Water quality, air quality, and hazardous wastes at the U.S. Army's White Sands Missile Range (WSMR)
- Performing a coastal zone consistency determination for Langley Research Center (LaRC)
- Raising awareness of metals in the environment
- Environmental impacts in outer space, including impacts on the Moon.

All comment submissions received by NASA during the Draft PEIS public review period can be found in Appendix B of this Final PEIS, along with NASA's responses to specific comments. No alternatives to the Proposed Action were raised during the public review of the Draft PEIS.

## ES.4 ALTERNATIVES EVALUATED

Two alternatives are evaluated in this Final PEIS: 1) the Proposed Action (Preferred Alternative) – to continue preparations for and to implement the Constellation Program; and 2) the No Action Alternative – do not continue preparations for nor implement the Constellation Program.

NASA also considered alternatives to the Proposed Action that were not evaluated further. These included modifying the Space Shuttle fleet, purchasing space transportation services for human exploration of space from foreign governments, varied designs and configurations for the CEV (*i.e.*, Orion) spacecraft, and multiple launch vehicle options for both crew and cargo launches. These alternatives were eliminated from further evaluation based on various considerations, including safety, technical feasibility, cost, development time and risk, and consistency with Presidential and Congressional directives.

### ES.4.1 Proposed Action (Preferred Alternative)

NASA proposes to continue preparations for and to implement the Constellation Program, using the ESAS and the underlying Presidential and Congressional directives as a starting point. The focus of the Constellation Program is the development of the flight systems and Earth-based ground infrastructure required to enable continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond. The Constellation Program also would be responsible for the development and testing of flight hardware and for performing mission operations once the infrastructure is sufficiently developed.

The Constellation Program would be an extremely large and complex program spanning decades and requiring the efforts of a broad spectrum of talent located throughout NASA and in private industry. Figure ES-4 provides a high-level schedule for the Constellation Program, shown in conjunction with related NASA initiatives. The Constellation Program would first undertake developing the infrastructure and systems necessary to support the International Space Station and return humans to the Moon. This initial effort would then be directed towards developing the capability to extend human exploration to Mars and beyond. The first crewed missions using the Orion spacecraft and the Ares I launch vehicle are proposed by 2014, and would provide crew transport to the International Space Station. Once operational, up to five flights per year are anticipated until the end of International Space Station operations (U.S. commitment to International Space Station operations extends well into the next decade). The first human mission to the Moon is proposed by 2020.

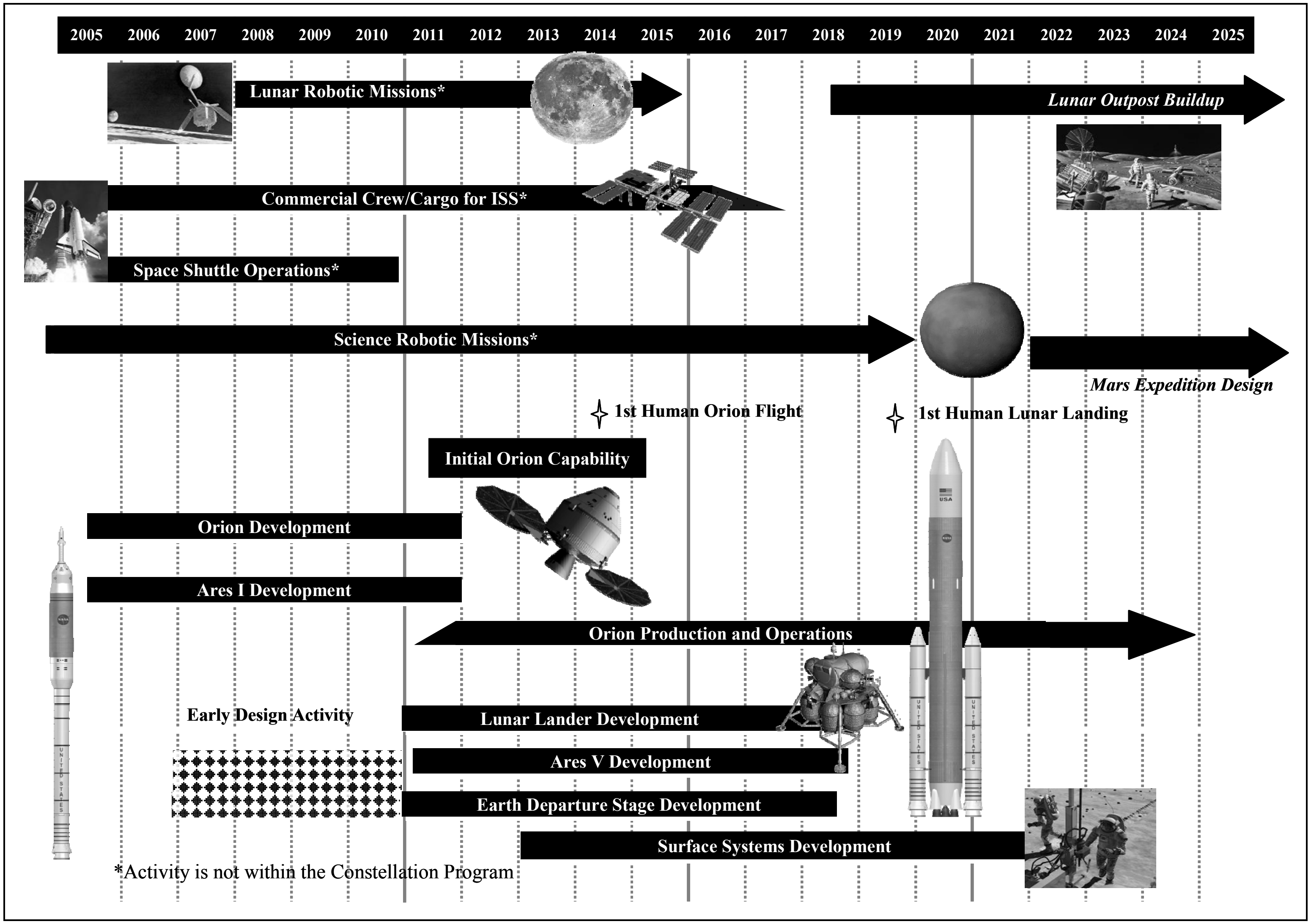


**Figure ES-4. NASA's Exploration Roadmap with the Constellation Program Through 2025**

The first missions to the Moon would be short-duration stays of up to 14 days. Once sufficient infrastructure is built, they would evolve into longer-duration missions, culminating in a permanently occupied lunar outpost. Expeditions to a lunar outpost would last up to 180 days. In addition to the lunar exploration capabilities associated with the outpost, these missions would provide the opportunity to test equipment and procedures that could be used on future human missions to Mars.

Organizationally, the Constellation Program would consist of a single Program Office at NASA's Lyndon B. Johnson Space Center (JSC) in Houston, Texas that would have overall responsibility for management of the Constellation Program, and multiple Project Offices. Each Project Office would focus on specific technology and systems development and operational capabilities for the Constellation Program (see Table ES-1).

**Table ES-1. Summary of Constellation Projects**

| Constellation Project | Lead NASA Center | Function | |
|---|---|---|---|
| | | Developmental Phase | Operational Phase |
| Project Orion | JSC | Develop and test the Orion spacecraft to transport crew and cargo to and from space. | Provide Orion spacecraft. |
| Project Ares | MSFC | Develop and test the Ares I and Ares V launch vehicles. | Provide Ares launch vehicles. |
| Ground Operations Project | KSC | Perform ground processing and integrated testing of the launch vehicles. Provide logistics and launch services. Provide post-landing and recovery services for the crew (if any), Orion Crew Module, and spent Ares I First Stage and Ares V solid rocket boosters. | Provide ground processing, logistics, and launch services. Provide post-landing and recovery services for the crew, Orion Crew Module, and spent Ares I First Stage and Ares V solid rocket boosters. |
| Mission Operations Project | JSC | Configure, test, plan, and operate facilities, systems, and procedures. Plan missions and flight operations. | Train crew, flight controllers, and support staff. Coordinate crew operations during missions. |
| Lunar Lander Project | JSC | Develop and test the Lunar Lander to transport crew and cargo to and from the lunar surface and to provide a habitat for initial lunar missions. | Provide Lunar Lander. |
| Extravehicular Activities Systems Project | JSC | Develop and test EVA systems (spacesuits, tools, and servicing and support equipment) to support crew survival during launch, atmospheric entry, landing, abort scenarios, and outside the space vehicle and on the lunar surface. | Provide spacesuits and tools. |
| Possible Future Projects | To be determined | Develop systems for future applications including Lunar Surface Systems (this consists of a wide array of research and development activities associated with equipment and systems needed to operate on the lunar surface) and systems for future Mars exploration activities (*e.g.*, Mars transportation and surface systems). | Provide future systems as needed. |

Note: Range Safety for the Constellation Program is managed by JSC.

Project Orion, led by JSC, would focus on production, assembly, and ground and flight testing the Orion spacecraft. The initial design, fabrication, and assembly of a limited number of Orion spacecraft has been addressed in the *Final Environmental Assessment for the Development of the Crew Exploration Vehicle*. NASA published a Finding of No Significant Impact (FONSI) in the *Federal Register* on September 1, 2006 (71 *FR* 52169), which allowed for the proposed action to proceed.

Project Ares, led by George C. Marshall Space Flight Center (MSFC) would be responsible for design, development, and testing of two new launch vehicles; the Ares I and the Ares V.

To support launch operations, the Ground Operations Project, led by KSC, would develop ground infrastructure for vehicle processing (*i.e.*, final assembly and testing) and launch (*i.e.*, ground servicing equipment, launch pads, and launch control) needed for both Orion and Ares. NASA has begun modifying Launch Complex (LC)-39 Pad B at KSC to launch initial Ares missions. This action was addressed in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida*. NASA signed a FONSI on May 2, 2007, which authorized the proposed action to proceed. Similar modifications would be made to LC-39 Pad A at a later time, which are incorporated by reference in this Final PEIS. The Ground Operations Project also would use systems developed for the Space Shuttle to recover the Ares I First Stage, the Ares V Solid Rocket Boosters (SRBs), while new systems would be developed for recovery of the Orion Crew Module upon its return to Earth. The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. This could gain additional performance margin for certain missions by eliminating the launch weight of the booster recovery systems.

The Mission Operations Project, led by JSC, would develop the processes needed to prepare for missions (primarily training programs and mission plans) and manage the Earth-based infrastructure needed to execute the missions (*e.g.*, the Mission Control Center at JSC). The Lunar Lander Project, led by JSC, would be responsible for the design, development, and testing of the Lunar Lander. The Extravehicular Activities (EVA) Project, led by JSC, would primarily be responsible for developing spacesuits, tools, and equipment necessary to work outside the protective confinements of a spacecraft. Future mission requirements (*e.g.*, Lunar Surface Systems and Mars Systems) would be developed within an Advanced Projects Office. Additional projects would be established once these requirements mature sufficiently.

In support of missions, Project Orion would build and deliver the Orion spacecraft to the Ground Operations Project at KSC for final assembly and integration with the Ares I launch vehicle. Project Ares would construct the components for the Ares I launch vehicle and deliver them to the Ground Operations Project at KSC, where final assembly of the launch vehicle would occur. The Lunar Lander and crew spacesuits and tools would be provided by the Lunar Lander Project and the EVA Systems Project respectively.

The Ground Operations Project would be responsible for final assembly and integration of the Orion spacecraft and Ares launch vehicles and for launch pad preparations and launch in coordination with Launch Range Safety at KSC/Cape Canaveral Air Force Station (CCAFS). The Mission Operations Project would be responsible for planning the mission and training the crew and ground personnel needed to perform the mission, and once the mission is launched, the Mission Operations Project would have responsibility for performing the mission and coordinating all crew and ground personnel activities during the mission (*e.g.*, docking, lunar landing and surface activities, and return to Earth). The Ground Operations Project would be responsible for recovery of the crew and all reusable flight hardware (Crew Module, Ares I First Stage, and Ares V SRBs).

Although the Constellation Program and the six Projects would be led from three NASA Centers (JSC, KSC, and MSFC) as currently defined, the Constellation Program would utilize personnel and facilities throughout NASA, in addition to other U.S. Government and commercial personnel and facilities. Figure ES-5 provides the locations of the primary U.S. Government facilities, along with commercial facilities where potential significant environmental impacts from implementing the Constellation Program could occur.

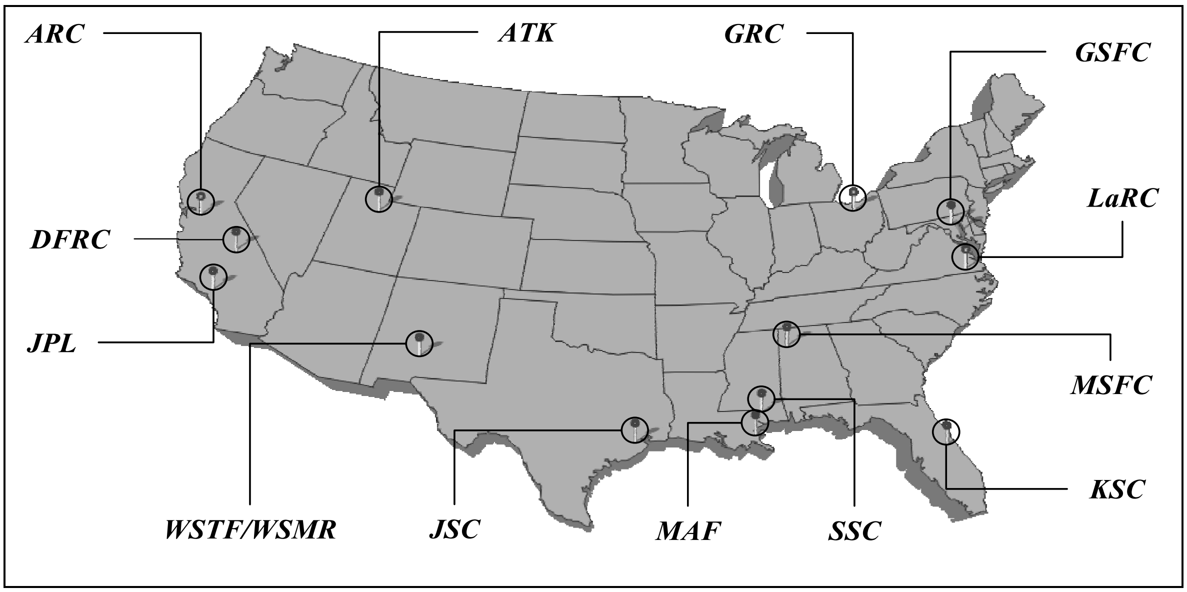


**Figure ES-5. Principal U.S. Government and Commercial Facilities Contributing to the Constellation Program**

These include KSC, John C. Stennis Space Center (SSC), Michoud Assembly Facility (MAF), JSC, MSFC, John H. Glenn Research Center (GRC) at Lewis Field and at Plum Brook Station (PBS), LaRC, Ames Research Center (ARC), WSMR/Johnson Space Center White Sands Test Facility (WSTF), Dryden Flight Research Center (DFRC), Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), and Alliant Techsystems-Launch Systems Group (ATK) facilities at Clearfield and Promontory, Utah.

It is expected that much of the construction and assembly of the Orion spacecraft would occur at MAF, KSC, and contractor facilities. Construction of the Ares launch vehicles would be expected to be performed at contractor and U.S. government facilities with final assembly at KSC. Development of the Orion spacecraft and the Ares launch vehicles would include a wide variety of test activities. Engine and solid rocket motor tests would be expected to be performed at both U.S. Government and contractor facilities (*e.g.*, SSC, MSFC, WSTF, and ATK) and would include vehicle test launches at KSC. Vacuum chamber and wind tunnel testing would primarily occur at NASA Centers although other U.S. Government and commercial facilities may also be used.

NASA prepared this PEIS early in the development of the proposed Constellation Program. As such, it remains undetermined what contractors and contractor facilities may be involved in many aspects of the fully implemented Constellation Program. However, as with previous NASA programs, contractors likely would play a major role in most aspects of the Constellation Program, and contractor work would likely be performed at both contractor-owned and government-owned facilities. This PEIS was drafted to provide a public discussion of the Constellation Program's environmental impacts that is as comprehensive as possible and, as a result, includes some discussion of the potential environmental impacts of contractor work that would not be fully defined until procurement actions related to the Constellation Program are finalized. These discussions of anticipated environmental impacts are based on experience with previous NASA programs and on the best available information at the time of preparing this PEIS, and are provided solely to inform the public about anticipated or potential environmental impacts of the Constellation Program. Such discussions do not impact future procurement activities or indicate NASA's intentions concerning such activities.

### ES.4.2 No Action Alternative

Under the No Action Alternative, NASA would not continue preparation for nor implement the Constellation Program. NASA would forego the opportunity for human missions to the Moon, Mars, and beyond using U.S. space vehicles. The U.S. would continue to rely upon robotic missions for space exploration activities. The opportunity for U.S. commercial entities to provide crew and cargo service to the International Space Station would be unaffected by the decision not to implement the Constellation Program. Other than the potential for commercial crew and cargo service to the International Space Station, the U.S. would depend upon foreign partners to deliver crew and cargo to and from the International Space Station.

## ES.5 RELATED NEPA ACTIVITIES

In order to meet the timeline established by the President and Congress for the exploration initiative, NASA needed to begin work on several activities (*e.g.*, facility modifications and vehicle design, construction, and testing) in advance of rendering a record of decision (ROD) for this Final PEIS, anticipated in early-2008. Therefore, NASA prepared the following separate NEPA documentation to analyze the potential environmental impacts of such activities prior to final planning and implementation. These NEPA documents are incorporated by reference in this Final PEIS:

- *Final Environmental Assessment for the Development of the Crew Exploration Vehicle*. NASA's FONSI was published in the *Federal Register* on September 1, 2006 (71 *FR* 52169).
- *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida*. A FONSI was signed by NASA on May 2, 2007.

- *Final Environmental Assessment for the Construction and Operation of the Constellation Program A-3 Test Stand, Stennis Space Center, Hancock County, Mississippi.* A FONSI was signed by NASA on June 4, 2007.
- *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico*. A FONSI was signed by NASA on August 5, 2007.
- *Final Environmental Assessment for Modification and Operation of TS 4550 in support of Ground Vibration Testing for the Constellation Program*. A FONSI is expected to be signed by NASA in early 2008.

The Constellation Program is considering the use of both water (ocean) and terrestrial landing sites for crew return. The selection of potential terrestrial landing sites is ongoing and some of the information necessary to identify and analyze the potential terrestrial landing sites was not available before this Final PEIS was completed. Therefore, this Final PEIS includes only a general discussion of the environmental impacts associated with terrestrial landings. NASA intends to address the selection and operation of terrestrial landing sites in separate NEPA documentation, as appropriate. The environmental impacts associated with a water landing are addressed in this Final PEIS.

This Final PEIS is intended to address the potential environmental impacts associated with Constellation Program activities through the early 2020s. Under the present schedule, this includes the proposed development of the Ares launch vehicles and Orion spacecraft, development of advanced systems needed to successfully complete missions (*e.g.*, Lunar Lander, Lunar Surface Systems, spacesuits [also used for missions to low Earth orbit], and tools), development and construction of infrastructure needed to support ground and mission operations, early missions to support the International Space Station, and short-duration missions to the Moon. The U.S. commitment to the International Space Station extends well into the next decade, with up to five proposed Orion/Ares I launches per year. The current Constellation Program baseline plan includes up to four lunar missions through 2020.

While significant detail is provided on the current planning configuration of the Ares V, the ultimate vehicle requirements and configuration would be dictated by the performance necessary to support the Lunar Lander, Lunar Surface Systems, and Mars missions. If significant changes to the Ares V planning configuration reflected in this Final PEIS occur, they would be subject to separate NEPA review and documentation, as appropriate.

There are potential future activities associated with the Constellation Program that are beyond the scope of this Final PEIS. Missions to establish a permanent lunar outpost and crewed missions to Mars are activities that are currently not expected to occur during the timeframe addressed in this Final PEIS. Development, operation, and mission activities associated with these actions would be subject to separate NEPA review and documentation, as appropriate. Future program activities may benefit from use of nuclear systems in areas such as planetary electrical power generation or interplanetary propulsion. Technical studies will be conducted to determine whether nuclear-based systems can safely and affordably enhance future mission capabilities. Any future activities associated with development and use of nuclear systems for the Constellation Program would be subject to separate NEPA review and documentation, as appropriate.

## ES.6 AFFECTED ENVIRONMENT

NASA would use multiple U.S. Government and commercial facilities in implementing the proposed Constellation Program. The activities proposed for the Constellation Program at these facilities would be expected to be within the scope of activities normally undertaken at each facility. Any activities determined to be outside the scope of activities normally undertaken at these facilities or at facilities which are not addressed in this Final PEIS would be subject to separate NEPA review and documentation, as appropriate.

### ES.6.1 U.S. Government Facilities

#### *ES.6.1.1 John F. Kennedy Space Center*

NASA's KSC is located on the east coast of Florida adjacent to CCAFS. KSC is composed of 56,000 hectares (ha) (139,490 acres [ac]) of land and open water resources in Brevard and Volusia Counties. The primary mission of KSC is to process and launch the Space Shuttle and future generations of crewed space vehicles and to process payloads for various expendable launch vehicles launched from CCAFS. Launches from KSC are coordinated with Launch Range Safety at CCAFS. For the Constellation Program, KSC would manage the Ground Operations Project, including pre- and post-launch ground processing, launch support, and landing and recovery planning and execution.

#### *ES.6.1.2 John C. Stennis Space Center*

NASA's SSC is located along the northern edge of the Gulf of Mexico in western Hancock County, Mississippi. SSC encompasses approximately 5,585 ha (13,800 ac) of land that is surrounded by a 9.7-kilometer (km) (6-mile [mi]) buffer area to provide an acoustical and safety protection zone for NASA testing operations. SSC is responsible for testing and flight-certifying large rocket propulsion systems for the Space Shuttle and future generations of space vehicles. For the Constellation Program, SSC would be responsible for liquid hydrogen/liquid oxygen propulsion engine testing and verification for the Ares Upper Stage and the Ares V Core Stage.

#### *ES.6.1.3 Michoud Assembly Facility*

MAF is a Government-owned, contractor-operated component of MSFC located on approximately 337 ha (833 ac) in southeastern Louisiana. MAF is within the boundaries of Orleans Parish in the eastern section of metropolitan New Orleans. MAF's primary activities involve the manufacturing of the Space Shuttle External Tank. For the Constellation Program, MAF would manufacture, assemble, and test components of the Orion Crew Module and Service Module and the Ares I Upper Stage. In addition, MAF could possibly manufacture and assemble the Ares V Core Stage and/or the Earth Departure Stage.

### *ES.6.1.4 Lyndon B. Johnson Space Center*

NASA's JSC is southeast of central Houston in Harris County, Texas. JSC encompasses approximately 640 ha (1,581 ac) of land and is devoted to research, development, and mission planning and control activities related to NASA's human space activities and operations. JSC would have lead responsibility for managing the Constellation Program, as well as Project Orion, the Mission Operations Project, the Lunar Lander Project, the Extravehicular Activities Systems Project and the Advanced Projects Office. JSC also operates two satellite facilities, Ellington Field and Sonny Carter Training Facility, located 13 km (8 mi) and 8 km (5 mi) northwest of JSC, respectively. Ellington Field is the center of aviation-related training operations for NASA's manned space program and the Sonny Carter Training Facility is utilized for astronaut training operations.

### *ES.6.1.5 George C. Marshall Space Flight Center*

NASA's MSFC is located on approximately 745 ha (1,841 ac) within the grounds of the U.S. Army's Redstone Arsenal, southwest of Huntsville, Alabama. Redstone Arsenal occupies 15,503 ha (38,309 ac) in the southwestern portion of Madison County, Alabama. MSFC is almost centrally located within Redstone Arsenal, which provides a 4- to 11.3-km (2.5- to 7-mi) buffer between MSFC's engine test stands and the general public. MSFC is NASA's principal propulsion research center. For the Constellation Program, MSFC would manage Project Ares.

### *ES.6.1.6 John H. Glenn Research Center*

NASA's GRC consists of two sites in Ohio: Lewis Field in western Cuyahoga County (near Cleveland) and Plum Brook Station (PBS) in west central Erie County, approximately 80 km (50 mi) west of Lewis Field. Lewis Field encompasses approximately 142 ha (350 ac) of highly developed and urbanized land within the city of Brook Park. PBS encompasses 2,614 ha (6,454 ac) of rural land, located south of Sandusky, Ohio. GRC specializes in power, propulsion, communications, and micro-gravity science research. For the Constellation Program, Lewis Field would manage Orion Service Module and Spacecraft Adapter development and provide Ares Upper Stage support and development. PBS would provide Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing and Ares Upper Stage engine testing and integrated stages testing.

### *ES.6.1.7 Langley Research Center*

NASA's LaRC is located on a coastal plain in the northeastern portion of the city of Hampton, Virginia. LaRC occupies 327 ha (808 ac) of land adjacent to the Langley Air Force Base. LaRC performs research in airframe systems and atmospheric sciences. For the Constellation Program, LaRC would manage Orion Launch Abort System development, the Orion landing system development and testing, and Ares ascent development flight test vehicle integration.

### *ES.6.1.8 Ames Research Center*

NASA's ARC encompasses approximately 800 ha (2,000 ac) in the northern portion of Santa Clara County, California. ARC primarily engages in the areas of information technology, nanotechnology, fundamental space biology, biotechnology, aerospace and thermal protection systems, and human factors research. For the Constellation Program, ARC would lead Orion Thermal Protection System development.

#### *ES.6.1.9 White Sands Missile Range/Johnson Space Center White Sands Test Facility*

WSMR is a multi-service facility managed by the U.S. Department of the Army to support research, development, testing, and evaluation of weapons and space systems. WSMR provides a variety of services to governmental agencies, approved commercial firms, and foreign governments. NASA's WSTF operates under JSC as a field test installation within the boundaries of WSMR with the primary purpose of providing test services to NASA for the U.S. Space Program. For the Constellation Program, WSMR would perform Orion abort flight test ground operations, launch pad abort testing, and flight ascent abort testing. During vehicle development and testing, WSTF would perform ground servicing and operational checkout of the Orion Launch Abort System flight tests. These tests would be coordinated with WSMR Range Safety. WSTF also would perform Ares Upper Stage hot fire engine verification testing of the Reaction Control System and Thrust Vector Control subsystems.

#### *ES.6.1.10 Other U.S. Government Facilities*

Other U.S. Government facilities that would support the Constellation Program include NASA's DFRC, GSFC, and JPL. Most of the activities that would be implemented at these facilities would be limited to engineering design and data analysis, project management, procurement, operational checkout, component testing, and administrative support, and would fall within the normal realm of operations at each facility. The Constellation Program also may use other U.S. Government facilities, such as the U.S. Air Force's wind tunnels and other test facilities.

### ES.6.2 Commercial Facilities

#### *ES.6.2.1 Alliant Techsystems-Launch Systems*

Activities associated with the Constellation Program would occur at two ATK locations in Utah, including ATK-owned facilities at Promontory, which is northwest of Brigham City, Utah, and at leased facilities at the Clearfield Refurbishment Center, which is southwest of Ogden, Utah. ATK provides manufacturing and testing services for rocket motor systems used in space launch vehicles, strategic missiles, and other missile systems. For the Constellation Program, ATK would provide solid rocket motor development, testing, and production for the Ares launch vehicles. ATK may perform additional work for the Constellation Program awarded through competitive procurements.

#### *ES.6.2.2 Other Commercial Facilities*

The Constellation Program would be supported by various other commercial facilities throughout the U.S. It is expected that the activities engaged in at each commercial facility involved in the Constellation Program would fall within the normal realm of operations at that facility. It is also expected that all such facilities would be in compliance with applicable Federal, state, and local environmental laws, regulations, and permits. NASA would ensure that this is the case as a matter of contract with all commercial entities selected to support the Constellation Program.

### ES.6.3 Global Environment

In accordance with EO 12114, *Environmental Effects Abroad of Major Federal Actions*, this Final PEIS provides a general overview of the global environment. It includes basic descriptions of the troposphere, stratosphere, and potential landing sites for the Orion Crew Module and jettisoned Orion and Ares hardware.

The troposphere is the atmospheric layer closest to the Earth's surface. This layer accounts for more than 80 percent of the mass and essentially all of the water vapor, clouds, and precipitation contained in the Earth's atmosphere. The height of the troposphere ranges from an altitude of 10 km (6 mi) at the poles to 15 km (9 mi) at the equator. In general, the troposphere is well-mixed and aerosols in the troposphere are removed in a short period of time as a result of this mixing and scavenging by precipitation. A narrow region called the tropopause separates the troposphere from the stratosphere.

The stratosphere extends from the tropopause to an altitude of approximately 50 km (31 mi). In general, vertical mixing is limited within the stratosphere, providing little transport between the layers above and below. Thus, the relatively dry, ozone-rich stratospheric air does not easily mix with the lower, moist, ozone-poor tropospheric air. The lack of vertical mixing and exchange between atmospheric 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. The Montreal Protocol, an international treaty ratified by the U.S., is designed to protect the stratospheric ozone layer by phasing out production and consumption of substances that deplete the ozone layer. It was first adopted in 1987 with additional revisions adopted through 1999. Recent measurements indicate that stratospheric chlorine levels are decreasing, consistent with expected declines resulting from the Montreal Protocol.

Although both ocean and terrestrial landing sites for the return of the Orion Crew Module are currently under study, terrestrial landing sites are not addressed in this Final PEIS. In general, it is expected the terrestrial landing site(s) would be in the western continental U.S. and would consist of the following characteristics: a sparsely populated large, flat area of land without marshes, forests, boulders, or ravines. At such time as the evaluations of terrestrial landing sites mature sufficiently, NASA will prepare separate NEPA documentation, as appropriate.

An ocean landing of the Orion Crew Module could occur in the Atlantic Ocean, Indian Ocean, or Pacific Ocean following a launch ascent abort, or in the Pacific Ocean off the western coast of the U.S. following a normal Earth atmospheric entry from the International Space Station or the Moon. A recovery team would retrieve the Orion Crew Module upon Earth return. Although specific atmospheric entry landing locations are unknown at this time, the future selection process would avoid sensitive marine environments to the extent possible.

The primary hardware that would be jettisoned during an Orion/Ares I launch would include the Ares I First Stage and Upper Stage, the Orion Launch Abort System, and the Spacecraft Adapter fairings. For an Ares V launch, the primary hardware that would be jettisoned would include the

Core Stage, payload fairings, and SRBs. Similar components would be jettisoned during Ares test launches at KSC. These components would fall into either the Indian Ocean or the Atlantic Ocean, depending upon when each is jettisoned during launch vehicle ascent. In addition, the Orion Service Module and docking mechanism (for International Space Station missions) would be jettisoned into the Pacific Ocean during atmospheric entry. Components could also be jettisoned into the Indian, Atlantic, or Pacific Ocean in the event of a launch ascent abort; however, the possibility exists that hardware components could fall on land. Under a normal launch, a recovery team would retrieve the Ares I First Stage and the Ares V SRBs. While all remaining hardware would not be recovered and would be expected to breakup in the atmosphere or upon ocean impact and sink to the ocean floor, some hardware components may remain temporarily afloat.

The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. This could gain additional performance margin for certain missions by eliminating the launch weight of the booster recovery systems.

## ES.7 ENVIRONMENTAL CONSEQUENCES

### ES.7.1 Proposed Action

#### *ES.7.1.1 U.S. Government Facilities*

##### ES.7.1.1.1 John F. Kennedy Space Center

Activities associated with launch operations for the Ares launch vehicles, including post-launch cleanup and rehabilitation of the launch platform and associated facilities, would be the primary source of environmental impacts from the Constellation Program at KSC.

Environmental impacts associated with Ares launches from LC-39 would be similar to those that are normally experienced with Space Shuttle launches. Space Shuttle launch impacts are principally associated with the hydrogen chloride (HCl) emissions in the exhaust cloud created from ignition of the Space Shuttle's SRBs at liftoff. The interaction of the SRB emissions with deluge water from the launch pad's sound suppression system creates a wet acidic deposition that produces local environmental impacts near the launch complex, including vegetation spotting, and temporary increase of acidity in the shallow surface waters near LC-39 Pads A and B, resulting in fish kills of up to several hundred individual fish. These periodic events do not appear to have had a long-term adverse effect on fish populations in these shallow waters. Differences in local environmental effects could result if the amount and use of water for sound suppression at liftoff differed for Ares launches. Because less solid propellant would be used for the Ares I launch vehicle than the Space Shuttle, the near-field impacts for this vehicle (within 500 m [1,640 ft] to 1,000 m [3,281 ft] of the launch pad) would be expected to be smaller than those from Space Shuttle launches. The near-field impacts from the Ares V launch vehicle would be expected to be similar to those resulting from Space Shuttle launches. The far-field impacts (more than a few kilometers from the launch pad) of Ares I and Ares V launches would be expected to be negligible, similar to those from the Space Shuttle. When launches are planned, Launch Range Safety uses models and launch safety criteria to ensure that measurable far-field effects do not occur.

Space Shuttle launches also typically result in a temporary startle response from nearby birds and other wildlife. Protected species such as bald eagles, Florida scrub jays, and wood storks near the launch complex do not appear to have sustained any long-term adverse impacts from the periodic Space Shuttle launches. It is anticipated that no protected species, critical habitats, or wetlands would be adversely impacted by Ares launches.

Noise modeling for the Ares V was performed using a bounding launch configuration with a total thrust of about 54.7 million Newton (N) (12.3 million pounds [lb]) rather than the current planning configuration thrust of about 44 million N (10 million lb). A bounding launch configuration was used to consider potential variations in future engine designs and configurations. Preliminary calculations indicate that sound levels for an Ares V launch with a bounding launch vehicle configuration would reach approximately 78 to 82 A-weighted decibels (dBA) at the city of Titusville for a short period. The predicted noise levels at the KSC Visitor Center and KSC Industrial Area would be 88 and 92 dBA, respectively. At 4.8 km (3 mi) away from the launch pad (the approximate distance to the Vehicle Assembly Building [VAB]), Ares V noise levels would be in the range of 99 to 102 dBA. Most KSC employees would be stationed beyond this distance. Noise levels of about 98 dBA would occur at the Saturn V viewing site. These values are comparable to, but likely to be a few dBA (1 to 2) higher than, those of Space Shuttle and past Saturn V (Apollo era) launches. Ares I launch noise levels are predicted to be approximately 5 to 9 decibels (dB) lower at each of these locations. As with other launches, the noise generated by Ares I and Ares V launch vehicles would last only for a very short duration (approximately 20 to 30 seconds). Human exposure to Ares V noise levels at a 75 dBA level for 30-seconds would be much lower than the Occupational Safety and Health Administration (OSHA) recommended maximum 8-hour exposure limit of 85 dBA. Exposure to short-term launch noise levels of 75 to 90 dBA would not be expected to result in effects among the public other than minor, short-term discomfort.

The potential impact of Ares I launch noise on structures would be expected to be minimal, since these noise levels should be lower than those experienced with Space Shuttle launches. The potential noise and vibration levels associated with Ares V launches would likely be comparable to past Space Shuttle and Saturn V launches; therefore, the potential exists for minor localized damage to windows (onsite and offsite) and other sensitive building elements. In the event of private property damage, NASA has procedures in place to evaluate such damage and provide for compensation, if warranted.

Sonic booms would occur over the open ocean during launch of an Ares I and Ares V, and when jettisoned components reenter the atmosphere. These sonic booms would be similar to those associated with Space Shuttle launches and would be expected to be minor.

NASA implements a Range Safety policy to protect the public against launch accidents. NASA's policy is designed to protect the public, employees, and high-value property and is focused on the understanding and mitigation (as appropriate) of risk. Potential impacts from catastrophic incidents involving launch vehicles are assessed as part of the overall Range Safety evaluation.

Impacts in the KSC area associated with launch accidents would be limited to those accidents which occur in the early ascent phase of a mission since the Ares launch vehicles would fly northeastwardly away from the launch pad over the Atlantic Ocean. The most significant potential health hazard from an Ares I or Ares V launch accident outside the immediate vicinity of the launch pad would be the HCl emitted from burning solid propellant. Launch Range Safety uses models to predict launch hazards to the public and onsite personnel prior to every launch. These models calculate the risk of casualty resulting from HCl, debris, and blast overpressure during potential launch failures after accounting for local meteorological conditions. Launches may be postponed if the predicted collective public risk of injury exceeds approved levels (they may also be allowed to continue, given approval from the NASA Procedural Requirements [NPR] 8715.5 "Range Safety Program" designated authority, depending on the specific hazards posed and risk levels on the day of launch). This approach takes into account the probability of a catastrophic failure; the resultant hazard distributions for the principal Range Safety hazards (toxics, debris, and blast overpressure); and emergency preparedness procedures.

It is expected that minor upgrades and modifications to historic ground processing and launch facilities currently being used for the Space Shuttle Program and International Space Station activities would occur at KSC. While most of these modifications would be minor and have little or no effect on the use or status of the properties, some would be major and constitute an adverse effect as defined in 36 CFR 800.5, *Protection of Historic Properties*. Some impacts identified to date include: the removal of the Fixed and Rotating Service Structures from LC-39 Pad B and potentially from LC-39 Pad A; modifications to the Firing Rooms in the Launch Control Center; and modifications to the Orbiter Processing Facility to accommodate Ares V Upper Stage or lunar payload processing. Additional adverse effects to other historic properties may be identified as the program matures. Mitigation activities would be developed in coordination with the State Historic Preservation Officer.

#### ES.7.1.1.2 John C. Stennis Space Center

At SSC, the principal environmental impacts would be associated with noise from testing of Ares J-2X Upper Stage and Ares V RS-68B Core Stage liquid fueled rocket engines. Individual RS-68B engines from the Ares V would be tested, as well as a cluster of five RS-68B engines that would collectively serve as the Ares V main engine in the current planning configuration.

Under the Proposed Action, full-scale liquid rocket engine testing at SSC would occur at either the B-1/B-2, A-1, or A-2 test stands. These test stands are located in the central portion of SSC and oriented in a manner that direct sound to the north and east. Because the propellants used in the Ares Upper Stage and the Ares V Core Stage would be liquid oxygen and liquid hydrogen, the principal air emission from engine testing would be water vapor. Thus, testing would not be expected to adversely impact air quality at SSC or in surrounding communities.

NASA is planning to operate a new test stand (A-3) (currently under construction) to test J-2X engines in a vacuum, simulating high altitude conditions (approximately 30,480 m [100,000 ft]). The high-altitude (vacuum) conditions would be simulated through the use of chemical steam generators that would use isopropyl alcohol, liquid oxygen, and water to reduce the pressure in the test cell and downstream of the engine. The environmental impacts of this new test stand are evaluated in more detail in the *Final Environmental Assessment for Construction and Operation of the Constellation Program A-3 Test Stand, Stennis Space Center, Hancock County, Mississippi*. In planning mitigation activities associated with development of the new A-3 Test

Stand for the Constellation Program, SSC has delineated 47.9 hectares (118.54 acres) of wetlands credits which would be charged against its "Mitigation Bank", managed by the U.S. Army Corps of Engineers.

NASA operations at SSC are considered to be a "major source" of air emissions as defined by the Clean Air Act and the addition of the A-3 Test Stand require modifications to the existing air permits. Since the proposed carbon monoxide (CO) emissions from the A-3 Test Stand at the projected peak test schedule of two tests per month would exceed the EPA's Prevention of Significant Deterioration annual significant emission increment threshold of 100 tons per year, SSC would model the impacts to supplement the Prevention of Significant Deterioration permit application to show that the increased emissions would not have a significant effect on air quality.

A perpetual restrictive easement of 506 square km (195 square mi) extends 9.7 km (6 mi) in all directions from SSC and acts as a buffer zone. The purpose of the buffer zone is to provide an acoustical and safety protection zone for NASA testing operations. Noise from Constellation Program engine tests at SSC would generally be similar to ongoing tests of Space Shuttle main engines and Delta IV RS-68 engines. Only the tests of the RS-68B cluster for the Ares V Core Stage would potentially produce noise levels that exceed ongoing test activities. The RS-68B cluster test noise levels would be expected to be similar to those experienced during Saturn V main engine testing and could result in similar noise impacts and complaints. During the Saturn V rocket-testing program between 1966 and 1970, NASA logged 160 complaints, of which 57 resulted in formal administrative claims to NASA. Eighteen of the complaints resulted in financial settlements.

Maximum offsite noise levels would be less than the 77 dBA level estimated for testing the Saturn V-like main-engine cluster, which produced over twice the thrust of the Ares V cluster. These noise levels would have an insignificant human health impact due to the short duration of the individual engine tests. At the anticipated noise levels of 65 dBA (single engine) and less than 77 dBA (five-engine cluster) during Constellation Program engine tests, some interference with individual conversations during daytime would be expected. Because of the infrequency and short duration (less than 10 minutes) of each test the impact would be small.

No protected species or critical habitats have been observed in the SSC engine test area. If a protected species is identified, the U.S. Fish and Wildlife Service would be consulted and a management procedure would be put in place. NASA has consulted with the Mississippi State Historic Preservation Officer regarding modifications to the existing A and B test stands and adverse effects would be mitigated.

#### ES.7.1.1.3 Michoud Assembly Facility

The principal environmental impacts at MAF would be associated with the manufacture, assembly, and component testing of the Orion Crew Module and Service Module and the Ares I Upper Stage, and the possible manufacture and assembly of the Ares V Core Stage and/or the Earth Departure Stage. The proposed activities and processes that would support the Constellation Program would be expected to be similar to the normal scope of activities undertaken at MAF. Therefore, anticipated air and noise emissions would not be expected to change substantially from current practices. No protected species, critical habitats, or wetlands would be adversely impacted. It is anticipated that minor upgrades and internal modifications to several historic facilities could occur at MAF. While most of these modifications would be minor and have little or no effect on the use or status of the properties, some could possibly be major and constitute an adverse effect and would be managed accordingly.

#### ES.7.1.1.4 Lyndon B. Johnson Space Center

The Constellation Program would utilize legacy Space Shuttle Program and International Space Station planning, training, and support facilities at JSC, including its two satellite facilities, Ellington Field and the Sonny Carter Training Facility. No protected species, habitat, or wetlands would be adversely impacted by the proposed Constellation Program activities at JSC. Mission operations that would be needed to support Constellation Program would be conducted in Building 30, but would not involve or pose an adverse effect on the Apollo Control Room, which is a National Historic Landmark or the Mission Control Center, which is eligible for listing in the National Register of Historic Places. Anticipated modifications to Building 30 would be limited to rewiring or other minor modifications that would not affect the historic status of either facility.

#### ES.7.1.1.5 George C. Marshall Space Flight Center

The principal environmental impacts at MSFC from Constellation Program activities would be associated with engine development and testing activities. Although most large engine testing would occur at other sites, some engine testing is anticipated at MSFC, such as full-scale J-2X engine testing (*e.g.*, Main Propulsion Test Article). These types of tests would be consistent with ongoing and past engine development and testing activities at MSFC. All engine test facilities are located in the southern portion of MSFC approximately 4 to 12 km (2.5 to 7 mi) from the nearest private property. Ground vibration testing of the Ares I launch stack and possibly the Ares V launch stack also would be performed at MSFC.

The air emissions generated at MSFC as a result of the Proposed Action would be limited to levels consistent with the typical types of engine testing that currently occur. The exhaust cloud from Main Propulsion Test Article testing would be principally water vapor. Detailed air emission projections for a range of engine types, including engines more powerful than those anticipated for the Constellation Program, have been modeled for MSFC. That modeling indicates that the maximum concentrations of air emissions from large-thrust engine tests would be well below regulatory standards and the Prevention of Significant Deterioration increment levels that would trigger additional evaluation and modeling.

The noise impacts of engine testing at MSFC have been extensively evaluated. Noise modeling has indicated that for a small-thrust engine such as the Space Shuttle main engine, the maximum sound pressure at the closest private property to MSFC test sites would be 107 dB. The predicted maximum offsite A-weighted sound levels would be approximately 94 dBA. These noise levels would be very noticeable locally but would not have health impacts because of their short duration (less than seven minutes per test). People are exposed to similar noise levels from traffic, aircraft, and other normal daily activities. These noise levels would not cause significant damage to structures. This is consistent with what has been historically observed in the nearby communities with past MSFC engine tests.

Maximum off-site noise levels of 94 dBA for up to seven minutes would be lower than the 100 dBA two-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). Therefore, no hearing effects among the general public would be projected. The impacts of noise from MSFC engine tests are mitigated by the physical separation of the test facilities from the general public. MSFC is surrounded by a large federally-owned area consisting of the Redstone Arsenal and the Wheeler National Wildlife Refuge.

A new spray-on foam insulation spray booth would be constructed in one or more existing MSFC buildings to support Ares Thermal Protection System development. This activity would potentially require modification to the existing CAA Title V air permit. There are currently no additional plans for new facility construction at MSFC. However, rehabilitation of existing facilities associated with Constellation Program activities would be anticipated.

#### ES.7.1.1.6 John H. Glenn Research Center – Lewis Field and Plum Brook Station

Air emissions generated as a result of the Proposed Action at GRC Lewis Field and PBS would likely be comparable to emissions from ongoing activities at each site. Constellation Program activities at GRC Lewis Field would not be expected to adversely impact biological resources at the site. It is not anticipated that Constellation Program activities at PBS would adversely impact any protected species or special management areas.

Testing of the J-2X engine at PBS would require modifications to the B-2 Vacuum Facility, which is part of the Spacecraft Propulsion Research Facility (Building 3211), a National Historic Landmark. The modifications would be considered an adverse effect and would therefore have to be managed in consultation with the Ohio State Historic Preservation Officer. In addition, the Space Power Facility (Building 1411) at PBS, a National Register of Historic Places-eligible facility, would undergo some modifications to accommodate integrated environmental qualification testing of the Orion spacecraft; however, no adverse effects would be expected.

#### ES.7.1.1.7 Langley Research Center

Air emissions from the activities anticipated under the Proposed Action at LaRC would likely be comparable to emissions from ongoing activities at the site. Constellation Program activities at LaRC would not be expected to adversely impact surface water or groundwater resources, protected species, habitat, or wetlands.

Several historic properties at LaRC may be modified to support Constellation Program activities; however, it is expected that most of these modifications would be minor and have little or no effect on the properties. Specifically, use of the Impact Dynamics Facility (Gantry) (Building 1297), a National Historic Landmark, for drop testing the Crew Module, may require refurbishing or modification. NASA has consulted with the Virginia State Historic Preservation Officer, who concurred with the proposed mitigation, indicating there would be no adverse effect to the Gantry from the proposed modifications.

ES.7.1.1.8 Ames Research Center

The reasonably foreseeable Constellation Program activities proposed for ARC would be very similar to ongoing activities conducted in support of the Space Shuttle Program. No adverse environmental impacts would be anticipated.

ES.7.1.1.9 White Sands Missile Range/Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico

Orion Launch Abort System testing would constitute the principal source of environmental impacts from the Constellation Program at WSMR/WSTF. NASA has prepared the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* to evaluate the potential impacts of both construction and facility modifications necessary to support the proposed tests and the potential impacts of the tests. All Launch Abort System testing activities would occur within the boundaries of WSMR. No protected species or critical habitats are anticipated to be impacted. Any modifications to historic properties would be performed in consultation with the New Mexico State Historic Preservation Officer.

ES.7.1.1.10 Other U.S. Government Facilities

Constellation Program activities associated with DFRC, GSFC, and JPL would be focused primarily on, but not be limited to, project management, engineering and data analysis, and procurement and administrative support. Only limited physical testing, fabrication, or assembly of Constellation Program components would be expected to be performed at these facilities. Activities at other U.S. Government facilities, such as the U.S. Air Force's wind tunnels and other test facilities, would be expected be within the normal realm of operations at each facility. Therefore, little or no impacts to land resources, air resources, water resources, noise, geology or soils, biological resources, socioeconomics, historical or cultural resources, transportation, or environmental justice would be anticipated. Any future construction of new buildings or major modifications needed to support future Constellation Program activities at these facilities would be subject to separate NEPA review and documentation, as appropriate.

### *ES.7.1.2 Commercial Facilities*

ES.7.1.2.1 Alliant Techsystems-Launch Systems, Utah

Air emissions from solid rocket motor tests and manufacturing accidents are the primary environmental impact concerns at ATK's Promontory facility. The Clearfield Refurbishment Center (CRC) is used to refurbish solid rocket motor casings for the Space Shuttle. Air emissions associated with solid rocket motor refurbishment are the principal environmental impact concerns at CRC.

The design for the Ares I First Stage and Ares V SRBs assumes the continued use of 1,1,1-trichloroethane (TCA), a banned substance under the Montreal Protocol. NASA and ATK have an Environmental Protection Agency (EPA) exemption allowing the use of remaining stockpiled TCA as an essential use item for the U.S. Space Program. This stockpile is adequate to support solid rocket motor production through 2020.

The Space Shuttle Program also holds an exemption from the EPA that allows the use of hydrochlorofluorocarbon (HCFC 141b) for critical Space Shuttle manufacturing operations. HCFC 141b is used as a blowing agent to produce foam plugs for solid rocket motor nozzles. Small quantities of HCFC 141b are used to fill test holes in foam insulation on the exterior surface of Space Shuttle solid rocket motors. It is expected that the Constellation Program would not use HCFC 141b for launch vehicles as NASA intends to develop cryoinsulation material without HCFC 141b. However, NASA may use small amounts of HCFC 141b for comparative studies when developing alternate materials.

Air quality analyses have indicated the primary emissions of concern from limited ground test firings of solid rocket motors and initial testing of the Ares solid rocket motors at the Promontory facility (HCl, $NO_x$, and particulate matter) have been well below Federal and Utah regulatory limits. The Promontory facility is in an attainment area and operates under a Clean Air Act Title V permit, which provides for ground firings of solid rocket motors.

Noise levels from past solid rocket motor test firings have been well below levels of concern in public areas. The Proposed Action would not result in any new types of noise sources introduced into either the CRC or Promontory areas.

#### ES.7.1.2.2 Other Commercial Facilities

Facilities owned or operated by other commercial entities would be utilized for the Constellation Program. While many of these facilities would be engaged in other aerospace activities, the Constellation Program would be a part of ongoing operations. Each facility also would have to comply with applicable Federal, state, and local environmental laws, rules, and regulations.

### *ES.7.1.3 Other Potential Impacts*

#### ES.7.1.3.1 Ocean Impacts of Launch Vehicle Components

The Proposed Action would result in an ocean splashdown of components jettisoned during the ascent phase of the crewed launches from KSC. These components include the Ares I First Stage and Upper Stage with the Service Module adapter and shrouds, Launch Abort System, and, for lunar missions, the Ares V Core Stage, payload shrouds, SRBs, and other minor hardware. Only the Ares I First Stage and Ares V SRBs would be expected to be recovered. However, The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. Similar components would be jettisoned to the ocean from uncrewed KSC test launches. Many aspects of the launch profile and recovery/disposal operations would be similar to those currently used for the Space Shuttle Program.

A residual amount of hydraulic fluid and hypergolic propellants would remain in the launch vehicle stages when they fall into the ocean. If released, the fluid and propellants would be diluted by seawater and would not be expected to affect marine species. Some soluble products from the Launch Abort System and residual Ares I First Stage and Ares V SRB fuel introduced into the ocean environment would be expected to produce short-term localized impacts.

NASA would ensure timely Notices to Airmen (NOTAM) and Notices to Mariners would be disseminated prior to each launch.

#### ES.7.1.3.2 Ocean Recovery of the Ares I First Stage and Ares V SRBs

NASA's current procedures for retrieval of expended Space Shuttle SRBs would be expected to be followed during recovery of Ares I First Stage and the Ares V SRBs. Environmental impacts from the jettisoned Ares I First Stage and, for lunar missions, the Ares V SRBs and subsequent recovery and transit back to KSC would be anticipated to be minimal. The splashdown zones would be in the open ocean, which is less biologically rich than upwelling and coastal areas and where the probability of striking marine mammals would be highly unlikely.

Vehicle elements not recovered, while not totally inert, would dissolve slowly, dissipate, and become buried in the ocean bottom. Some components could remain temporarily afloat. Corrosion of stage hardware would contribute various metal ions to the water column; however, due to the slow rate of corrosion in the deep ocean environment and the quantity of water available for dilution, toxic concentrations of metals are not likely to occur. Because of the limited number of launch events scheduled and the very large volume of water available for dilution, no adverse impacts would be expected from the nonfuel materials associated with the jettisoned launch vehicle stages.

Launch Range Safety would ensure that the risks to ships, aircraft, and personnel in the splashdown zone would be managed according to NPR 8715.5 "Range Safety Program."

#### ES.7.1.3.3 Service Module and Docking Mechanism Jettison and Crew Module Landing in the Pacific Ocean

The Orion Service Module (and docking mechanism for International Space Station missions) would be jettisoned prior to atmospheric entry. These components would breakup and fall as debris into a targeted area of the Pacific Ocean. Potential environmental impacts associated with the resulting debris field would be expected to be small. Activities most likely to be affected would be trans-ocean surface shipping and airline routes. No impacts with aircraft or ships would be anticipated as NOTAMs and Notices to Mariners would be disseminated well in advance. It is anticipated that the probability of striking marine mammals within the debris field would be small due to the large footprint of the area relative to the amount of debris and the open ocean being less biologically rich than upwelling and coastal areas. JSC Range Safety would ensure that the risks to ships, aircraft, and personnel in the splashdown zone would be managed according to NPR 8715.5 "Range Safety Program."

It is expected that most components would sink and slowly corrode on the ocean floor; however, some components could remain temporarily afloat. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the volume of seawater available for dilution. Propellant in the Service Module would be expected to vent fully prior to debris impact. Trace amounts of propellant could remain which would be expected to have a negligible environmental impact.

The return of the Orion spacecraft would result in a sonic boom, the magnitude of which would be expected to remain below the magnitude of sonic booms from Space Shuttle atmospheric entries. The impacts from the sonic boom would be expected to be minor.

Ocean landing and recovery of the Crew Module would be similar for both International Space Station and lunar mission returns. Environmental impacts associated with ship operations supporting the recovery of the Crew Module would be typical of ongoing U.S. Navy sea and port operations. Residual fuel (methane/oxygen bipropellant) would remain in the Crew Module and would be properly managed during recovery operations to minimize the potential for spilling into the ocean. The Constellation Program is currently studying the possibility of substituting the methane/oxygen bipropellant with a monopropellant (*e.g.*, hydrazine).

#### ES.7.1.3.4 Terrestrial Landing and Recovery of the Crew Module

Landing and recovery of the Crew Module at a terrestrial location(s) in the continental U.S. is presently under evaluation and would be the subject of separate NEPA review and documentation, as appropriate. NASA would manage entry Range Safety according to NPR 8715.5 “Range Safety Program.”

#### ES.7.1.3.5 Transportation of the Ares I First Stage and Ares V SRBs

The primary Constellation Program terrestrial transportation hazards would be the same as for the Space Shuttle Program (*i.e.*, accidents during railcar transport of fueled solid rocket motors). Solid rocket motors could ignite and burn under potential railcar accident conditions. Ignition could be caused by high temperature, static discharge, or mechanical impact. These could occur during a transportation accident caused by a collision or train derailment, vandalism, or sabotage. Depending on location and surrounding conditions, such an event could potentially have serious consequences. Direct damage from one or more solid rocket motors burning accompanied by potentially induced secondary fires or explosions, could clearly be greater in urban or developed areas.

Current practice for transporting fueled solid rocket motors from ATK to KSC for the Space Shuttle Program is via rail on specially designed rail cars with on-board ATK personnel. It is anticipated that the Constellation Program would adopt the same protocols for transporting solid rocket motors. Rail transportation has been used approximately 300 times to transport fueled Space Shuttle motor segments from Utah to KSC. Each of these has been followed with a return trip, and in about 10 instances return trips have carried fueled solid rocket motor segments. Each of these shipments was conducted safely with no instances of accidental ignition. These shipments comply with all applicable Department of Transportation regulations for rail shipment of hazardous materials. As such, minor rail incidents, such as train derailments, have not resulted in ignition of the solid propellant.

On May 2, 2007, a train transporting Space Shuttle solid rocket motors and a passenger car with technicians on board to monitor their transportation derailed near Linden, Alabama when a railroad bridge (trestle) collapsed under the locomotives. Six people were injured when the two locomotives and the passenger car dropped about 3 m (10 ft) and turned on their sides. One of the railcars carrying solid rocket motor segments also fell on its side and three other railcars and segments experienced a jarring drop. The four other railcars containing segments remained upright and undamaged. As was expected with the safety precautions taken with each shipment, the incident did not result in ignition of the solid propellant.

#### *ES.7.1.4 Global Environment*

Cumulative global impacts on stratospheric ozone depletion from Ares launches have been considered in this Final PEIS. Over the 2009 to 2014 timeframe, seven Ares I test launches are planned and up to five Ares I mission launches per year are planned between 2015 to 2020, although the actual number of launches could be lower. In addition, five Ares V launches are planned between 2018 and 2020. Assuming a direct relationship between stratospheric releases of ozone-depleting substances from launch vehicles and annually averaged global ozone level changes, the expected annually averaged global ozone level reductions from Constellation Program stratospheric HCl and $Al_2O_3$ releases would be no more than 0.0038 percent and 0.0014 percent, respectively, or a total of 0.0051 percent over that period.

The principal source of global warming emissions associated with the Constellation Program would be from NASA's energy use in support of the Program. NASA consumes energy primarily across four end-use sectors: 1) standard buildings; 2) industrial, laboratory, and other energy intensive facilities; 3) exempt facilities; and 4) vehicles and equipment, including aircraft operations. Between fiscal year 1990 and 2005, NASA reduced its total primary energy use by 14 percent. It is NASA's policy to fully comply with the requirements of the National Energy Conservation Policy Act, EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and other statutory and Presidential directives regarding energy efficiency.

Ares engine testing, Launch Abort System testing, and launches over the 2009 to 2020 timeframe resulting in emissions of water vapor, CO, and $CO_2$, and potentially the continued use of HCFC 141b in foam blowing, would constitute the other principal sources of Constellation Program emissions with the potential of affecting global warming. Although water vapor is considered a greenhouse gas, it is not tracked in the U.S. inventory. The Constellation Program's cumulative contribution to global warming from $CO_2$ and CO rocket exhaust emissions would be expected to be much smaller than NASA's contribution from energy consumption.

Under the Proposed Action, it has been assumed that HCFC 141b would not be used to produce foam insulation for the liquid hydrogen/liquid oxygen tanks for the Ares I and Ares V vehicles. To comply with EPA requirements to phase out Ozone Depleting Substances (ODS), and to reduce the long-term supportability risk posed by ODS usage, NASA intends to develop cryoinsulation replacements for the Ares I Upper Stage that do not contain HCFC 141b. NASA may continue to employ relatively small amounts of HCFC 141b foam for use in comparative studies.

Collectively, the total global warming potential from NASA's Constellation Program activities (rocket emissions, rocket testing, and foam blowing) and NASA's primary energy use over the 2009 to 2020 time period is estimated to be less than 0.004 percent of that from all annual U.S. carbon emissions over that period.

### ES.7.2 No Action Alternative

Under the No Action Alternative, the environmental impacts associated with implementing the Proposed Action would not occur. Specifically, no direct impacts associated with launch vehicle engine tests, launches, wind tunnel tests, construction of new facilities and modifications of existing facilities, and other direct actions connected with human spaceflight would occur. This would result in less noise and contamination of the air, water, and soil in the near term. In addition, the secondary impacts associated with the workforce supporting the Proposed Action would not occur. These impacts relate to the support infrastructure (*e.g.*, structures, utilities and roads) and include waste, water impacts, noise and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

At this time, a prediction cannot be made as to how the President or Congress would redirect funding and personnel that would otherwise support the proposed Constellation Program. As indicated earlier, the President has directed NASA to close-out the Space Shuttle Program no later than 2010. Without new programs and projects to fill the void left by the close-out of the Space Shuttle Program, substantial adverse socioeconomic impacts would be experienced by localities that host NASA Centers heavily involved in the Space Shuttle Program.

### ES.7.3 Cumulative Impacts

The proposed Constellation Program would largely be built upon the ongoing Space Shuttle Program's technologies and facilities. Therefore, at each of the potential sites that would have both Space Shuttle Program and Constellation Program-related activities, the potential environmental impacts would be either very small when compared to past, ongoing, or future activities, or would be very similar to the current impacts associated with the Space Shuttle Program. For most of the sites, the proposed activities under the Proposed Action would be expected to initially overlap with the Space Shuttle Program until the Space Shuttle fleet is retired. As a result, the broad incremental impacts of the Proposed Action above those that have been or are currently being felt would generally be small, but could be larger at sites that have minimal ongoing Space Shuttle Program work.

Each NASA Center has multiple on-going programs that would be managed concurrently with the Constellation Program. It is reasonable to expect that these programs would conduct testing and evaluation activities and could engage in the construction or modification of buildings as needed. In addition, each NASA Center has funding plans which identify activities such as construction, demolition, or rehabilitation of buildings and test stands. Such activities would be evaluated for environmental impacts by the sponsoring program or affected Center(s) and would be subject to separate NEPA review and documentation, as appropriate. However, these activities may or may not occur within the given timeframe of the funding plan due to many factors (*e.g.*, implemented funding and program direction) and may or may not have any environmental impacts. NASA has identified categories of actions that have demonstrated no impact to the environment when implemented. In general, many on-going activities at NASA Centers fall into these categories of actions. For purposes of the cumulative impacts analysis, those Center activities that have no environmental impact are not discussed in detail in this Final PEIS.

### ES.7.4 Incomplete or Unavailable Information

The Constellation Program is in the early design stages; therefore, it is reasonable to expect that there would be changes to the Program's plans and designs if the Proposed Action is selected. The changes could include modification to the Orion spacecraft and the Ares launch vehicles; the locations where development and testing would occur as well as their timing; and/or a reduction in the number of launches from the planned baseline.

The fundamental aspects of the Constellation Program that would potentially result in environmental impacts are not expected to change. Launches would be anticipated to occur from KSC and would likely rely on one or more SRBs for liftoff. The direct impacts of launch, including noise levels and exhaust cloud effects, would likely remain similar.

Several key aspects of the Constellation Program are not sufficiently defined to be thoroughly evaluated in this Final PEIS. These include:

- Potential building modifications or new construction at MAF, if MAF is chosen as the facility for Ares V Core Stage and/or Earth Departure Stage development
- Configuration of a potential new launch vehicle Vertical Integration Facility at KSC
- A new Launch Complex and new Launch Pad at KSC
- A new Crawlerway from the Vertical Assembly Building to LC-39 and new Crawler-Transport at KSC
- Addition of a new building at KSC to process hazardous materials for the Constellation Program
- Extent to which qualified commercial suppliers would be utilized to provide crew and cargo service to and from the International Space Station
- Potential building modifications at ARC in support of Orion Thermal Protection System tests
- Potential Orion Thermal Protection System flight tests
- Need for and magnitude of continued use of ozone depleting substances now used by the Space Shuttle Program, such as HCFC 141b foam
- Candidate Orion terrestrial landing sites
- Development of Lunar Landers, Lunar Surface Systems, Mar Systems, and other future systems to be implemented beyond 2020.

Detailed analysis of the socioeconomic impacts of implementing the Constellation Program cannot be performed at this time as most of the prime contract procurements are not completed. Furthermore, complete and accurate socioeconomic information, including budgetary data, workforce projections, and future procurement actions in addition to prime contract procurements are not available thus limiting the ability to quantify the socioeconomic impact of the Constellation Program.

### ES.7.5 Mitigation Measures

Activities associated with the Proposed Action that would be expected to have potential environmental impacts include rocket engine tests, rocket launches and Earth atmospheric entries, wind tunnel tests, and construction of new facilities. NASA would employ mitigation measures to avoid or reduce the magnitude of environmental impacts from Constellation Program activities, as appropriate. NASA also would continue the good environmental practices already being employed at each of the NASA facilities supporting the Constellation Program. Many of these mitigation measures and good environmental practices would be much like those currently being employed for the Space Shuttle Program.

Examples of mitigation activities and ongoing environmental practices that would contribute to mitigation of potential Constellation Program environmental impacts include:

- Range Safety policies and procedures employed at launch sites (KSC and WSMR) which are designed to protect the public, employees, and high-value property
- Notices to Airmen (NOTAM) and Notices to Mariners preceding Ares launches and Earth atmospheric entry of the Orion spacecraft to prevent collisions with surface ships and aircraft
- Mitigation of bird and bat strikes resulting from modifications to LC-39 Pads A and B at KSC (*e.g.*, minimize lightning tower height, use of minimum number of low intensity lights, use of large diameter stainless steel grounding wires) and at the launch complex used for the Launch Abort System tests at WSMR (*e.g.*, use of minimum number of low intensity lights and surveys of tower during nesting season)
- Compliance with the KSC lighting plan during construction, modification, and operation of LC-39 Pads A and B to protect nesting sea turtles
- The perpetual restrictive easement at SSC (the "Buffer Zone") that provides an acoustical and safety protection zone for NASA testing operations
- Wetland banking at SSC to mitigate the loss of wetlands associated with construction of the new A-3 Test Stand
- The physical separation between engine test facilities at MSFC and public property provided by the U.S. Army's Redstone Arsenal that provides an acoustical and safety protection zone for NASA testing operations
- SSC and MSFC would continue their practice of making engine test firing schedules available to the public through press releases
- SSC and MSFC would delay engine tests if substantial risk of structural damage to private property is determined to exist
- Offsite noise monitoring would be conducted at MSFC for engine tests whose thrust level meets or exceeds that of one medium engine

- Noise impacts at WSMR would be mitigated by excluding the public from areas where they could be exposed to potentially harmful noise levels and by requiring WSMR personnel to use hearing protection devices, as appropriate
- If a cultural site is discovered during excavations at WSMR, the Historic Preservation Officer would be notified for action
- WSMR also would employ dust control techniques during construction activities, vehicle controls on off-road traffic, and soil remediation for hazardous and non-hazardous waste spills.

In addition, since 1990 NASA has reduced overall annual ODS usage by more than 96 percent and is committed to finding safe and technically acceptable substitutes for remaining ODS uses. NASA intends to develop cryoinsulation replacements for use on the Ares I Upper Stage that do not contain HCFC 141b. This test program would require relatively small amounts of HCFC 141b-blown foam for use in comparative studies that would be required to ensure that replacement cryoinsulation materials have similar properties and perform at least as well as the current materials.

If the Proposed Action is implemented, a number of historic resources at various NASA facilities could be adversely affected. Modifications to historic properties could affect the character or historic integrity of such properties. NASA has a programmatic agreement with the Department of the Interior, National Park Service to mitigate impacts to National Historic Landmarks. Modifications required for the Constellation Program at NASA facilities would be undertaken in consultation with the respective State Historic Preservation Officer (SHPO). The NASA Historic Preservation Officer at each NASA facility would, in consultation with the SHPO, determine if proposed modifications would be considered “adverse” under the National Historic Preservation Act and other applicable rules and regulations. For such situations, NASA and the SHPO would develop a mitigation strategy to ensure that important historic information is preserved.

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# 1. PURPOSE AND NEED FOR ACTION

This *Final Constellation Programmatic Environmental Impact Statement* has been prepared by the National Aeronautics and Space Administration (NASA) to assist in the decision-making process as required by the National Environmental Policy Act of 1969, as amended (NEPA) (42 United States Code [U.S.C.] 4321 *et seq*.); Council on Environmental Quality regulations for implementing the procedural provisions of NEPA (40 Code of Federal Regulations [CFR] parts 1500-1508); NASA policies and procedures at 14 CFR subpart 1216.3; and Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*.

## 1.1 BACKGROUND

The Constellation Program would provide the flight systems and Earth-based ground infrastructure for an expanded human presence in the Solar System. Building on the achievements of previous lunar exploration efforts and crewed missions to low Earth orbit and the many technological advancements made over the past five decades, the Constellation Program would enable the United States (U.S.) to continue to access the International Space Station, return humans to the Moon, and enable human exploration of Mars and beyond.

### 1.1.1 U.S. Human Space Exploration Programs

Beginning in the late 1950s, the U.S. embarked upon the ongoing effort of human space exploration. The first human spaceflight initiative was Project Mercury, established in October 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 January 1962 and served to perfect maneuvers in Earth orbit. The Apollo Program was initiated in 1961, successfully landing U.S. astronauts on the Moon beginning in 1969 and returning them safely to Earth.

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, the Space Shuttle was the first and is still the only winged U.S. spacecraft capable of launching crew vertically into orbit and landing horizontally upon returning to Earth. Over the past 25 years, the Space Shuttle fleet has supported more than 100 missions.

### 1.1.2 New Exploration Initiative

After the Space Shuttle *Columbia* accident on February 1, 2003, NASA established the Columbia Accident Investigation Board (CAIB) to perform an in-depth review of the Space Shuttle Program. As a result of this review, the CAIB concluded that it was in the best interest of the U.S. to develop a replacement for the Space Shuttle. The CAIB concluded that it should be possible by 2010 using past and future investments in technology to develop the basis for a system, "significantly improved over one designed 40 years earlier, for carrying humans to orbit and enabling their work in space" (NASA 2003).

In January 2004, President George W. Bush announced a new exploration initiative (the *Vision for Space Exploration*) to return humans to the Moon by 2020 in preparation for human exploration of Mars and beyond. As part of this initiative, NASA will continue to use the Space Shuttle fleet to fulfill its obligation to complete assembly of the International Space Station and then retire the fleet by 2010. As the first step toward developing the vehicles to explore the Moon, Mars, and beyond, the President directed NASA to build and fly a new Crew Exploration Vehicle (CEV [since named Orion]) by 2014. The Orion spacecraft would be a new multi-functional human-rated space vehicle capable of supporting four to six crew members. The Orion spacecraft would be used to transport humans to low Earth orbit for missions to support the International Space Station and would be a key component for future missions to Mars and beyond. It would also be the vehicle used to transport a crew to lunar orbit.

Congress expressly endorsed the President's exploration initiative and provided additional direction for the initiative in the NASA Authorization Act of 2005, authorizing NASA to "…establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations" (Pub. L. 109-155).

### 1.1.3 The Exploration Systems Architecture Study

In May 2005, in response to the President's exploration initiative, NASA Administrator Michael Griffin commissioned the Exploration Systems Architecture Study (ESAS) (NASA 2005e) to perform four specific tasks:

1. Complete assessment of the top-level CEV requirements and plans to enable the CEV to provide crew transport to the International Space Station and to accelerate the development of the CEV and crew launch system to reduce the gap between Space Shuttle retirement and CEV initial operational capability
2. Provide definition of top-level requirements and configurations for crew and cargo launch systems to support the lunar and Mars exploration programs
3. Develop a reference lunar exploration architecture concept to support sustained human and robotic lunar exploration operations
4. Identify key technologies required to enable and significantly enhance these reference exploration systems and reprioritize near- and far-term technology investments.

The ESAS Team took on the task of developing CEV requirements and a baseline configuration to meet those requirements. Many design studies were performed to address potential CEV shapes, including blunt-body, slender-body, and lifting shapes. Aspects of a CEV mission to the International Space Station were examined in detail, including docking approaches and the use of the CEV as a cargo transport and return vehicle. Requirements for activities performed outside the confines of the CEV and any lunar habitat (*i.e.*, extravehicular activities [EVAs]) were examined, and different airlock designs were investigated. Additional CEV studies included, but were not necessarily limited to, landing mode, propellant type, number of engines, level of capability with a failed engine, and abort approaches.

The ESAS Team examined multiple combinations of launch elements to perform missions to the International Space Station, the Moon, and Mars. Different types and sizes of launch vehicles and numbers of launches required to meet specific mission configurations called Design Reference Missions were evaluated. The ESAS Team performed a detailed examination of the costs, schedule, reliability, safety, and risk of using launch vehicles derived from the Space Shuttle and from current and proposed U.S. heavy-lift launch vehicles (*e.g.*, Delta IV and Atlas V launch vehicles) for crew and cargo missions. Other studies included propellant types for launch vehicle stages, numbers of engines per stage, use of common components and systems on vehicle stages, and number of stages. Based upon the results of the studies, the ESAS Team developed new architecture-level requirements and an overall architecture approach to meet those requirements.

In order to determine the crew and cargo transportation requirements, the ESAS Team examined a variety of lunar surface mission types, surface systems, and approaches to constructing a lunar outpost. The use of in situ resources for propellant and power production was examined, as were nuclear and solar power sources. The central study conducted by the ESAS Team was an examination of various mission modes for transporting crew and cargo to the Moon, including lunar and Earth orbit operations, and direct return from the lunar surface. In addition, a number of different configurations were examined for the Lunar Surface Access Module (Lunar Lander). Studies performed for the Lunar Lander included the number of stages, propellants and engine types, level of capability with a failed engine, airlock approaches, cargo capacity, and abort options.

The ESAS Team's assessment of the exploration goals and mission requirements was formulated into the ESAS as a set of recommendations for a future exploration architecture. The study concluded that the launch vehicles should be derived from existing technologies, leveraging the lessons learned from past programs, such as the Apollo Program and the Space Shuttle Program. Specifically, the ESAS recommended an architecture which included a Crew Launch Vehicle (CLV [since named Ares I]) to ferry crew and cargo to the International Space Station and to carry crew to Earth orbit and a heavy-lift Cargo Launch Vehicle (CaLV [since named Ares V]) to support missions to the Moon and Mars.

### 1.1.4 The Constellation Program

To comply with Presidential and Congressional directives and to implement the ESAS recommendations, NASA initiated and is in the early planning stages of the proposed Constellation Program. The Constellation Program used the ESAS Team's recommendations and the underlying Presidential and Congressional directives as a starting point and has continued to refine the mission requirements, evaluate capabilities for the technologies studied by the ESAS, and perform more detailed examination of the developmental requirements (*e.g.*, test and verification requirements). This has resulted in a modified concept for the Constellation Program from that articulated in the ESAS. NASA expects that the Constellation Program would further evolve as human exploration needs and the capabilities of the selected technologies are assessed.

As envisioned by NASA, an incremental buildup would begin with up to four person crews making several short-duration trips of up to 14 days to the Moon until power supplies, rovers, and living quarters become operational. These initial missions would be focused, to a greater degree than originally envisioned in the ESAS, on the establishment of a lunar outpost. These initial missions would be followed by long-duration lunar missions, increasing up to 180 days.

As the long-term objectives of U.S. space exploration evolve, the near-term goals remains the same: to develop the flight systems and ground infrastructure required to enable continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond. The exploration vehicles proposed to be developed to meet this goal include the Orion spacecraft and two new launch vehicles, the Ares I and the Ares V. The Ares I launch vehicle would carry the Orion spacecraft to low Earth orbit where it would dock with either the International Space Station or with a payload launched earlier on an Ares V launch vehicle for transit to the Moon. For lunar missions, the Ares V launch vehicle would carry an Earth Departure Stage and Lunar Payload in a single launch. After the Orion spacecraft docks with the Earth Departure Stage/Lunar Payload in Earth orbit, the Earth Departure Stage engine would be ignited and would propel the Lunar Payload and the Orion spacecraft to the Moon. For future missions to Mars, Ares V launch vehicles would be used to launch the components needed to send and return a crew to Mars. This could include a Mars transfer vehicle, a lander, a surface habitat, and surface equipment.

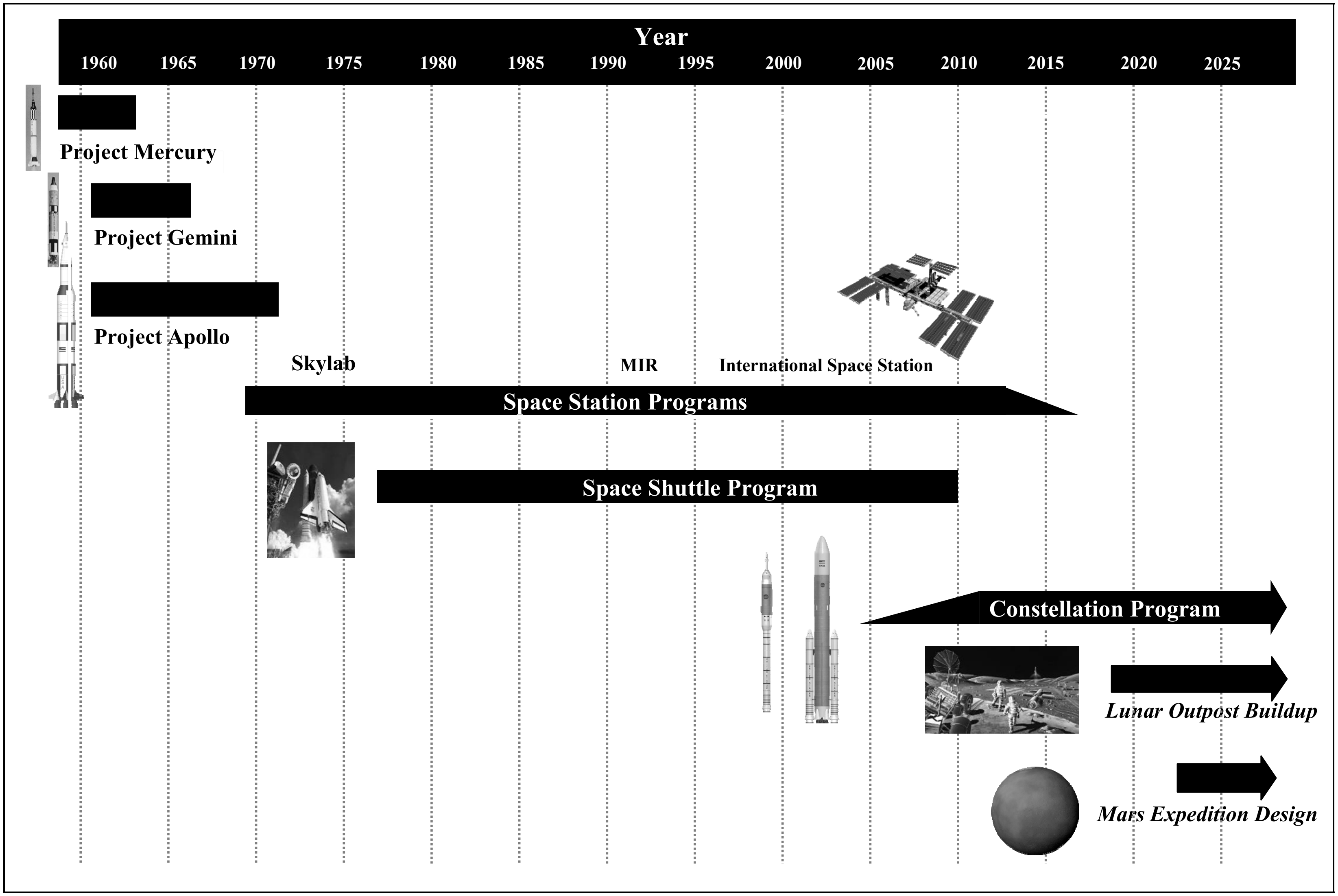
A timeline depicting U.S. human exploration efforts from Project Mercury through the proposed Constellation Program is shown in Figure 1-1.

## 1.2 PURPOSE AND NEED FOR ACTION

The announcement by President Bush in January 2004 of a new exploration initiative (the *Vision for Space Exploration*) set the long-term goals and objectives for U.S. space exploration efforts. The underlying goal of the initiative, hence the need for NASA action, is to advance the Nation's scientific, security, and economic interests through a robust space exploration program (TWH 2004). In achieving this goal, the U.S. will pursue the following initiatives:

- Implement a sustained and affordable human and robotic program to explore the Solar System and beyond
- Extend human presence across the Solar System, starting with a return of humans to the Moon by 2020 in preparation for human exploration of Mars and other Solar System destinations
- Develop innovative technologies, knowledge, and infrastructure both to explore and to support decisions about the destinations for human exploration
- Promote international and commercial participation in this new space exploration program.

As the lead agency, NASA was tasked with development of the plans, programs, and activities required to implement the Nation's space exploration efforts. The following directives were among those given to NASA in the NASA Authorization Act of 2005 (Pub. L. 109-155) and/or the President's announcement of the *Vision for Space Exploration* (TWH 2004):




Source: Adapted from NASA 2006c

**Figure 1-1. Timeline of the U.S. Human Exploration of Space**

- Develop a CEV to replace the Space Shuttle fleet by 2014, and as close to 2010 as possible
- To the fullest extent possible consistent with a successful development program, use the personnel, capabilities, assets, and infrastructure of the Space Shuttle Program in developing the CEV, CLV, and a heavy-lift launch vehicle
- Undertake lunar exploration activities directed at enabling robotic and human exploration of Mars and beyond
- Conduct the first extended human exploration mission to the lunar surface by the end of the next decade
- Use the knowledge gained from successful sustained human exploration of the Moon and robotic exploration of Mars, conduct human exploration expeditions to Mars and ultimately, other destinations in our Solar System.

The purpose of NASA's Proposed Action (Preferred Alternative) is to undertake the activities necessary to pursue the human exploration elements of these directives, including developing the flight systems and ground infrastructure required to enable the United States to have continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond. Robotic exploration activities are the responsibility of other NASA programs and are subject to separate NEPA review and documentation, as appropriate.

NASA's current human space flight system, the Space Shuttle, was designed to support missions and activities in low Earth orbit and is not suited to travel to the Moon or beyond. To fulfill the purpose outlined in the President's exploration initiative and to accomplish the specific directives given to NASA by the President and Congress, NASA has initiated the proposed Constellation Program to develop a new class of exploration vehicles and the infrastructure necessary to support their development and use in exploring the Moon, Mars, and beyond. Those exploration vehicles are the proposed Orion spacecraft and the Ares launch vehicles.

Developing the Orion spacecraft and the Ares launch vehicles is only a part of the effort needed for human exploration of space. Missions need to be planned, crews and ground personnel need to be trained, and ground systems need to be readied for launch. These efforts would require an extensive Earth-based infrastructure. This infrastructure (test stands, launch pads, and other support facilities) would provide the means to develop the exploration vehicles; to develop test systems and procedures; configure the flight and ground systems; train the crew and flight controllers; perform integrated launch services; plan and fly the missions; and provide post-landing and recovery services. The Constellation Program would meet this need through the use of existing (modified, if necessary) and new systems and facilities, as appropriate.

Human exploration of the Moon and Mars would also require the development of systems to protect the crew outside the confines of the Orion spacecraft or a habitation module and additional transportation systems to get to, land on, and return from the Moon and Mars. The Constellation Program would meet these needs by developing EVA systems (*e.g.*, spacesuits, tools, and servicing and support equipment), the Lunar Lander, Lunar Surface Systems, and Mars transportation and surface systems.

Beyond meeting the needs of the exploration initiative, the Constellation Program would greatly enhance NASA's ability to meet other broad goals of the U.S. Space Program. Historically, the U.S. Space Program has produced technological advances that have tangible, global benefits. For example, advances in weather forecasting, communications, computing, search and rescue technologies, and robotics and electronics are direct results of the U.S. Space Program. Medical technologies that help save lives, such as computer-aided tomography (CAT) scanners and magnetic resonance imaging (MRI) machines, are derived from technologies developed for use in the U.S. Space Program. Such benefits have come directly from activities by NASA and activities inspired by the discoveries and advancements made through NASA programs. The Constellation Program would continue to provide the opportunity for other advancements by contributing to:

- The extension of the human presence beyond Earth orbit
- The pursuit of scientific activities that address fundamental questions about the history of Earth, the Solar System, and the Universe
- A challenging, shared peaceful experience that unites nations in pursuit of common objectives
- The expansion of Earth's economic sphere and conducting activities with benefits to life on Earth
- A vibrant space exploration program to engage the public, encourage students, and help develop the high technology workforce that will be required to address the challenges of tomorrow.

As directed by the President, retirement of the Space Shuttle fleet is expected to occur by 2010 and is a separate action from the Constellation Program. The environmental impacts associated with retiring the Space Shuttle fleet will be addressed in the *Draft Programmatic Environmental Assessment for Space Shuttle Program Transition and Retirement*, which is scheduled to be released by NASA for public review and comment in early 2008.

## 1.3 NEPA ACTIVITIES FOR THE CONSTELLATION PROGRAM

### 1.3.1 NEPA Planning and Scoping Activities

On September 26, 2006, NASA published a Notice of Intent (NOI) in the *Federal Register* (*FR*) (71 *FR* 56183) to prepare a Draft Programmatic Environmental Impact Statement (PEIS) and conduct scoping for the Constellation Program. Scoping meetings to solicit public input on the environmental issues to be addressed and the alternatives to be considered in the PEIS were held on October 18, 2006 in Cocoa, Florida; on October 20, 2006 in Washington, DC; and on October 24, 2006 in Salt Lake City, Utah. Comments were solicited from Federal, state, and local agencies, and other interested parties on the scope of the Constellation Program. Scoping comments were received from private organizations and individuals in the form of letters, electronic mail, telephone messages, and oral and written comments provided at the public scoping meetings. The scoping period ended on November 13, 2006. Scoping comments expressed concerns or questions about technological and environmental issues.

The issues and concerns contained within the scoping comments fall into several broad categories, including environmental impacts associated with the Constellation Program, technological alternatives to the Proposed Action, and a variety of issues that are outside the scope of this Final PEIS. Issues that are outside the scope of this Final PEIS were not considered in the development of this Final PEIS.

The following issues were identified through the public scoping process:

- The economic impact of the Constellation Program, locally and nationally, with an emphasis on the impact of the Program on jobs near NASA Centers
- Risks to the public associated with launch and Earth atmospheric entry
- Environmental impacts of the use of solid rocket fuels on the ozone layer and impacts associated with the deposition of combustion products near the launch area
- Impacts on local animal species (*e.g.*, sea turtles and manatees) associated with construction and launch activities in the KSC area
- Noise impacts associated with launch events
- Relationship between the Constellation Program and the Space Shuttle Program, including how the socioeconomic impacts of the Space Shuttle retirement and the Constellation Program overlap.

These issues are addressed in various sections of Chapter 4 of this Final PEIS.

Additional technology-related issues that were identified through the public scoping process include:

- Alternative technologies to be used for the launch vehicles, including the possibility of using Evolved Expendable Launch Vehicles (*i.e.*, Atlas V and Delta IV launch vehicles) developed by the U.S. Air Force instead of developing new launch vehicles
- Involvement of entities other than NASA in the development of the launch systems, in particular, potential international partnerships and partnerships with private industry.

These issues are addressed in Section 2.3 of this Final PEIS.

Issues raised that are outside the scope of this Final PEIS include the following:

- Possible military applications associated with the Constellation Program.
- Legal issues associated with the use of the Moon and its raw materials.
- Environmental impacts in outer space, including impacts on the Moon.
- Use of nuclear systems in support of the Constellation Program. (Future program activities may benefit from use of nuclear systems in areas such as planetary electrical power generation or interplanetary propulsion. Technical studies will be conducted to determine whether nuclear-based systems can safely and affordably enhance future mission capabilities. Any future activities associated with development and use of nuclear systems for the Constellation Program would be subject to separate NEPA review and documentation, as appropriate.)

- Maintaining funding for the Constellation Program for the extended period required to meet the Program's goals.
- Possible gap in the ability of the U.S. to provide crew transport to the International Space Station.
- Supply of crew and/or cargo to the International Space Station by commercial entities (which would be subject to separate NEPA review and documentation, as appropriate, by NASA independently or in connection with the Federal Aviation Administration commercial licensing process).

An additional issue that was raised which is relevant to the Constellation Program, but not addressed fully in this Final PEIS, involves traffic impacts (*e.g.*, congestion and emissions) associated with landing events at a terrestrial landing site. Impacts associated with terrestrial landing sites would be addressed in separate NEPA documentation, as appropriate.

The Constellation Program actions have the potential to impact several resources that fall under the jurisdiction of other Federal agencies. Therefore, NASA would consult with these agencies as to the impact of the Constellation Program on these resources. The resource areas include, but are not limited to, marine habitats, threatened and endangered species, and historic properties. The Constellation Program has consulted with the U.S. Fish and Wildlife Service regarding sea turtles and the National Marine Fisheries Service regarding essential fish habitats at KSC for Ares launches. Consultations with the respective State Historic Preservation Officers also are underway at the NASA Centers where historic properties may have to be modified to accommodate Constellation Program activities. The Constellation Program would initiate other consultations as appropriate.

### 1.3.2 Results of Public Review of the Draft PEIS

NASA published a Notice of Availability (NOA) of the *Draft Constellation Programmatic Environmental Impact Statement* on August 17, 2007 (72 *FR* 46218). NASA mailed over 300 hard copies and/or compact disks (CDs) of the Draft PEIS to potentially interested Federal, state, and local agencies; organizations; and individuals. In addition, the Draft PEIS was made publicly available in electronic format on NASA's web site. NASA also sent electronic mail (e-mail) notifications to potentially interested individuals who had submitted scoping comments via e-mail but who had not provided a mailing address.

The public review and comment period for the Draft PEIS closed on September 30, 2007. NASA received a total of 21 submissions (letters and e-mails) from Federal, state, and local agencies; organizations; and individuals, of which, 14 submissions contained comments regarding the Constellation Program. Seven submissions only requested to be added to the mailing list to receive a copy of the Final PEIS. The comment submissions included concerns regarding:

- Establishing a light management plan at KSC
- Establishing a monitoring program for bird strikes at KSC
- Water quality, air quality, and hazardous wastes at the U.S. Army's White Sands Missile Range (WSMR) in New Mexico

- Performing a coastal zone consistency determination for Langley Research Center in Virginia
- Raising awareness of metals in the environment
- Environmental impacts in outer space, including impacts on the Moon.

All comment submissions received by NASA during the Draft PEIS public review period can be found in Appendix B of this Final PEIS, along with NASA's responses to specific comments. No alternatives to the Proposed Action were raised during the public review of the Draft PEIS.

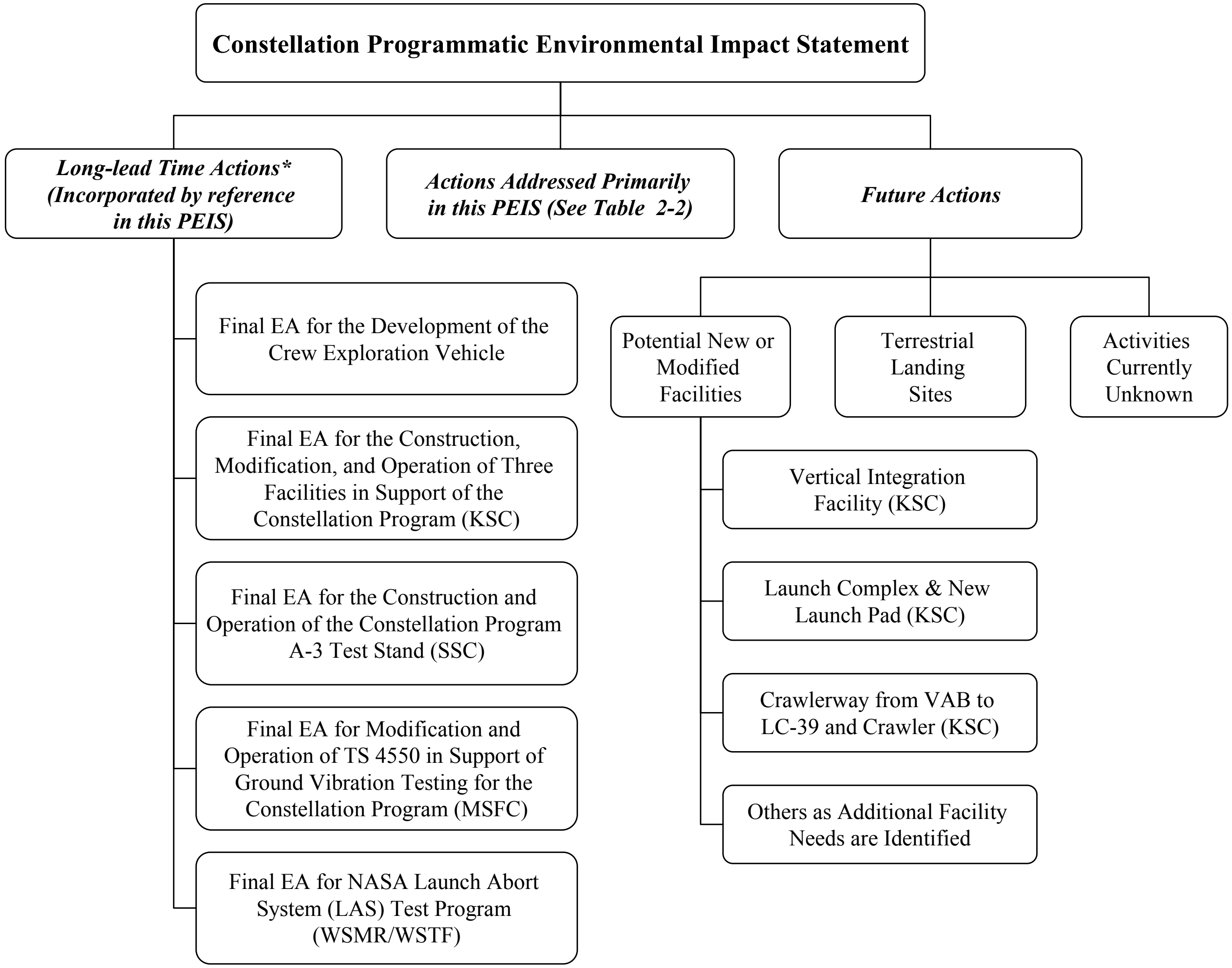
## 1.4 RELATED NEPA ACTIVITIES

The Constellation Program would be completed or accomplished in phases over several decades. This Final PEIS provides analyses of the anticipated and potential environmental impacts associated with the overall Constellation Program based on, and limited by, information currently available. However, in order to meet the timeline established by the President and Congress for the exploration initiative, NASA needed to begin work on several activities (*e.g.*, facility modifications and vehicle design, construction, and testing) in advance of rendering the record of decision (ROD) for the Final PEIS for the Constellation Program, anticipated in early-2008. As discussed in the following paragraphs and identified in Figure 1-2, NASA prepared separate NEPA documentation to analyze the potential environmental impacts of such activities prior to final planning and implementation. These NEPA documents are incorporated by reference in this Final PEIS.

NASA prepared the *Final Environmental Assessment for the Development of the Crew Exploration Vehicle* to address the design, fabrication, and assembly of a limited number of Orion spacecraft prior to selecting a prime contractor for this effort. NASA signed and published a Finding of No Significant Impact (FONSI) in the *Federal Register* on September 1, 2006 (71 *FR* 52169) enabling this action to proceed. Manufacture of the Orion spacecraft and additional testing are addressed in this Final PEIS.

NASA prepared the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* to address modifications to Launch Complex (LC)-39 Pad B and associated elements at KSC to support early flight development tests of the Orion/Ares I launch configuration and subsequent mission launches. In order to support these test launches, modifications to several KSC facilities would be required, including the installation of a new Lightning Protection System for LC-39 Pad B. In addition, a new Mobile Launcher would be developed and fabricated. The planning and initial construction associated with these activities needed to begin in 2007 to perform early ascent test flights in time to support the proposed first crewed Orion spacecraft flight by 2014. NASA signed a FONSI on May 2, 2007 enabling this action to proceed.

NASA prepared the *Final Environmental Assessment for the Construction and Operation of the Constellation Program A-3 Test Stand, Stennis Space Center, Hancock County, Mississippi* to address construction and operation of a new test stand (A-3) in support of Ares I Upper Stage liquid engine tests. Test stand construction needed to begin at SSC in 2007 in order to support




*Activities that need to be completed in advance to meet the Constellation Program Schedule

**Figure 1-2. Constellation Program NEPA Elements**

the proposed Ares I orbital flight tests from KSC in the 2012 timeframe. NASA signed a FONSI on June 4, 2007 enabling this action to proceed.

NASA prepared the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* to address test facility preparations and Launch Abort System testing activities. The Orion spacecraft design includes a Launch Abort System attached to the top of the Crew Module that would provide a means for the crew to escape in the event of an accident on the launch pad or during launch and ascent. An Orion/Launch Abort System Flight Development Test Program has been developed for this system and activities associated with the preparation of the test facilities needed to begin in 2007 in order to support the proposed first crewed Orion spacecraft flight by 2014. Launch Abort System tests would include on-pad and launch abort tests, which are expected to occur at WSMR. NASA signed a FONSI on August 5, 2007 enabling this action to proceed.

NASA prepared the *Final Environmental Assessment for Modification and Operation of TS 4550 in Support of Ground Vibration Testing for the Constellation Program* to address the modification of structures to support ground vibration testing of the Orion/Ares I integrated vehicle at George C. Marshall Space Flight Center (MSFC) in Huntsville, Alabama. The modification effort would consist of reconfiguring the existing East Test Area Test Stand (Building 4550) to conduct structural dynamic tests that would measure the dynamic characteristics of a full-scale Orion/Ares I vehicle. A FONSI is expected to be signed by NASA in early 2008.

In addition to the NEPA actions stated above, there are several other independent but overlapping actions discussed in the following paragraphs that would be expected to occur during the developmental phase of the Constellation Program.

The Constellation Program is considering the use of both water (ocean) and terrestrial landing sites for crew return. The selection of potential terrestrial landing sites is ongoing and some of the information necessary to identify and analyze the potential terrestrial landing sites will not be available before this Final PEIS is completed. Therefore, this Final PEIS includes only a general discussion of the environmental impacts associated with terrestrial landings. NASA intends to address the selection and operation of terrestrial landing sites in separate NEPA documentation, as appropriate. The environmental impacts associated with a water landing are addressed in this Final PEIS.

By Presidential order, the Space Shuttle fleet is to be retired by 2010 under a separate action from the Constellation Program. The environmental impacts associated with retiring the Space Shuttle fleet will be addressed in the *Draft Programmatic Environmental Assessment for Space Shuttle Transition and Retirement*, which is scheduled to be released by NASA for public review and comment in early 2008.

NASA has initiated agreements with several private sector companies via the U.S. Space Act to explore the possibility of supplying crew and cargo to the International Space Station on commercial terms, similar to terrestrial transportation (*e.g.*, commercial air transport) services. This effort could result in the replacement of some of NASA's transportation capabilities needed to support the International Space Station with privately developed launch vehicles and ground systems. The effort also could reduce the need for the Constellation Program to provide supply services needed to support the International Space Station. This effort would be addressed by separate NEPA review and documentation, as appropriate.

This Final PEIS is intended to address the potential impacts associated with proposed Constellation Program activities through the early 2020s. Under the present schedule, this includes the proposed development of the Ares launch vehicles and Orion spacecraft, development of advanced systems needed to successfully complete lunar missions (*e.g.*, the Lunar Lander, Lunar Surface Systems, spacesuits [also used for missions to low Earth orbit], and tools), development and construction of the infrastructure needed to support ground and mission operations, early missions to support the International Space Station, and short-duration missions to the Moon. The U.S. commitment to the International Space Station extends well into the next decade, with up to five proposed Orion/Ares I launches per year. The current Constellation Program baseline plan includes up to four lunar missions through 2020.

There are potential future activities associated with the Constellation Program that are beyond the scope of this Final PEIS. Missions to establish a permanent lunar outpost and crewed missions to Mars are activities that are currently not expected to occur during the timeframe addressed in this Final PEIS. Development, operation, and mission activities associated with these actions would be subject to separate NEPA review and documentation, as appropriate. Future program activities may benefit from use of nuclear systems in areas such as planetary electrical power generation or interplanetary propulsion. Technical studies will be conducted to determine whether nuclear-based systems can safely and affordably enhance future mission capabilities. Any future activities associated with development and use of nuclear systems for the Constellation Program would be subject to separate NEPA review and documentation, as appropriate.

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# 2. DESCRIPTION AND COMPARISON OF ALTERNATIVES

This Final Programmatic Environmental Impact Statement (PEIS) for the Constellation Program evaluates two alternatives, the Proposed Action (Preferred Alternative) and the No Action Alternative.

- Proposed Action: The National Aeronautics and Space Administration (NASA) proposes to continue preparations for and to implement the Constellation Program. The focus of the Constellation Program is the development and use of the flight systems and Earth-based ground infrastructure required to enable the United States to have continued access to space and to enable future human missions to the International Space Station, Moon, Mars, and beyond. The Constellation Program also would be responsible for development and testing flight hardware, and for performing mission operations once the infrastructure is sufficiently developed.
- No Action Alternative: NASA would not continue preparation for nor implement the Constellation Program. NASA would forego the opportunity for human missions to the Moon, Mars, and beyond using U.S. space vehicles. The U.S. would continue to rely upon robotic missions for space exploration activities. Other than the potential for commercial crew and cargo service to the International Space Station, the U.S. would depend upon our foreign partners to deliver crew and cargo to and from the International Space Station and for human space exploration.

## 2.1 DESCRIPTION OF THE PROPOSED ACTION (PREFERRED ALTERNATIVE)

### 2.1.1 Overview of the Proposed Action

As stated in Chapter 1, in January 2004, President George W. Bush announced a new exploration initiative (the *Vision for Space Exploration*) to return humans to the Moon by 2020 in preparation for human exploration of Mars and beyond. As part of this initiative, NASA was directed to retire the Space Shuttle fleet by 2010 and build and fly a new Crew Exploration Vehicle (CEV [since named Orion]) by 2014. Congress expressly endorsed the President's exploration initiative and provided additional direction for the initiative in the NASA Authorization Act of 2005 (Pub. L. 109-155).

NASA established an Exploration Systems Architecture Study (ESAS) Team to develop the framework for a program to meet the goals established in the exploration initiative. The ESAS Team took on the task of developing requirements for the new CEV and a baseline configuration to meet those requirements. The ESAS Team also examined multiple combinations of launch elements (types of launch vehicles and number of launches) to identify various types of missions (Design Reference Missions) needed to support lunar and Mars exploration activities and support missions to the International Space Station (see Appendix A). Studies evaluating additional options to meet these requirements then were conducted from this initial assessment.

The Proposed Action, to continue preparations for and to implement the Constellation Program, uses the ESAS and the underlying Presidential and Congressional directives as a starting point. The purpose of the Constellation Program would be to develop the flight systems and ground infrastructure required to enable the United States to have continued access to space and to enable future human missions to the International Space Station, the Moon, Mars, and beyond. The Constellation Program also would be responsible for testing flight hardware and performing mission operations once the infrastructure is sufficiently developed.

The Constellation Program would be extremely large and complex, spanning decades and requiring a combined effort from the broad spectrum of talent located throughout NASA and in private industry. Figure 2-1 provides a high-level schedule for the projected implementation of the Constellation Program, shown in conjunction with related NASA initiatives. The first crewed missions using the Orion spacecraft and the new Crew Launch Vehicle (CLV [since named Ares I]) are proposed by 2014 and would initially provide crew transport to the International Space Station. Once the Constellation Program is capable of supporting crewed transport, up to five flights per year are anticipated until the end of International Space Station operations. The United States (U.S.) commitment to International Space Station operations extends well into the next decade. The first human mission to the Moon is proposed by 2020. The initial crewed missions to the lunar surface would be short-duration stays (up to 14 days), similar to, but longer than the Apollo missions. These missions would demonstrate the capability to land humans anywhere on the Moon, operate for a limited time on the surface, and safely return the crew to Earth.

The initial short-duration missions would be used to explore sites of high scientific interest and identify potential future lunar outpost locations. They would evolve into longer duration missions, culminating in a permanently occupied lunar outpost. Expeditions to a lunar outpost would last up to 180 days. In addition to the lunar exploration capabilities associated with the outpost, these missions would provide the opportunity to test equipment and procedures that could be used on future human missions to Mars.

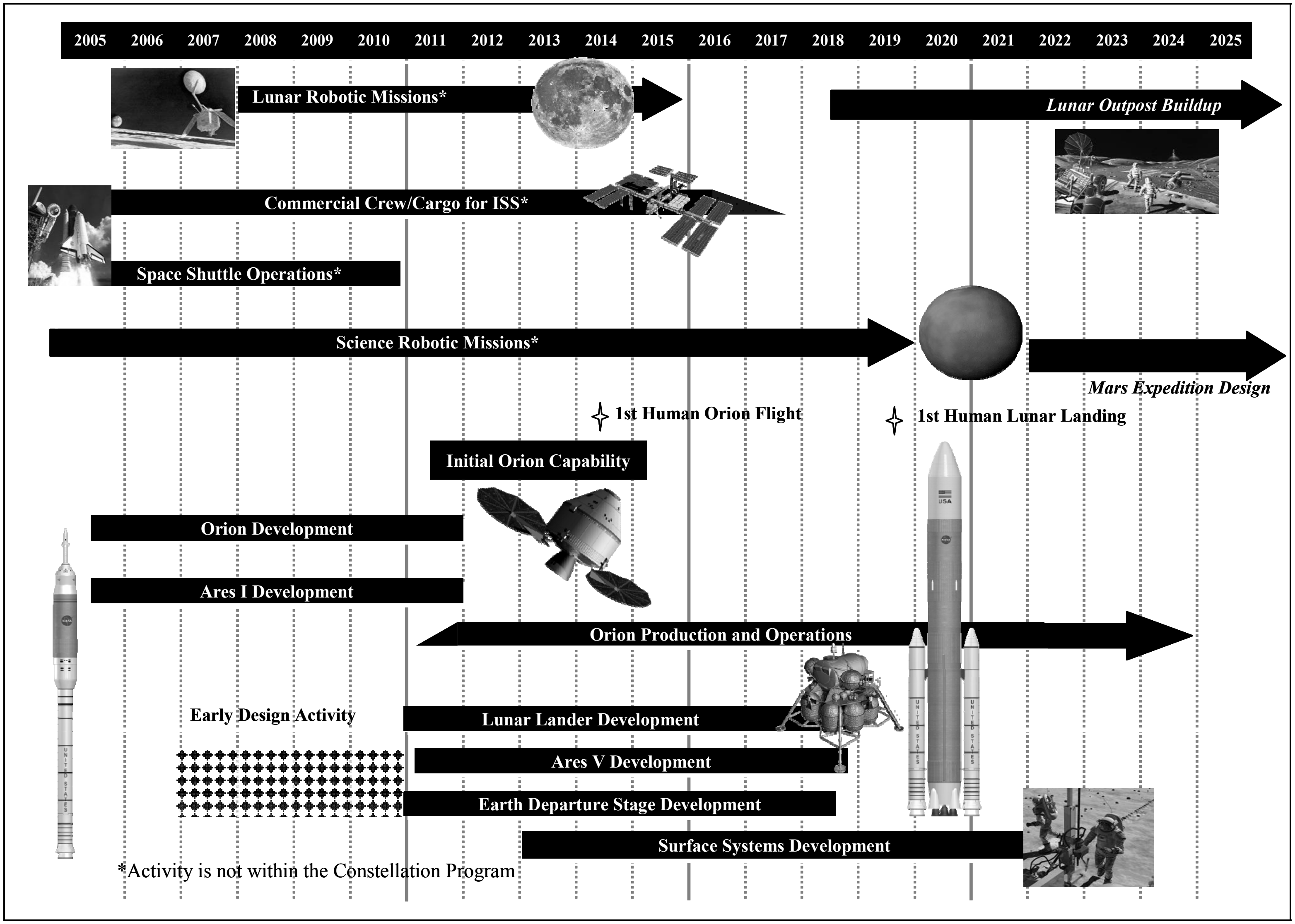
**PRINCIPAL U.S. GOVERNMENT AND COMMERCIAL FACILITIES CONTRIBUTING TO THE CONSTELLATION PROGRAM**
(based on current program information and contracts awarded to date)

***NASA Facilities***
- John F. Kennedy Space Center (KSC)
- John C. Stennis Space Center (SSC)
- Michoud Assembly Facility (MAF)
- Lyndon B. Johnson Space Center (JSC)
- George C. Marshall Space Flight Center (MSFC)
- John H. Glenn Research Center (GRC) at Lewis Field and at Plum Brook Station (PBS)
- Langley Research Center (LaRC)
- Ames Research Center (ARC)
- Johnson Space Center White Sands Test Facility (WSTF)
- Dryden Flight Research Center (DFRC)
- Goddard Space Flight Center (GSFC)
- Jet Propulsion Laboratory (JPL)

***Other Government Facilities***
- White Sands Missile Range (WSMR)

***Commercial Facilities***
- Alliant Techsystems-Launch Systems Group at Clearfield and Promontory, Utah (ATK)

Organizationally, the Constellation Program would consist of a single Program Office and multiple Project Offices. The Program Office, located at the Lyndon B. Johnson Space Center (JSC), would have overall responsibility for management of the Constellation Program. Each of the Project Offices would focus on specific technology and systems development and operational capabilities for the Program. The Project Offices currently consist of Project Orion, Project Ares, the Ground Operations Project, the Mission Operations Project, the Lunar Lander Project, and the Extravehicular Activities (EVA) Systems




Source: Adapted from NASA 2006c

**Figure 2-1. NASA's Exploration Roadmap with the Constellation Program through 2025**

Project (see Table 2-1). As additional mission requirements are developed, additional Project Offices would be established with the responsibility to develop the systems to meet such requirements (*e.g.*, Lunar Surface Systems and Mars Surface Systems). Collectively, these Project Offices would develop the mission systems (*i.e.*, crew vehicles, launch vehicles, and mission hardware) and the infrastructure needed to support crewed missions to the International Space Station and human exploration of the Moon, Mars, and beyond.

**Table 2-1. Summary of Constellation Projects**

| Constellation Project | Lead NASA Center | Function | |
|---|---|---|---|
| | | Developmental Phase | Operational Phase |
| Project Orion | JSC | Develop and test the Orion spacecraft to transport crew and cargo to and from space. | Provide Orion spacecraft. |
| Project Ares | MSFC | Develop and test the Ares I and Ares V launch vehicles. | Provide Ares launch vehicles. |
| Ground Operations Project | KSC | Perform ground processing and integrated testing of the launch vehicles. Provide logistics and launch services. Provide post-landing and recovery services for the crew (if any), Orion Crew Module, and spent Ares I First Stage and Ares V SRBs. | Provide launch services. Provide post-landing and recovery services for the crew, Orion Crew Module, and spent Ares I First Stage and Ares V SRBs. |
| Mission Operations Project | JSC | Configure, test, plan, and operate facilities, systems, and procedures. Plan missions and flight operations. | Train crew, flight controllers, and support staff. Coordinate crew operations during missions. |
| Lunar Lander Project | JSC | Develop and test the Lunar Lander to transport crew and cargo to and from the lunar surface and to provide a habitat for initial lunar missions. | Provide Lunar Lander. |
| Extravehicular Activities Systems Project | JSC | Develop EVA systems (spacesuits, tools, and servicing and support equipment) to support crew survival during launch, atmospheric entry, landing, abort scenarios, and outside the space vehicle and on the lunar surface. | Provide spacesuits and tools. |
| Possible Future Projects | To be determined | Develop systems for future applications including Lunar Surface Systems (this consists of a wide array of research and development activities associated with equipment and systems needed to operate on the lunar surface) and systems for future Mars exploration activities (*e.g.*, Mars transportation and surface systems). | Provide future systems as needed. |

Note: Range Safety for the Constellation Program is managed by JSC.

NASA prepared this Final PEIS early in the development of the proposed Constellation Program. As such, it remains undetermined what contractors and contractor facilities may be involved in many aspects of the fully implemented Constellation Program. However, as with previous NASA programs, contractors likely would play a major role in most aspects of the Constellation Program, and contractor work would likely be performed at both contractor-owned and government-owned facilities. This Final PEIS attempts to provide a public discussion of the Constellation Program's environmental impacts that is as comprehensive as possible and, as a result, includes some discussion of the potential environmental impacts of contractor work that would not be fully defined until procurement actions related to the Constellation Program are finalized. These discussions of anticipated environmental impacts are based on experience with previous NASA programs and on the best available information at the time of publishing this Final PEIS, and are provided solely to inform the public about anticipated or potential environmental impacts of the Constellation Program. Such discussions do not impact future procurement activities or indicate NASA's intentions concerning such activities.

#### *2.1.1.1 Project Office Responsibilities – Developmental Phase*

Project Orion would focus on production, assembly, and ground and flight testing of the Orion spacecraft (see Section 2.1.2). The initial design and development of the Orion spacecraft has been addressed in the *Final Environmental Assessment for the Development of the Crew Exploration Vehicle* (KSC 2006a). Project Ares would be responsible for design, development and testing the two new launch vehicles, Ares I and Ares V (see Section 2.1.3). To support launch operations, the Ground Operations Project would develop the ground infrastructure for vehicle processing (*i.e.*, final assembly and test) and launch (*i.e.*, ground servicing equipment, launch pads, and launch control) needed for both Orion and Ares (see Section 2.1.4). Ground Operations also would use systems developed for the Space Shuttle to recover the Ares I First Stage and Ares V Solid Rocket Boosters (SRBs) while new systems would be developed for recovery of the Orion Crew Module upon its return to Earth. The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. This could gain additional performance margin for certain missions by eliminating the launch weight of the booster recovery systems. The Mission Operations Project would develop the processes needed to prepare for missions (primarily training programs and mission plans) and manage the Earth-based infrastructure needed to execute the missions (*e.g.*, the Mission Control Center at JSC) (see Section 2.1.5). The Lunar Lander Project would be responsible for the design, development, and testing of the Lunar Lander (see Section 2.1.6). The EVA Systems Project would be responsible for developing spacesuits, tools, and equipment necessary to work outside the protective confinements of a spacecraft (see Section 2.1.7). Future mission requirements (*e.g.*, Lunar Surface Systems and Mars Systems) would be developed within an Advanced Projects Office (see Section 2.1.8). Separate projects would be established once these requirements mature sufficiently.

#### *2.1.1.2 Project Office Responsibilities – Operational Phase*

Once the mission systems have been developed, the Constellation Program would be responsible for providing the launch vehicles and infrastructure needed for each human exploration mission. The Constellation Program would be responsible for planning and executing human missions to multiple destinations.

Several mission concepts (see Appendix A) envisioned in the ESAS form the basis for the Constellation Program systems to be developed, including:

- Crewed missions to the International Space Station

- Cargo transport to the International Space Station
- Short-term lunar missions
- Cargo transport to the Moon
- Long-term lunar missions
- Crewed missions to Mars.

For each of these missions, each Project would be responsible for providing the systems and operational capabilities developed during the developmental phase (see Table 2-1). Project Orion would be responsible for building and delivering the Orion spacecraft to the Ground Operations Project at John F. Kennedy Space Center (KSC) for final assembly and integration with the Ares I launch vehicle. Project Ares would be responsible for constructing the components for the Ares I and, for lunar or Mars missions, the Ares V and delivering them to the Ground Operations Project at KSC where final assembly of the launch vehicle(s) would occur. For the short-term lunar missions, the Lunar Lander Project would be responsible for providing the Lunar Lander. Spacesuits and tools would be the responsibility of the EVA Systems Project. The Ground Operations Project would be responsible for final assembly and integration of the Orion spacecraft and Ares launch vehicles and for launch pad preparations and launch in coordination with Launch Range Safety at KSC/Cape Canaveral Air Force Station (CCAFS). The Ground Operations Project also would be responsible for retrieving the Ares I First Stage and Ares V SRBs, as appropriate. The Mission Operations Project would be responsible for planning the mission and training the crew and ground personnel needed to perform the mission. Once the mission is launched, the Mission Operations Project also would have the responsibility to perform the mission and coordinate all crew and ground personnel activities (*e.g.*, docking, lunar landing, surface activities, and return to Earth). Once the crew has returned to Earth, the Ground Operations Project assumes responsibility for the recovery of the crew and the Crew Module.

Table 2-2 summarizes the major Constellation Program activities that have the potential for environmental impacts. As discussed in Section 1.4, some of the activities (building modifications and construction of new facilities) are being addressed in separate NEPA documentation. These activities are part of the Proposed Action and the information contained within such separate NEPA documentation is incorporated into this Final PEIS by summary and reference.

#### *2.1.1.3 Project Locations*

Although the Constellation Program and the Projects would be led from three NASA Centers (JSC, KSC, and George C. Marshall Space Flight Center [MSFC]), the Constellation Program would utilize personnel and facilities throughout NASA, in addition to other U.S. Government and commercial personnel and facilities. Figure 2-2 provides the locations and responsibilities of the primary U.S. Government facilities, along with commercial facilities where potential significant environmental impacts from implementing the Constellation Program could occur. The construction and assembly of the Orion spacecraft would primarily occur at the Michoud Assembly Facility (MAF), KSC, and contractor facilities.

**Table 2-2. Summary of the Major Constellation Program Activities that Have the Potential for Environmental Impacts**

| Constellation Project | Project Elements | Project Actions | | | |
|---|---|---|---|---|---|
| | | Facility Construction and Modifications | Ground Tests | Flight Tests (Program Action) | Flight Missions |
| Project Orion | • Crew Module<br>• Service Module<br>• Launch Abort System<br>• Spacecraft Adapter | Modifications to various buildings, test facilities, and wind tunnels at multiple NASA Centers (JSC, GRC, LaRC, MAF, SSC, and WSTF) and at contractor sites.<br>Modifications to launch pad at WSMR. | Structural tests, drop tests, and wind tunnel tests.<br>Launch pad abort tests at WSMR. | Launch ascent abort tests at WSMR.<br>Ares sub-orbital and orbital flight tests.<br>Recovery of Ares I First Stage, Ares V SRBs, crew, and Crew Module. | Production of Orion flight systems. |
| Project Ares | <u>Ares I</u><br>• First Stage<br>• Upper Stage<br>• Upper Stage engine (J-2X)<br><u>Ares V</u><br>• SRBs<br>• Core Stage<br>• Core Stage engines (RS-68B)<br>• Earth Departure Stage<br>• Earth Departure Stage engine (J-2X) | Modifications to various buildings and test stands at multiple NASA Centers (MSFC, SSC, MAF) and at contractor sites. (MAF is a candidate site for manufacture and assembly of the Ares V Core Stage and the Earth Departure Stage)<br>Construction of a new test stand (A-3) at SSC.<br>Modifications to Structural Dynamic Test Facility at MSFC. | Engine/motor tests, structural tests, and wind tunnel tests.<br>J-2X engine tests at SSC.<br>Main Propulsion Test Article engine tests and Ares structural tests at MSFC.<br>SRB drop tests for parachute testing. | | Production of Ares flight systems. |
| Ground Operations Project | • Vehicle integration<br>• Vehicle processing<br>• Ares I First Stage and Ares V SRB recovery<br>• Crew and Crew Module recovery<br>• LC-39 Pads A and B | Modifications to various buildings, processing and test facilities, and LC-39A at KSC.<br>Modifications to LC-39B, Launch Control Center, and Mobile Launch Platform at KSC. | Orion/Ares integrated system checks. | | Final processing and launch, refurbish LC-39 Pads A and B following launches, and recovery of the Ares I First Stage, Ares V SRBs, crew, and Crew Module. |
| Mission Operations Project | • Flight and ground crew training<br>• Mission planning and execution | Modifications to various buildings at JSC. | None | | Mission management. |
| Lunar Lander Project | <u>Lunar Lander</u><br>• Descent and ascent stages | None currently defined | None currently defined | | Production of Lunar Lander flight systems. |
| Extravehicular Activities Systems Project | • Spacesuits<br>• Tools and equipment for space and surface operations | None currently defined | None currently defined | | Production of systems to sustain humans in space and lunar surface environments. |

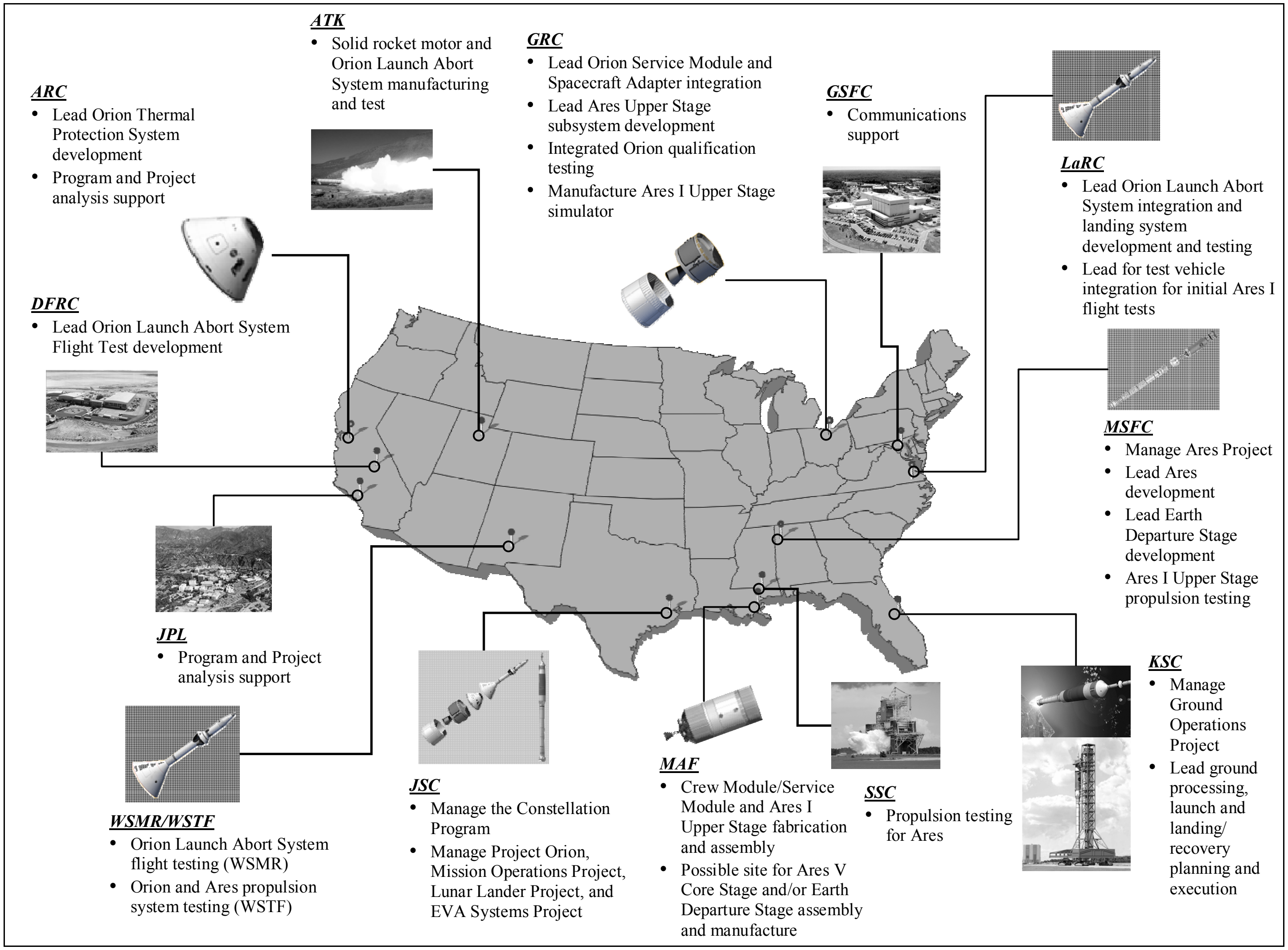



**Figure 2-2. Major Constellation Program Responsibilities**

The construction of the Ares launch vehicles would be performed at contractor and government facilities with final assembly at KSC. The Ares I First Stage and the Ares V Solid Rocket Boosters would be manufactured at Alliant Techsystems-Launch Systems Group (ATK). The Ares I Upper Stage would be assembled at MAF. Development of the vehicles would include a wide variety of test activities. Engine and solid rocket motor tests would be expected to be performed at both contractor and U.S. Government facilities (*e.g.*, John C. Stennis Space Center [SSC], MSFC, Johnson Space Flight Center White Sand Test Facility (WSTF), and ATK and would include vehicle test launches at KSC). Vacuum chamber and wind tunnel testing would primarily occur at NASA Centers although other U.S. Government and commercial facilities may also be used.

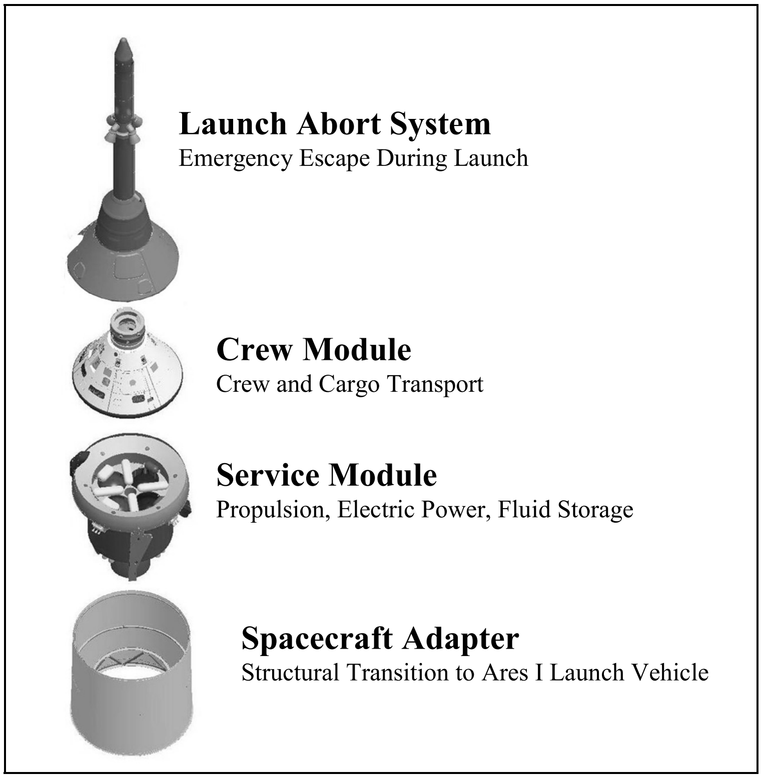
The Constellation Program would utilize many existing resources (*e.g.*, buildings, test stands, and wind tunnels) at each site, as well as require the construction of several new facilities for specialized use. Section 2.1.9 of this Final PEIS identifies the proposed government resources being considered for use in the Constellation Program that would be newly constructed, would require substantial modifications in which NEPA documentation via an EA or EIS would be anticipated, and/or are considered a historic resource.

### 2.1.2 Project Orion

Project Orion would be led by JSC with participation from Ames Research Center (ARC), Dryden Flight Research Center (DFRC), John H. Glenn Research Center (GRC), Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), KSC, Langley Research Center (LaRC), MSFC, MAF, WSTF, and the U.S. Army's White Sands Missile Range (WSMR). In August 2006, Lockheed Martin Corporation was selected as the Prime Contractor for the Orion spacecraft.

Project Orion would lead the development of the Orion spacecraft. In order to meet the proposed Constellation Program schedule for flight readiness of the Orion spacecraft, developmental efforts needed to begin before this PEIS was scheduled to be completed. Therefore, design, fabrication, and assembly of a limited number of spacecraft for testing purposes were addressed in the *Final Environmental Assessment for the Development of the Crew Exploration Vehicle* (KSC 2006a). In addition, Launch Abort System tests would need to be performed on several test articles, currently planned for September 2008. Preparation for these tests at WSMR needed to begin before this PEIS was scheduled to be completed. An Environmental Assessment (*Final Environmental Assessment for NASA Launch Abort System [LAS] Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico*) addressing this testing activity has been completed. Manufacture, integrated testing, and flight testing of Orion elements as well as flight missions are addressed in this Final PEIS.

The basic design of the Orion spacecraft consists of the Crew Module, Service Module, Spacecraft Adapter, and Launch Abort System (see Figure 2-3). The Orion spacecraft would be approximately 5 meters (m) (16.4 feet [ft]) in diameter and 15.3 m (50.3 ft) in length with a mass of approximately 14,000 kg (31,000 lb). This configuration provides the capability to carry crew and cargo to and from low Earth orbit and lunar orbit. The Orion spacecraft would provide crew habitation in space; docking capability with other launched components and the International Space Station; and perform Earth return, atmospheric entry, and landing. The Orion spacecraft could be configured to carry a crew of up to four to and from lunar orbit and up to six to and from the International Space Station, or carry pressurized cargo to and from the International Space Station without a crew.



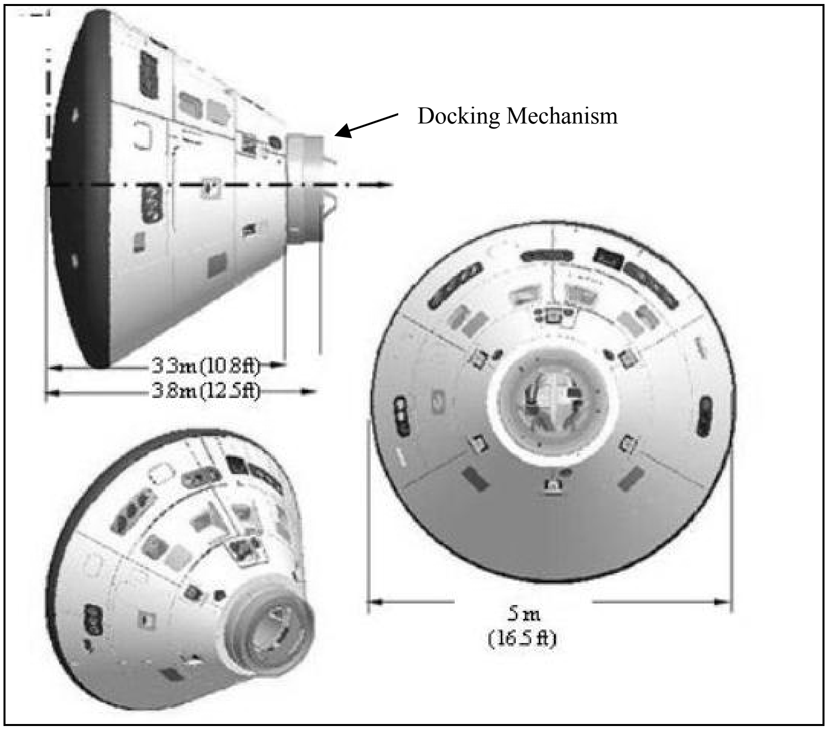

Source: Adapted from JSC 2007g

**Figure 2-3. Orion Spacecraft Modules**

### *2.1.2.1 Crew Module*

The Crew Module would provide habitable volume for four to six crew members (approximately 20 to 25 cubic m [$m^3$] or 706 to 883 cubic ft [$ft^3$]), life support, pressurized space for cargo during uncrewed missions, the ability to dock with other space vehicles, and atmospheric entry and landing capabilities (see Figure 2-4). The primary landing mode for the Crew Module (*i.e.*, terrestrial or water [ocean] landing) has not yet been selected; however, the ability to land on both is a Constellation Program requirement. After atmospheric friction slows the descending spacecraft during atmospheric entry, the Crew Module would deploy its parachutes and may jettison the heat shield and other components (*e.g.*, drogue parachutes and parachute covers). If a terrestrial landing location is selected, it is anticipated that the heat shield and other components jettisoned during descent would land within the confines of the landing location (defined as a 10 km [6.2 mi] diameter circle) and be recovered. After recovery, the Crew Module would be retrieved, refurbished, and reflown (NASA 2005e).

The shape of the Crew Module is similar to that of the Apollo Command Module; however, the Orion Crew Module is much larger, providing more than twice the usable interior volume. The Crew Module support structure would be fabricated from aluminum, with the outside skin panels composed of a carbon-fiber composite similar to that developed previously for NASA's X-37 Approach and Landing Test Vehicle. The Crew Module's windows would be made from fused silica similar to the windows on the Space Shuttle.




Source: Adapted from JSC 2007g

**Figure 2-4. Orion Crew Module**

The Crew Module Thermal Protection System consists of an expendable heat shield on the bottom of the spacecraft and reusable external and internal insulation. A number of candidate materials were evaluated for use in the Thermal Protection System (*e.g.*, silica, carbon fibers, ceramics, and combinations of these materials). Many of these have been deployed previously on NASA spacecraft, including the Space Shuttle (JSC 2005a). Phenolic impregnated carbon ablator (PICA), a low-density composite, is the currently preferred material for use in the Thermal Protection System. PICA was first used on the Stardust robotic sample return mission.

The Crew Module Reaction Control System would provide vehicle control, using a gaseous-oxygen and gaseous-methane bipropellant, following separation from the Service Module in preparation for atmospheric entry. A similar system was developed and ground-tested for potential use on the Space Shuttle and commercial spacecraft (NASA 2005e). The Constellation Program is currently studying the possibility of substituting the methane/oxygen bipropellant with a monopropellant (*e.g.*, hydrazine) for the Reaction Control System.

Four rechargeable lithium-ion batteries aboard the Crew Module, in conjunction with two solar arrays mounted on the Service Module, would provide electric power to the Orion spacecraft. These batteries also would provide power following separation from the Service Module prior to atmospheric entry (NASA 2005e).

Other Crew Module systems would include landing mechanisms (which could include a parachute deceleration system, a landing loads attenuation system [possibly including airbags] to facilitate a terrestrial touchdown, as well as a water flotation system for water landing) and a docking mechanism for mating with the International Space Station and other space vehicles. While the nominal landing location (terrestrial or water) has not been finalized, the possibility of launch aborts during ascent dictates that the Crew Module be capable of landing in water. The Crew Module would have ground service capability to extract and contain any residual fuel.

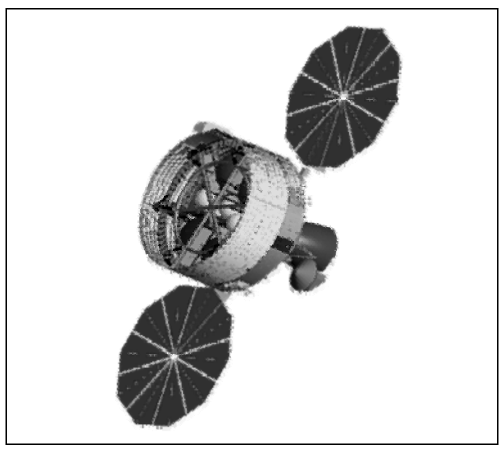
Table 2-3 summarizes the potential materials of concern that would be used in major Crew Module subsystems and components. A majority of these materials have been deployed in NASA human space-flight missions.

**Table 2-3. List of Potential Materials of Concern for Use in the Orion Crew Module**

| Subsystem or Component | Potential Materials of Concern |
|---|---|
| Pressure Vessel | May be composed of aluminum honeycomb sandwich core and aluminum face sheets |
| Outer Skin | A carbon-based resin composite may be used; other materials to be considered (*e.g.*, aluminum) |
| Windows | May be composed of double-paned fused silica panels |
| Heat Shield | May be composed of PICA; other materials to be considered |
| External and Internal Insulation | May be composed of silica and nylon-based materials for external use; other external materials to be considered; internal insulation may be fibrous alumina |
| Propulsion | Primary and backup Reaction Control System may be gaseous oxygen and gaseous methane. The use of a monopropellant (*e.g.*, hydrazine) is currently under study. |
| Electric Power | Lithium-ion batteries assumed for primary and backup power |
| Environmental Control | Fire suppression system would be expected to use halon; active thermal control may include propylene glycol loop and a dual fluid loop (water or Freon®) for peak heating loads |

### *2.1.2.2 Service Module*

The Orion Service Module is a cylindrical structure that would be attached aft of the Crew Module and would primarily house propulsion and power systems, a high-gain antenna for communication, and the radiator panels used to reject heat developed within the Crew Module. It would be 16.4 ft (5 m) in diameter and 20.4 ft (6.2 m) long (including engine nozzle) (see Figure 2-5). The Orion Service Module is similar in design to the cylindrical Apollo Service Module (which provided propulsion and housed spacecraft support systems) with the addition of solar arrays. NASA is still evaluating the design of the Service Module, but is considering a design in which the Service Module would be encapsulated within the



Source: Adapted from JSC 2007d

**Figure 2-5. Orion Service Module**

fairings of the Spacecraft Adapter. The Spacecraft Adapter fairings would be jettisoned (in three sections) during ascent. While physically different from the original design, the encapsulated design would be functionally similar. Candidate construction materials include carbon-fiber composites and aluminum alloys (JSC 2005a).

The Service Module would have a service propulsion system and a Reaction Control System with the capability to perform a late-ascent abort, if required. The propulsion system would be used for rendezvous and docking maneuvers in Earth orbit, ferry the Crew Module back from the Moon, and at the end of a mission to place the Service Module on a trajectory to splash down in the Pacific Ocean following separation from the Crew Module. It is expected that components of the Service Module that survive atmospheric entry would sink, although some components (including fuel tanks) may survive sufficiently intact to remain afloat. The fuel tanks would be expected to vent fully prior to debris impact, although trace amounts of propellant could be contained within some surviving components. The propellants for the Service Module Reaction Control System would be monomethylhydrazine and nitrogen tetroxide (NASA 2006b).

Two deployable solar arrays attached to the Service Module, along with the four rechargeable lithium-ion batteries aboard the Crew Module, would be used to generate electric power for the Orion spacecraft. The solar arrays would use state-of-the-art photovoltaic cells (*e.g.*, gallium-arsenide).

The Service Module also would provide a mounting location for radiator panels. These panels would provide heat rejection capability for the Orion fluid-loop system. The radiator would have a heat-rejecting coating (*e.g.*, silver-Teflon®). The Service Module Thermal Protection System would consist of insulation blankets for passive thermal control. Insulation materials would likely be similar to the non-heat shield components of the Crew Module Thermal Protection System (NASA 2005e).

Table 2-4 summarizes the potential materials of concern that would be used in major Service Module subsystems and components. A majority of these materials have been deployed in NASA human space-flight missions.

**Table 2-4. List of Potential Materials of Concern for Use in Major Service Module Subsystems and Components**

| Subsystem or Component | Potential Materials of Concern |
|---|---|
| Structure | A carbon-based resin composite may be used; other materials to be considered (*e.g.*, aluminum) |
| Internal Insulation | May be composed of silica, nylon, or alumina-based materials |
| Propulsion | Monomethylhydrazine and nitrogen tetroxide* |
| Electric Power | Gallium-arsenide may be used in solar arrays |
| Environmental Control | May use a radiator system with a silver-Teflon® coating |

* These materials have been selected for use as the Service Module propellants.

### *2.1.2.3 Launch Abort System*

Should an emergency arise during launch or early ascent operations, rapid escape from the Orion/Ares I launch stack would be made possible by means of the Launch Abort System.

NASA completed an EA (*Final Environmental Assessment for NASA Launch Abort System [LAS] Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico*) for testing activities and associated construction to develop the Launch Abort System. The Orion Launch Abort System would consist of solid fueled motors for tower jettison, launch escape, and attitude-control, and would be mounted on top of the Crew Module (see Figure 2-3). Pyrotechnics would be utilized to separate the Crew Module from the Service Module and a rocket motor in the Launch Abort System would pull the Crew Module away from the remainder of the launch vehicle stack. The Launch Abort System would utilize approximately 2,350 kg (5,200 lbs) of polybutadiene acrylonitrile (PBAN) solid propellant (JSC 2005c).

During a routine launch, the Launch Abort System would be jettisoned approximately 30 seconds after First Stage separation and would splash down in the Atlantic Ocean. The Launch Abort System, along with unburned propellant (during a routine launch most of the solid propellant would be unburned), would not be recovered. After the Launch Abort System is jettisoned, emergency abort capability for the crew would be provided by the Service Module propulsion system (JSC 2005c, NASA 2005e).

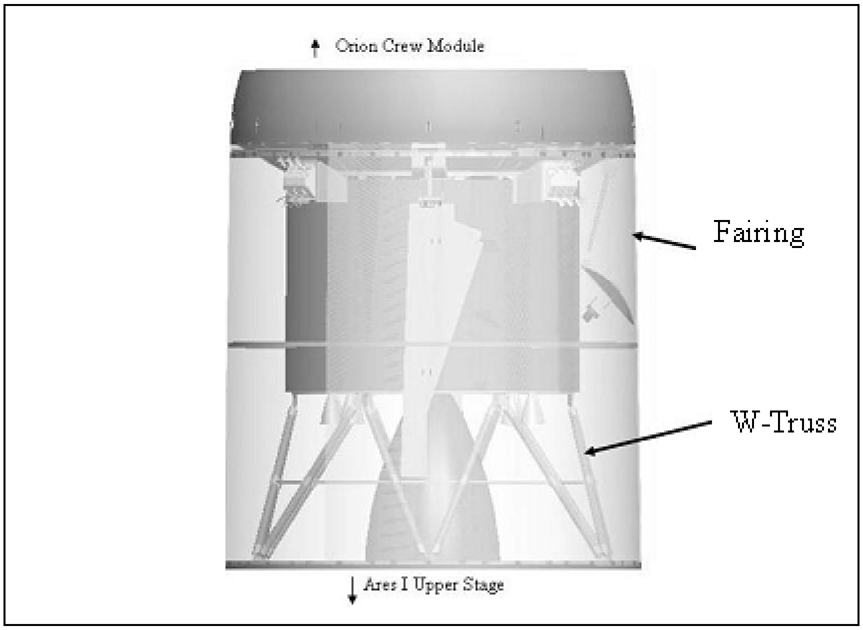
#### *2.1.2.4 Spacecraft Adapter*

The Service Module is connected to the Ares I launch vehicle through the Spacecraft Adapter, which consists of a W-Truss and a fairing (see Figure 2-6). The Spacecraft Adapter fairing could fully encapsulate the Service Module, as discussed in Section 2.1.2.2. The Spacecraft Adapter provides a smooth physical transition from the Ares I Upper Stage to the Orion and a conduit for data transfer between the vehicles. This arrangement allows structural load sharing between the Service Module internal structure and the fairing during peak loading events of the ascent phase, but allows the fairing to be jettisoned once the vehicle has left the atmosphere. The Spacecraft Adapter fairing sections also provide protection for the Service Module structure (including the main engine, the solar arrays, and the high gain antenna) during ascent. After main engine cutoff, the Spacecraft Adapter, without the fairings, remains attached to the Ares I Upper Stage while the Service Module separates from the Spacecraft Adapter. Structural materials to be used for the Spacecraft Adapter would be similar to those used for the Service Module.

#### *2.1.2.5 Facilities*

The Orion Crew Module and Service Module would be largely fabricated and assembled at MAF. Final assembly, integration, and checkout of the four modules of the Orion (*i.e.*, Crew Module, Service Module, Launch Abort System, and Spacecraft Adapter) would be performed at KSC.

System test and development activities of the Orion spacecraft would take place at several NASA and other U.S. Government facilities, as well as at contractor facilities. Drop testing of the Orion Crew Module would occur at LaRC to test prospective air bags for terrestrial landings. Wind tunnel tests could be performed in several existing LaRC facilities. Additional vacuum chamber dynamic testing would be performed at GRC's Space Power Facility (Building 1411) at Plum Brook Station (PBS). Environmental qualification testing performed at this facility would include acoustic and random vibration, thermal vacuum, and electromagnetic interference and compatibility tests.




Source: Adapted from JSC 2007f

**Figure 2-6. Spacecraft Adapter**

Flight testing of the Launch Abort System would be conducted at WSMR. This activity is discussed in more detail in Section 2.1.10.2.

The Long Duration Evaluation Facility (Building 29) at JSC would be modified to house the CEV Avionics Integration Laboratory. The CEV Avionics Integration Laboratory would provide the capability to perform integrated testing of the avionics software and hardware systems for the Orion spacecraft.

### 2.1.3 Project Ares

Project Ares would be led by MSFC and would be responsible for the development of the Ares I and the Ares V launch vehicles. Project Ares would be responsible for design, development, testing, and evaluation, as well as supporting requirements development and planning for integrating the Ares launch vehicle to the payload, and providing the appropriate interfaces with Ground Operations, and Mission Operations.

Two launch vehicles would be developed under the Proposed Action, the Ares I (the Crew Launch Vehicle), and the Ares V (the Cargo Launch Vehicle). The Ares V is in an early conceptual stage and while significant detail is provided on its current planning concept, the ultimate vehicle requirements and configuration would be dictated by the performance necessary to support Lunar Lander, Lunar Surface Systems, and Mars missions. If significant changes to the Ares V planning configuration reflected in this Final PEIS occur as the project matures, they would be subject to separate NEPA review and documentation, as appropriate (MSFC 2007i).

The Ares I launch vehicle would provide the capability to carry the Orion spacecraft towards low Earth orbit where the Orion spacecraft can dock to the International Space Station or a payload previously launched by an Ares V. The Ares V would provide the capability to carry the lunar payload, and other necessary systems and hardware, to low Earth orbit for lunar, and eventually Mars, missions. The Ares I and Ares V would be developed with propulsion and structures hardware commonality. Common elements being developed for the Ares I and Ares V launch vehicles potentially include the solid rocket motors and the J-2X Upper Stage engine. The Ares V Core Stage would use RS-68B engines derived from the RS-68 currently used in the Delta IV launch vehicle, and liquid oxygen (LOX) and liquid hydrogen (LH) tanks similar to those used in the Space Shuttle.

Project Ares would build on legacy systems to maximize the use of existing knowledge bases and resources, such as infrastructure and workforce, and involves multiple NASA Centers providing support in their respective areas of expertise. Project Ares would use the SRB technology from the Space Shuttle Program as the basis for the Ares I First Stage. The J-2X engine planned for use in the Ares I Upper Stage (and the Earth Departure Stage of the Ares V) would be a derivative of the J-2 engine used on the second and third stages of the Saturn V and the second stage of the Saturn IB launch vehicles. The RS-68 engine was developed in the late 1990s and early 2000s for the U.S. Air Force's (USAF's) Evolved Expendable Launch Vehicle Program.

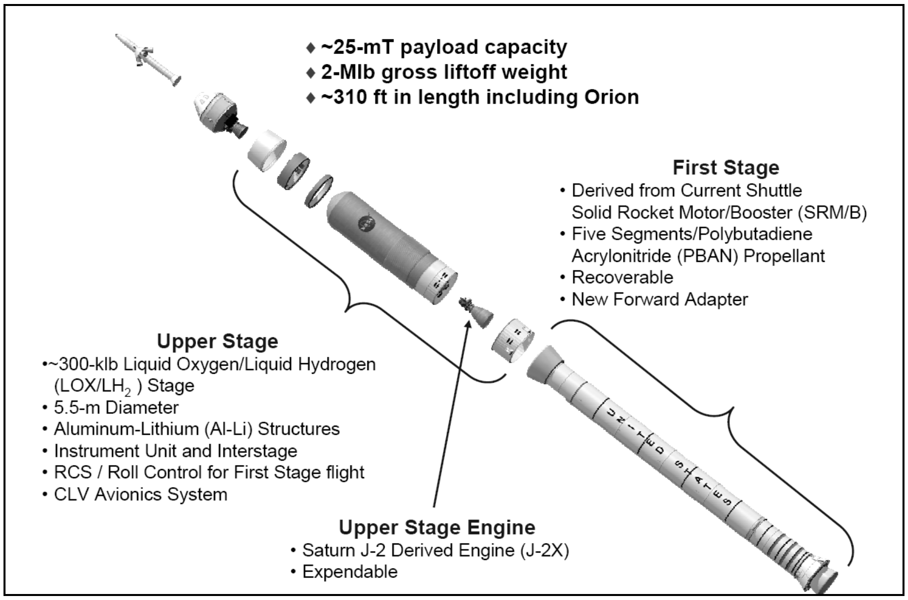
Project Ares would test increasingly flight-like vehicle configurations leading to full-up flight tests that would be followed by initial operational flights. The flight tests would provide engineering data and give confidence in the engineering designs. The flight tests would be used as final verification of the vehicle designs and manufacturing methods. Ground testing would utilize wind tunnel test facilities at ARC, MSFC, LaRC, and potential commercial facilities. Vibration and inertial testing would be performed at MSFC. Engine test stands at SSC would be used for ground test firings of the liquid fueled engines, both individually and in clusters (for Ares V Core Stage tests). Engine test stands at MSFC also would be used for ground test firings of the liquid fueled engines of the Main Propulsion Test Article to support development of the Ares I Upper Stage and Ares V Earth Departure Stage. Flight testing would occur at KSC utilizing Space Shuttle launch facilities (*e.g.*, Launch Complex [LC]-39), which would be modified for the Ares launch vehicles (see Section 2.1.4.2).

#### *2.1.3.1 Ares I – Crew Launch Vehicle*

The Ares I would be a two-stage launch vehicle with interfaces for the Orion spacecraft and ground systems at the launch site (see Figure 2-7). The First Stage would be a five-segment SRB fueled with approximately 635,000 kg (1.4 million lbs) of PBAN solid propellant. The Upper Stage would be a self-supporting cylindrical system that would house the LOX and LH tanks that feed propellant to the J-2X engine, along with the avionics, roll control, and thrust vector control systems.

The Ares I would be able to lift an estimated 23,400 to 25,000 kg (51,500 to 55,000 lb). During a mission, the Ares I First Stage interstage would be jettisoned a little more than two minutes after launch. The interstage and First Stage frustum would separate from the spent stage and splash down in the Atlantic Ocean and not be recovered. It is expected the First Stage frustum and interstage would survive impact in the Atlantic Ocean and sink. Residual hydrazine propellant from the roll control system may remain in the fuel tanks at impact. A parachute system would allow the First Stage to be recovered from the Atlantic Ocean and returned to

KSC. At KSC, the Ares I First Stage would be disassembled and cleaned, and the solid rocket motor casings would be transported to ATK in Utah for refurbishment and refueling. Other components of the First Stage would be refurbished at KSC (see Section 2.1.4). The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage for certain missions. This could gain additional performance margin for certain missions by eliminating the launch weight of the booster recovery systems.




Source: MSFC 2007e

**Figure 2-7. Ares I Launch Vehicle**

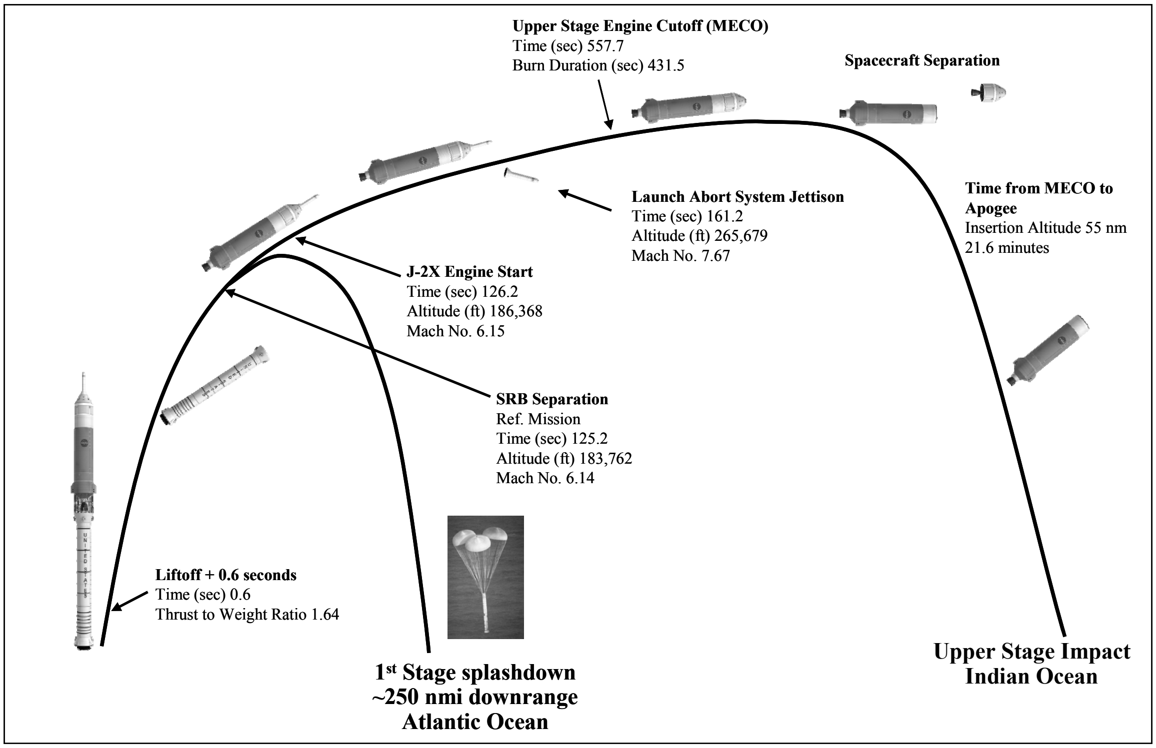
The Upper Stage would separate from the Orion spacecraft after main engine cutoff. The Upper Stage would enter the Earth's atmosphere and splash down in the Indian Ocean (see Figure 2-8). It is expected that components of the Upper Stage that survive atmospheric entry would sink although some (including fuel tanks) may survive sufficiently intact to remain temporarily afloat. Residual amounts of propellant may be contained within surviving components.

The Orion/Ares I is estimated to be as much as 10 times safer for the crew than the Space Shuttle, primarily due to its in-line design and incorporation of the Launch Abort System for crew escape (NASA 2005e).

#### 2.1.3.1.1 Description of the Ares I Launch Vehicle

First Stage

The five-segment Ares I First Stage would be derived from existing four-segment Space Shuttle SRB hardware and constructed of generally the same materials except for Ares I unique hardware (see Table 2-5). Once assembled, the Ares I First Stage would be 53 m (174 ft) long and 3.6 m (12 ft) in diameter. The aft section contains avionics, a Thrust Vector Control system which includes redundant hydraulic systems and hydrazine fueled power units, and a nozzle extension jettison system. The forward section of the First Stage contains avionics, a sequencer, pilot, drogue and main parachutes, and a recovery system (*e.g.*, recovery beacon and light).




Note: Ares I launch profiles for lunar missions and International Space Station missions are similar.

Source: Adapted from MSFC 2006c

**Figure 2-8. Ares I Launch Profile**

**Table 2-5. List of Potential Materials of Concern for Use in the Ares I First Stage**

| Component | Potential Materials of Concern |
|---|---|
| Motor Casings | Steel, aluminum, and insulating materials |
| Nozzles | Carbon, glass, and silica cloth phenolics and natural and silicon rubber.<br>Small quantities of the following (few lbs or gallons [gal] per nozzle): phenolic resin, PR-1422 polysulfide, paints, silicone elastomer, thermal insulation compound (silicone base/carbon filled silicone rubber), cork-filled epoxy ablator, and adhesives |
| Aft Skirt | Steel, aluminum, titanium, hydraulic fluid, hydrazine, and foam insulation |
| Forward Structures | Steel, aluminum, composite structures, cork insulation, nylon and kevlar (parachutes) |

Source: ATK 2006

Like the current Space Shuttle SRB, the First Stage would use PBAN solid propellant (see Table 2-6). The First Stage would be designed with a new forward adapter (replacing the nose cap used on the Space Shuttle SRB) for mating to the Upper Stage. The First Stage expanded view is shown in Figure 2-9.

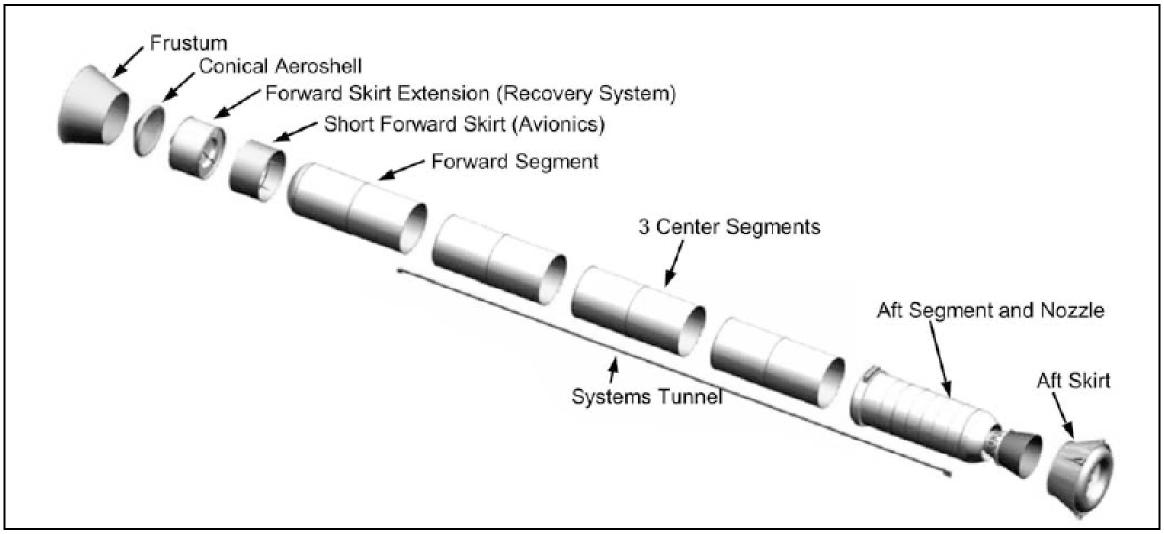
Upper Stage

The Ares I Upper Stage would be a new configuration that would be designed by MSFC. The Upper Stage would be a self-supporting cylindrical structure, approximately 35 m (115 ft) long and 5.5 m (18 ft) in diameter and powered by a single J-2X main engine. In September 2007, the Boeing Company was selected as the prime contractor for the Upper Stage.

**Table 2-6. PBAN (Solid Propellant) Composition for Ares I First Stage**

| PBAN Materials | Quantity |
|---|---|
| Ammonium Perchlorate | 434,000 kg (957,000 lbs) |
| Aluminum Powder | 100,000 kg (220,000 lbs) |
| HB Polymer | 75,000 kg (165,000 lbs) |
| Epoxy Resin | 12,000 kg (27,000 lbs) |
| Ferric Oxide | 1,800 kg (4,100 lbs) |

Source: ATK 2006



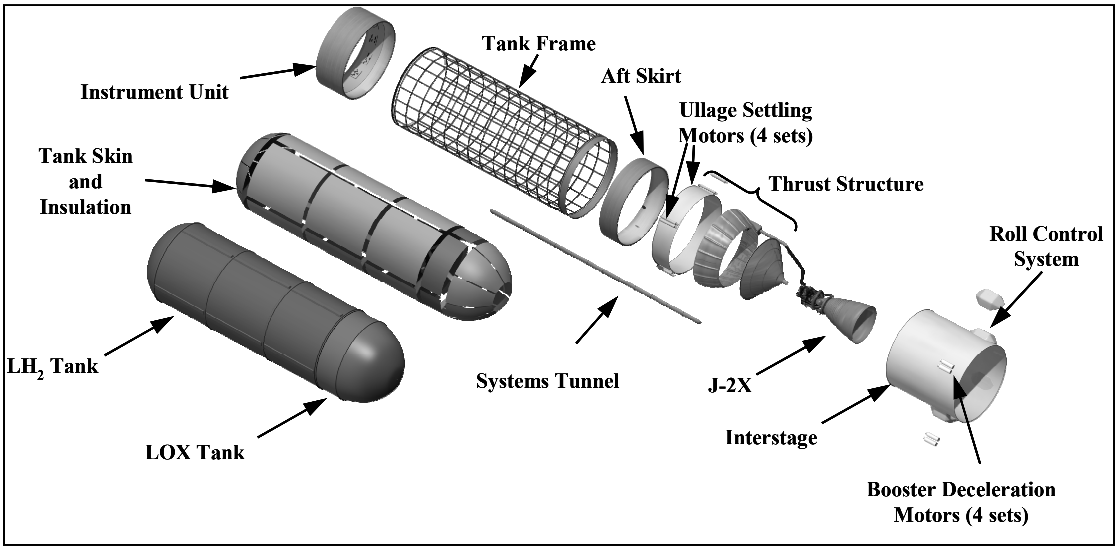

Source: MSFC 2006b

**Figure 2-9. Ares I First Stage**

Figure 2-10 provides an overall conceptual arrangement of the Upper Stage subsystems. The primary structures include the LH and LOX propellant tanks (collectively containing approximately 140,000 kg [300,000 lbs] of propellant in the Ares I configuration), aft skirts, thrust structure, interstage, and instrument unit, which also houses the avionics.

While engine testing would be performed at MSFC and SSC, fabrication, assembly, checkout, delivery, and ongoing logistics support of the completed Upper Stage would performed at MAF and contractor facilities. Potential materials of concern that would be expected to be used in the Upper Stage are shown in Table 2-7.

The human-rated J-2X LOX/LH engine would power the Ares I Upper Stage and Ares V Earth Departure Stage. It would deliver an estimated 448 seconds of specific impulse (Isp) and 1.3 million newtons (N) (300,000 foot-pounds force [lbf]) in vacuum. The engine weighs approximately 2,300 kg (5,100 lbs) and would be 4.7 m (15 ft) long, with a nozzle exit diameter of just over 3 m (9.5 ft). It would be gimbaled for Thrust Vector Control, which enables control of Upper Stage attitude and trajectory through control of the orientation of the engine nozzle. Testing would be performed on a prototype propulsion engine, development engines, and certification engines (see Figure 2-11). Typical materials that would be used in the construction of a J-2X engine are shown in Table 2-7.

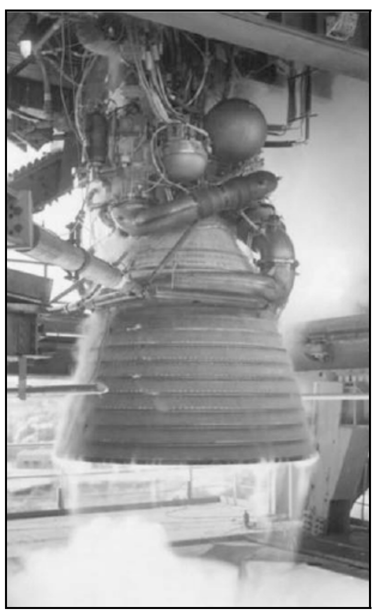



Source: MSFC 2007f

**Figure 2-10. Ares I Upper Stage**

**Table 2-7. List of Potential Materials of Concern for Use in the Ares I Upper Stage and Upper Stage Engine**

| Component | Potential Materials of Concern |
|---|---|
| Upper Stage (composite structures) | Aluminum, aluminum-lithium alloy, stainless steel, and small quantities of adhesives, sealants, oil/lubricants, and paints |
| Upper Stage engine | Stainless steel, inconel (nickel-chromium alloys), aluminum and aluminum alloys, titanium, nozzle materials (ablative materials and aluminum), and cork |



Source: MSFC 2006b

**Figure 2-11. Test Firing of a J-2X Precursor: the Apollo-Era J-2 Engine**

#### 2.1.3.1.2 Facilities Used for Ares I Development, Test, and Manufacture

Development, test, and manufacture of the First Stage would use existing Space Shuttle Program and contractor facilities and infrastructure. Most of these activities would occur at ATK facilities in Utah. Sufficient capacity exists to support both Space Shuttle SRB and Ares I First Stage requirements with no appreciable increase in infrastructure.

Testing of propulsion test articles and flight-like simulators would be performed at NASA Centers as would the assembly, integration, and testing of initial prototype vehicles. Ares I engine development tests would include the following:

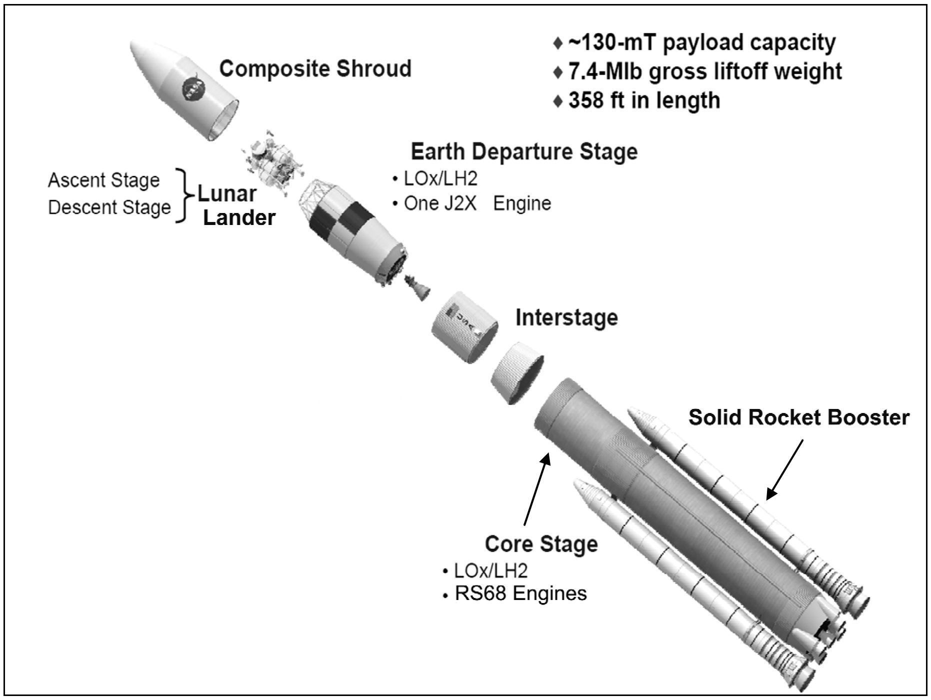
- Aerodynamic testing of the Ares I launch vehicle at existing wind tunnel test facilities (and supporting test article fabrication facilities) at ARC, MSFC, LaRC, and potential contractor facilities.
- Propulsion system development and acceptance testing at MSFC and SSC. Component testing (including Main Propulsion Test Article and vibration testing) for the Ares I Upper Stage engine at existing MSFC facilities. Prototype propulsion article testing and engine system testing at SSC's A-1 Rocket Propulsion Test Stand (Building 4120) with the PBS Spacecraft Propulsion Research Facility (B-2 Facility [Building 3211]) and contractor facilities available as backup test facilities, if needed (JSC 2006b, SSC 2006). In addition, the SSC A-2 Rocket Propulsion Test Stand (Building 4122) would be used for engine component testing.
- Subsystem-level hot fire verification testing of the Reaction Control System and Thrust Vector Control systems at WSTF.
- Flight tests at KSC.

Facility modifications at several NASA Centers would be required to support the integrated assembly and test of Ares launch vehicles. At MSFC, in addition to minor modifications to several facilities, the Structural Dynamic Test Facility (Building 4550) would be substantially modified. The modifications to this facility are addressed in the *Final Environmental Assessment for Modification and Operation of TS 4550 in support of Ground Vibration Testing for the Constellation Program*. The Cryogenic Structural Test Facility (Building 4699) at MSFC would require major modifications to support various Ares I Upper Stage structural loads tests. Also at MSFC, one or more existing buildings would require internal modifications to allow for application of spray-on foam insulation to the Ares I Upper Stage Thermal Protection System. Implementing this spraying process would require a modification to the Clean Air Act Title V permit for MSFC. A new test stand (A-3 Test Stand) is under construction at SSC to test the J-2X engine in vacuum conditions. Construction of the new A-3 Test Stand, located south of Test Stands A-1 and A-2 (Buildings 4120 and 4122), is addressed in the *Final Environmental Assessment for the Construction and Operation of the Constellation Program A-3 Test Stand*. In addition, SSC's B-1/B-2 Test Complex (Building 4220) would need to be reactivated to support the RS-68B engine testing. The GRC PBS B-2 facility would need to be modified to support vacuum testing of the J-2X engine. Major modifications also would be required to MAF's Manufacturing Building (Building 103) and Acceptance and Preparation Building (Building 420) to support Ares I Upper Stage manufacturing. See Section 2.1.9 for an additional discussion of NASA facilities needing modification to support the Constellation Program.

### *2.1.3.2 Ares V – The Heavy Cargo Launch Vehicle*

#### 2.1.3.2.1 Description of the Ares V Launch Vehicle

The Ares V launch vehicle would provide heavy lift capability (see Figure 2-12). The vehicle would stand roughly 110 m (360 ft) tall and would lift 136,000 kg (300,000 lb) to low Earth orbit or propel 54,000 kg (120,000 lb) on a lunar trajectory. In its current planning configuration, the Ares V consists of a liquid propellant Core Stage with two SRBs and an Earth Departure Stage derived from the Ares I Upper Stage. Atop the Earth Departure Stage would be a payload shroud enclosing the payload for lunar and future Mars missions.




Source: Adapted from MSFC 2007e

**Figure 2-12. Ares V Launch Vehicle**

The Ares V Core Stage leverages manufacturing processes and materials used on the Space Shuttle External Tank. The Core Stage would be 10 m (33 ft) in diameter and 65 m (212 ft) in length, making it the largest rocket stage ever built. It would be the same diameter as the Saturn V First Stage, but its length would be about the same as the combined length of the Saturn V First and Second Stages. The Core Stage would use five RS-68B LOX/LH engines in its current planning configuration, each supplying about 3.1 million N (700,000 lbf) of thrust.

The two Ares V SRBs would each provide about 14.7 million N (3.3 million lbf) of thrust at liftoff and are currently planned to be derived from the SRBs currently used on the Space Shuttle (see Section 2.1.3.1) and from the First Stage planned for the Ares I. Much like the Ares I, they would be five-segment motors, but like the Space Shuttle SRBs, they would have aerodynamic nose caps instead of a frustum to interface with the Core Stage. The Ares V SRBs would also use the same forward and aft booster separation motors used on the Space Shuttle. They would provide the capability to separate the SRBs from the Core Stage during ascent, allowing the SRBs to be recovered in the Atlantic Ocean. The Constellation Program is studying the possibility of not recovering the spent Ares V SRBs for certain missions. This could gain additional performance margin for certain missions by eliminating the launch weight of the booster recovery systems.

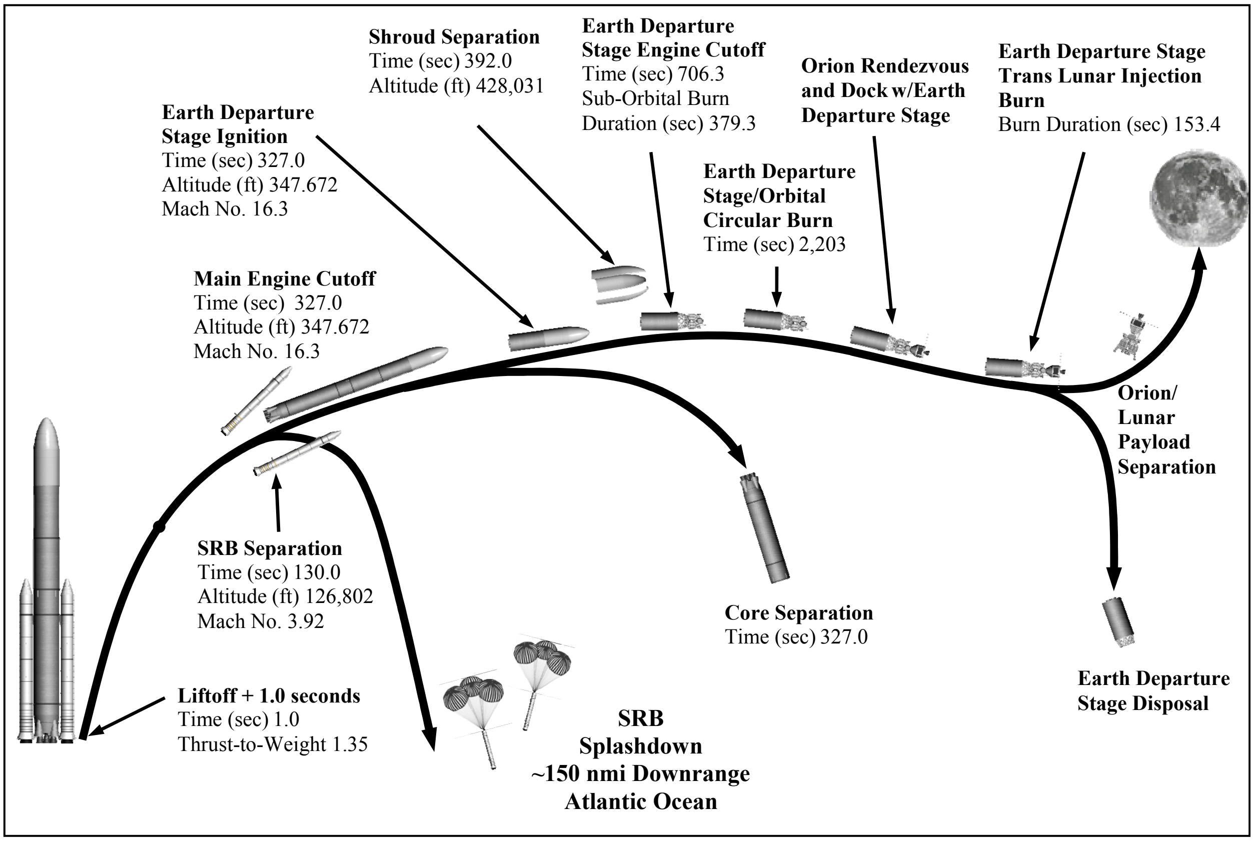
The Second Stage of the Ares V is called the Earth Departure Stage. The Earth Departure Stage would be powered by one J-2X engine developed for Ares I but modified with an air restart capability. The Earth Departure Stage has two functions: 1) provide a suborbital burn to place the lunar payload into a stable Earth orbit and 2) ignite a second time after the Orion spacecraft, launched separately on an Ares I, docks with the Earth Departure Stage to place the combined vehicle into a trajectory towards the Moon. Potential materials of concern that would be used to produce the Ares V Core Stage and Earth Departure Stage are identified in Table 2-8. An Ares V launch profile reflecting the current planning configuration is provided in Figure 2-13.

**Table 2-8. List of Potential Materials of Concern for Use in the Ares V Core Stage and Earth Departure Stage**

| Component | Potential Materials of Concern |
|---|---|
| Core Stage Structures/Tanks | Aluminum-lithium alloy, steel alloy, insulating materials, oil/lubricants, ablative materials, paints, and adhesives |
| RS-68B Engines | Aluminum, inconel, stainless steel, steel alloy, titanium, nozzle materials (ablative materials and aluminum), cork, and relatively small amounts of platinum, silicone, tantalum, tin, copper, phenolic, and plastic |
| Earth Departure Stage Structures/Tanks | Aluminum-lithium alloy, composites, steel alloy, insulating materials, oil/lubricants, ablative materials, paints, and adhesives |
| Upper Stage engine | Stainless steel, inconel (nickel-chromium alloys), aluminum and aluminum alloys, titanium, nozzle materials (ablative materials and aluminum), and cork |
| Shroud | Composites, aluminum, insulation materials, steel alloys, and plastic |

After a little more than two minutes after launch, the Ares V SRBs propellant would be exhausted and they would be jettisoned. The nose cap would separate from the spent stage, starting the parachute system deployment sequence. The SRBs would be recovered from the Atlantic Ocean and towed in to KSC. At KSC, the SRBs would be disassembled and cleaned with the solid rocket motor segments transported via rail to ATK in Utah for refurbishment and refueling for reuse at KSC. Other components of the SRBs would be refurbished at KSC (see Section 2.1.4).

For a lunar mission, the Core Stage would separate from the Earth Departure Stage after its engines cut off. After atmospheric entry, the Core Stage would splash down in the Indian or Pacific Ocean and would not be recovered. It is expected that components of the Core Stage would sink, although some components (including fuel tanks) may survive sufficiently intact to remain temporarily afloat. Residual amounts of propellant may be contained within the surviving components. Prior to lunar orbit insertion, the Earth Departure Stage would be jettisoned and placed on a trajectory away from the Earth and the Moon.




Source: Adapted from MSFC 2006c

**Figure 2-13. Ares V Launch Profile**

2.1.3.2.2 Facilities Used for Design, Development, Test, and Manufacture

Core Stage engine development and testing is anticipated to begin in 2012, through first engine delivery, including certification tests. Once certified, the production goal would be to produce RS-68B engines at a rate of 10 to 15 engines per year.

The Constellation Program is evaluating current assembly operations and facilities for Ares V. Recommendations for process improvements are being identified. It is anticipated that existing contractor assembly facilities would be adequate to support development activities and production rates; however, the launch manifest would drive the required number of development, certification, and flight stages to be produced and subsequent facility requirements.

Engine tests for individual RS-68B engines and engine clusters of the RS-68B would be expected to be performed at the B-1/B-2 Rocket Propulsion Test Complex at SSC.

### 2.1.4 Ground Operations Project

The Ground Operations Project would be led by KSC. The Ground Operations Project would be responsible for the ground processing and testing of the integrated launch vehicles, provide launch logistics and services, Ares I First Stage and Ares V SRB recovery, and provide post-landing and recovery services. The Ground Operations Project also would be responsible for the infrastructure necessary to support launch operations for the Constellation Program. Proposed modifications to several KSC facilities that would be used to support initial Ares I flight tests, anticipated to start in 2009, have been addressed in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f). Pre-launch ground operations activities would occur almost exclusively at KSC. Post landing and recovery operations would occur at the landing site. The design of the Orion spacecraft would allow for both terrestrial (land) and water (ocean) landings.

### *2.1.4.1 Ground Support Services*

#### 2.1.4.1.1 Ground Processing of the Orion/Ares I

Ground processing would include end-to-end interface testing between the Orion spacecraft, the Ares I launch vehicle, and processing facilities. This would verify end-to-end connectivity and functionality between the flight systems, mission control, and launch facilities.

Ground operations associated with the launch and recovery of the Orion spacecraft would include the following activities:

- Orion Spacecraft Processing – Pre-Integration
- Ares I Ground Processing
- Orion/Ares I Integrated Stack Processing
- Countdown and Launch Operations
- Orion/Ares I First Stage Recovery
- Crew Module Recovery.

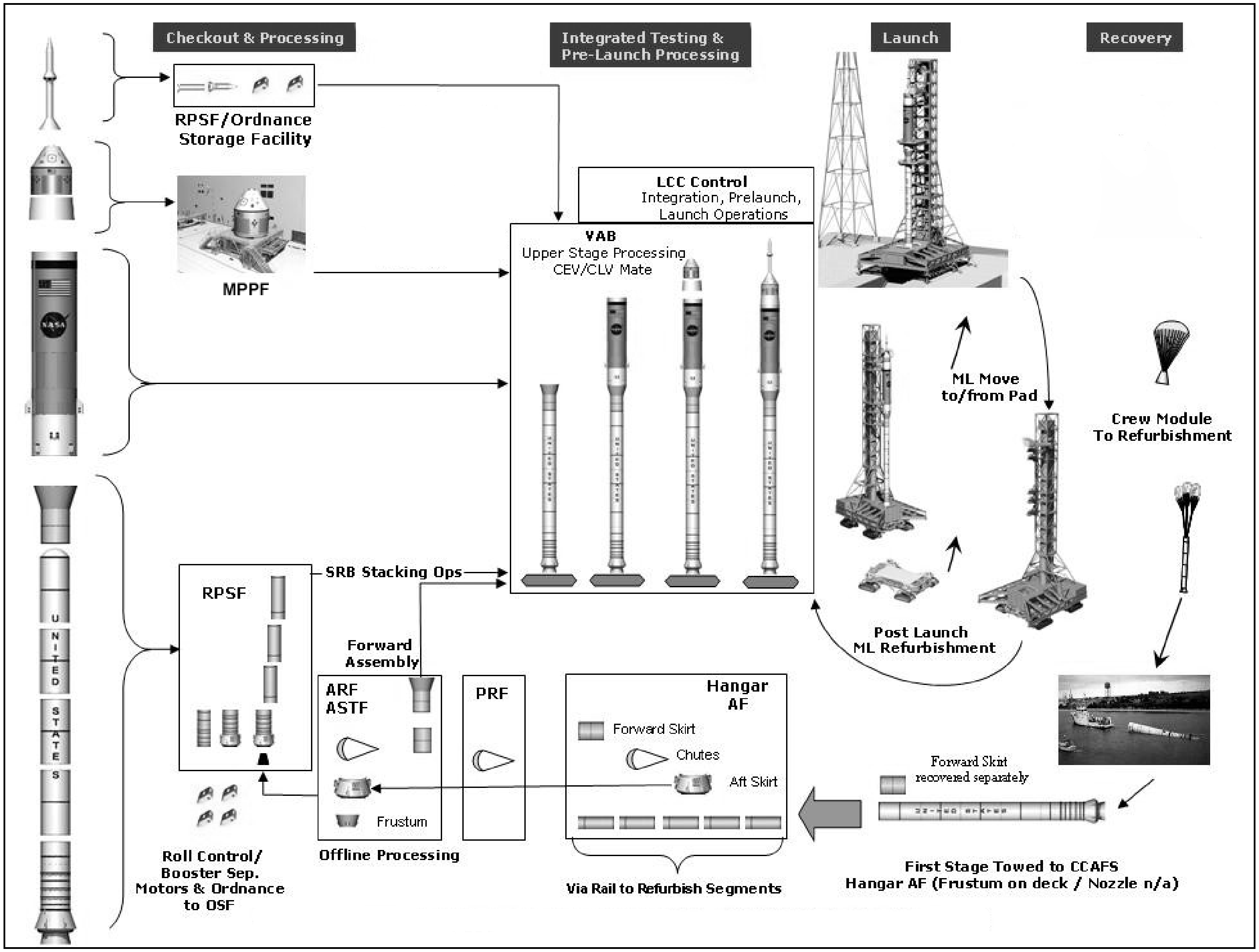
Figure 2-14 provides an illustration of these activities.

<u>Orion Spacecraft Processing – Pre-Integration</u>

The contractor-assembled elements of the Orion spacecraft would be transported to the Multi-Payload Processing Facility at KSC. The Launch Abort System would be assembled in an ordnance processing facility at KSC; both new and existing hazardous processing facilities are under consideration for this activity.

Hazardous processing (*e.g.*, ordnance installation and propellant servicing) would be performed in a hazardous processing facility (either an existing or new facility) at KSC prior to transporting the integrated vehicle to the Vehicle Assembly Building (VAB). However, due to processing facility restrictions, some hazardous operations required for operational readiness (*e.g.*, ordnance connection and hypergolic propellant pressurization) would have to be performed at the launch pad.

During the pre-integration process, all flight interfaces, including mechanical, fluid, electrical, gases, propellants, and other data related to command and control, would be verified using either flight hardware or flight hardware emulators. The spacecraft then would be configured for transport to the VAB at KSC.




Note: Abbreviations and acronyms are defined on page xx

Source: Adapted from KSC 2007b.

**Figure 2-14. Orion/Ares I Mobile Launch Concept Flow**

Ares I Ground Processing

First Stage components would be delivered from the manufacturer or refurbishment facility to a hazardous processing facility, the Rotation, Processing, and Surge Facility at KSC for subsystem processing, integration, and testing. The components then would be transported to the VAB for First Stage stacking.

The Upper Stage would arrive at the launch site as a complete stage, with a J-2X engine and interstage installed at the VAB. The Upper Stage then would be installed on the First Stage and prepared for integration with Orion.

Orion/Ares I Integrated Stack Processing

The Orion would be transported to the VAB for integration with the Ares I launch vehicle on a new mobile launcher developed expressly for the Ares I launch vehicle. The Orion spacecraft, when integrated with the Ares I launch vehicle, forms the Orion/Ares I integrated stack.

Once all interfaces between the Orion/Ares I launch vehicle and mobile launcher are verified, the integrated Orion/Ares I stack would be transported by the crawler transporter from the VAB to the launch pad (initially LC-39 Pad B, although both LC-39 Pads A and B ultimately would be capable of supporting an Ares I launch).

Hazardous processing would be performed prior to moving the integrated stack to the launch pad. Only the final steps required for operational readiness (*e.g.*, ordnance connection and hypergolic propellant final activation) would be performed at the launch pad. Hazardous and nonhazardous servicing and processing and final stowage of cargo would be completed prior to power being provided to the cargo, as required.

Orion/Ares I Countdown and Launch Operations

Prior to countdown, cryogenic propellants would be loaded and/or replenished and final ordnance operations and vehicle closeouts would be performed. When practical, final configuration, checkout, and inspection of the Orion spacecraft, the Ares I launch vehicle, and facility systems would be performed remotely from the Launch Control Center at KSC to minimize the need for launch pad access.

The suited crew would board the spacecraft, all crew-to-spacecraft interfaces (*e.g.*, life support and communications) would be connected and tested, and the crew would be secured in the Orion spacecraft. The closeout team then would enable the Launch Abort System and would clear the launch pad.

Launch Control, Mission Control, and all systems would be placed in final flight configuration and ground systems would be verified for readiness to support the mission.

The integrated stack would be ready for launch once the final automated verification of systems is completed. Nominal terminal countdown would result in launch of the vehicle at T-0 when First Stage ignition occurs and the integrated stack lifts off from the launch pad. All interfaces between the launch vehicle and the ground, such as mechanical, fluid, and data interfaces, would disconnect and umbilicals would be separated from the integrated stack just prior to liftoff.

Once the First Stage ignites and lifts off the launch pad, launch vehicle control transitions from Ground Operations to Mission Operations. Mission Operations manages the mission until landing of the Orion Crew Module, at which point Ground Operations assumes responsibility for recovery operations. Ground Operations also would be responsible for Ares I First Stage recovery shortly after launch.

First Stage Recovery

Assets similar to those currently used for the Space Shuttle would be expected to be used for the recovery of the Ares I First Stage. A recovery team and recovery equipment (NASA owns two recovery vessels each fully equipped to recover the First Stage, including the main and drogue parachutes) would be pre-deployed to the vicinity of the planned Atlantic Ocean splash down location. The recovery team would perform required safing activities (actions taken to limit the risks associated with hazardous conditions or materials [*i.e.*, residual propellants]) and recover parachutes and boosters for return to CCAFS's Hangar AF for refurbishment. After initial inspection and removal of hazardous materials, the First Stage solid rocket motor casings would be transported by rail to the refurbishment facility at ATK near Ogden, Utah.

Crew Module Recovery

A recovery team (possibly including ships and aircraft for an ocean landing recovery) and associated support equipment would be pre-deployed to the planned Crew Module landing site prior to landing. For terrestrial Orion landings, as with Space Shuttle landings, NASA anticipates having multiple potential landing sites for each mission. The specific logistics associated with the deployment of recovery teams have not been fully defined at this time. The recovery team would assist the crew in exiting the Crew Module and would perform any required safing activities. This includes safing or removal of unspent ordnance as necessary in preparation for transportation to the Operations and Checkout Building at KSC. The recovery team would remove other materials from the vehicle that would need to be shipped separately from the vehicle. This would include timely and protected transport of returned samples and payloads and health monitoring devices to the appropriate facility. Any purge, cooling, draining, or handling of the spacecraft after landing would be expected to be performed with equipment designed to minimize leakage of any hazardous material. Contingency plans would be developed in order to minimize the extent of any such leakage.

2.1.4.1.2 Ground Processing of the Lunar Payload/Ares V

Ground operations associated with the launch and recovery of the current Ares V planning configuration and its payload include the following:

- Lunar Payload Processing – Pre-Integration
- Ares V Ground Processing
- Lunar Payload/Ares V Integrated Stack Processing
- Lunar Payload/Ares V Countdown and Launch Operations
- Solid Rocket Booster Recovery.

Figure 2-15 provides an illustration of these operations.

Lunar Payload Processing – Pre-Integration/SRB Recovery

The activities associated with lunar payload processing and SRB recovery would be similar to those associated with Orion/Ares I ground processing and Ares I First Stage recovery, respectively. The facilities to be used for lunar payload processing have not been identified at this time. Once those facilities have been identified, potential modifications to support lunar payload processing could be subject to separate NEPA review and documentation, as appropriate.

Ares V Ground Processing

The SRB components would be delivered from the manufacturer or refurbishment facility to the Rotation, Processing, and Surge Facility at KSC for subsystem processing, integration, and testing. The SRB components then would be delivered to the VAB and stacked on the mobile launcher to be tested. The Core Stage would be delivered to the Orbiter Processing Facility at KSC or directly to the VAB. If initially delivered to the Orbiter Processing Facility, the Core Stage then would be moved to the VAB. The Core Stage would be mated and tested with the

SRBs at the VAB. The Earth Departure Stage would arrive at KSC with the J-2X. The interstage would be installed and the assembly would be transported to the VAB. The Earth Departure Stage then would be attached to the Ares V Core Stage and tested.

Ares V Integrated Stack Processing

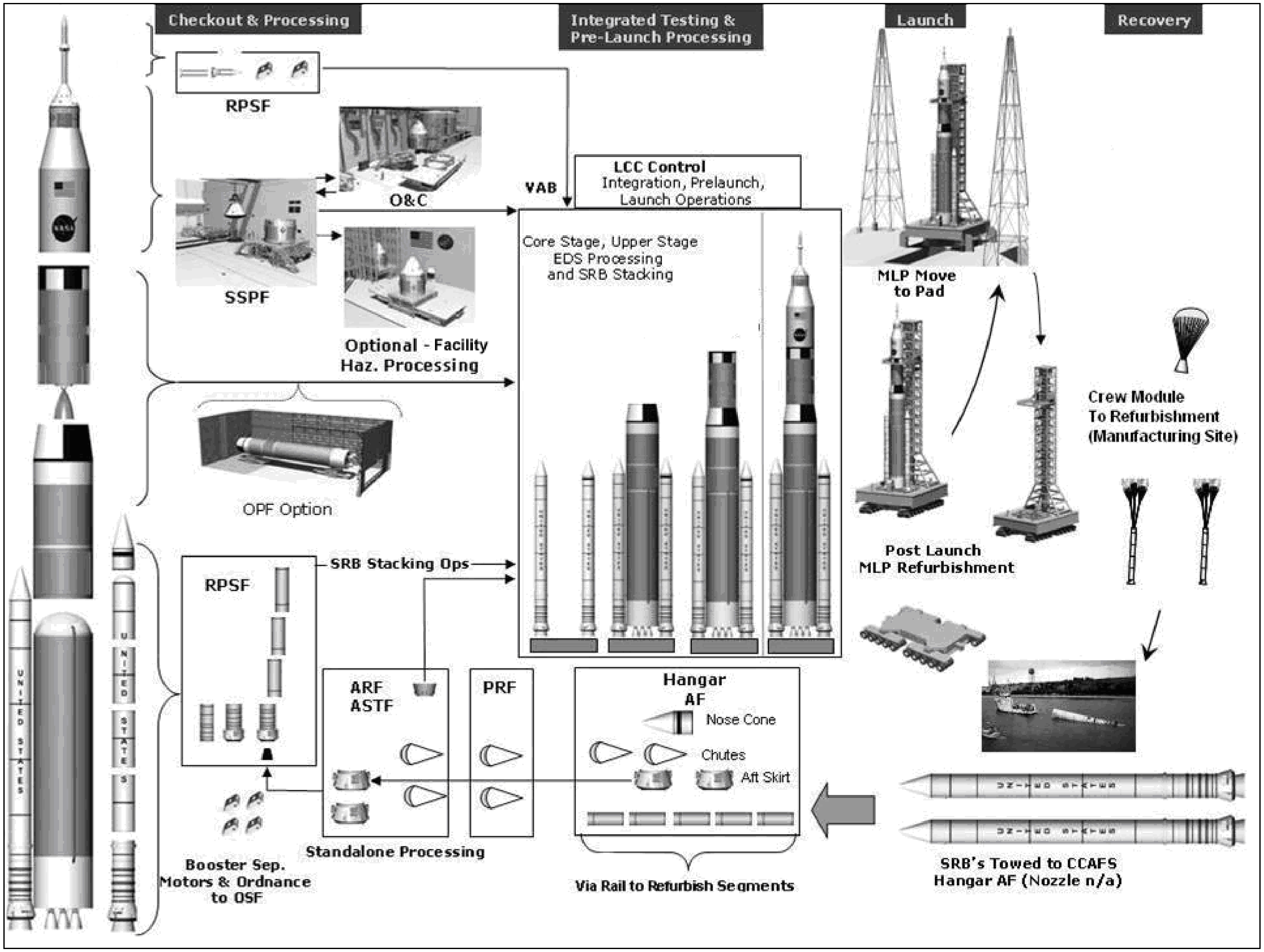
The lunar payload, spacecraft adapter, and payload shroud (fairing) would be integrated with the Ares V flight element in the VAB to form the completed Ares V launch vehicle. Hazardous processing (*e.g.*, ordnance installation and propellant servicing) would be performed prior to transportation of the integrated vehicle to the launch pad. However, due to processing facility restrictions, some hazardous operations (*e.g.*, ordnance connection and hypergolic activation and/or pressurization) would be performed at the pad.

Hazardous and nonhazardous commodity servicing and final stowage of cargo would be completed prior to providing power to the cargo, as required.

Once all interfaces between the Ares V launch vehicle and mobile launcher are verified, the integrated Ares V launch vehicle would be transported by the crawler transporter from the VAB to the launch pad (initially LC-39 Pad A, although both LC-39 Pads A and B ultimately would be capable of supporting an Ares V launch). NASA is evaluating the need for a modified crawler transporter and crawlerway for transport of the Ares V launch vehicle.

Ares V Countdown and Launch Operations

Cryogenic propellants for the Ares V launch vehicle, would be loaded and/or replenished after arrival at the launch pad. When practical, final configuration, checkout, and inspection of the launch vehicle, spacecraft, and facility systems would be performed remotely from the Launch Control Center at KSC to minimize the need for pad access.




Note: Abbreviations and acronyms are defined on page xx. Source: Adapted from KSC 2007b

**Figure 2-15. Lunar Payload/Ares V Mobile Launch Concept Flow**

Prior to the final decision to launch, the remaining final automated verification of systems would be completed and the integrated stack would be ready for launch. Nominal terminal countdown would result in ignition of the Core Stage and launch of the vehicle at T-0 when the SRBs ignite and the integrated stack lifts off from the launch pad. All interfaces between the launch vehicle and the ground, such as mechanical, fluid, and data interfaces, would disconnect and retract from the integrated stack just prior to or at liftoff.

Once the Ares V lifts off the launch pad, vehicle control would transition from Ground Operations to Mission Operations.

For lunar missions, the Orion/Ares I launch would follow the Lunar Payload/Ares V launch either on the same day or up to several days later. This would ensure successful launch and on-orbit checkout of the Earth Departure Stage and lunar payload prior to committing the crew to launch. Timely launches of both the cargo and crew would reduce exposure to the space environment and the depletion of consumables and propellants.

#### 2.1.4.1.3 Hazardous Materials

The types and approximate quantities of hazardous materials contained within the flight vehicles are listed in Table 2-9. Additional quantities would be stored at the Launch Complex for launch servicing requirements and contingencies within acceptable limits as defined by permits.

**Table 2-9. Approximate Quantities of Hazardous Materials in Flight Vehicles**

| Hazardous Material | Quantity* | | |
|---|---|---|---|
| | Ares I | Orion | Ares V |
| Nitrogen tetroxide ($N_2O_4$) | — | 12,000 lb | 1,350 lb |
| Monomethylhydrazine ($CH_3NHNH_2$) | — | 6,456 lb | 725 lb |
| Hydrazine ($N_2H_4$) | 1,250 lb | — | 880 lb |
| Liquid Oxygen/Liquid Hydrogen (LOX/LH2) | 307,000 lb | 275 lb | Core Stage: 3,101,000 lb<br>Earth Departure Stage: 513,000 lb |
| Polybutadiene Acrylonitrile (PBAN) | 1,370,000 lb | 5,200 lb | 2,750,000 lb |
| Hydraulic Oil | 70 gal | — | 320 lb |
| Liquid Methane | — | 115 lb | — |
| Gaseous Oxygen | — | 2,075 scf | — |
| Liquid Ethanol | — | 25 gal | — |
| Propylene Glycol | — | 5 gal | — |
| Freon® 134A | — | 78 lb | — |
| Halon Gas | — | 55 lb | — |

* Quantities are for a single launch.

Note: See conversions table on page xxiii for metric units.

### *2.1.4.2 Launch Facility Modifications*

Launch facilities associated with ground processing at KSC would be modified to process the Ares I and Ares V launch vehicles, the Orion spacecraft, and other payloads and cargo for International Space Station and lunar missions. All KSC facility modifications currently identified for the Constellation Program are modifications to facilities currently utilized by the Space Shuttle Program and/or the International Space Station, although the possible need for new facilities is being considered (see Table 2-10 and Section 2.1.9).

The following facilities at KSC have been identified as needing modification to support early Ares I test flights, scheduled to begin in 2009: LC-39 Pad B, the VAB, the Firing Rooms of the Launch Control Center, the Mobile Launch Platform, the Operations and Checkout Building, and CCAFS's Hangar AF/Assembly and Refurbishment Facility. Also required would be the development of a new mobile launcher. The most visible of the facility modifications would be the addition of three 184 m (605 ft) lightning towers to LC-39 Pad B as part of the Lightning Protection System and the possible modifications to the Hangar AF/Assembly and Refurbishment Facility needed to handle the five-segment SRBs to be used by both Ares I and Ares V launch vehicles.

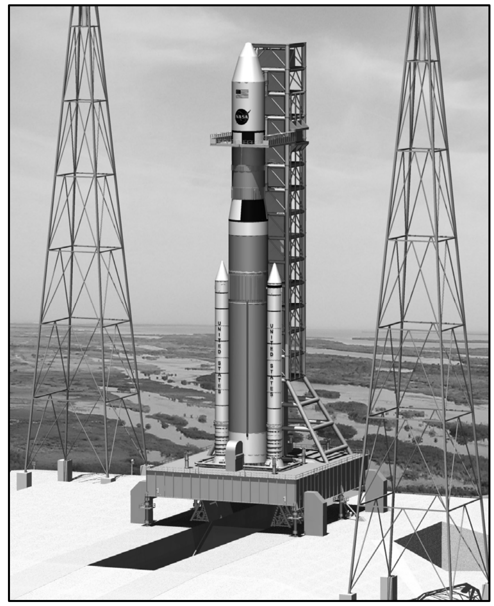
Of these facilities, modifications to LC-39 Pad B launch tower and the installation of a Lightning Protection System at this pad, and the construction of a new mobile launcher have been addressed in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f).

To support launches beyond the initial flight test of the Ares I launch vehicle, additional facility modifications would be required. Modifications similar to those described above for LC-39 Pad B would be required for LC-39 Pad A, including modifications to the propellant and launch control systems, emergency egress and crew access systems, and the construction of a similar lightning protection system. The rotating and fixed towers at both LC-39 Pads A and B also would be removed. Figure 2-16 depicts the final configuration for LC-39 Pads A and B. In addition to the LC-39 launch pad modifications, other facilities would be modified as follows:

- Launch Control Firing Rooms in the Launch Control Center – Firing Room 1 is currently being modified for the Constellation Program. At least one additional firing room (2, 3, or 4) would be modified for this Program. Future requirements may drive modifications to the other rooms as the Program matures
- Rotation, Processing, and Surge Facility – modifications to handle higher First Stage component throughput
- Space Station Processing Facility – modifications to processing stands
- Multi-Payload Processing Facility in the Hazardous Processing Facility – install bi-propellant service equipment, upgrade containment and ventilation systems, and upgrade to meet hazardous processing building code requirements. Under this scenario, construct a high-bay addition to hazardous processing building code requirements. Construct blast walls and/or earth berms adequate to protect all nearby facilities

- Orbiter Processing Facility – modifications to processing stands in three processing bays (two in one building, and one in a second building)
- Modifications to the VAB to upgrade the mechanical, electrical, communications, and control systems. Structural upgrades and modifications to the VAB High-Bay platforms for Ares launch vehicle configurations
- Refurbishment of the existing JJ Railroad Bridge and ultimately the removal and replacement of the existing bridge with a new bridge at approximately the same location
- Modifications to the Parachute Refurbishment Facility.

**LC-39 Pad B Current Configuration (Space Shuttle shown)**



**LC-39 Pad B Future Configuration (Ares V shown)**

**Figure 2-16. KSC Launch Complex-39 Pad B**

#### *2.1.4.3 Orion Crew Module Recovery and Transportation (Crew and Crew Module)*

Landing and recovery equipment and facility requirements would be identified when the Crew Module landing sites are selected. A recovery team (possibly including ships and aircraft for an ocean landing recovery) and associated support equipment would be pre-deployed to the planned Crew Module landing site prior to landing. For terrestrial landing sites, facility requirements may be met with either permanent or mobile facilities consisting of minimal office, laboratory, and medical clinic space and may include landing recovery vehicle and equipment hanger space. Depending on which terrestrial landing sites are selected, existing facilities and/or new facilities may be required. This action would be subject to separate NEPA review and documentation, as appropriate.

### 2.1.5 Mission Operations Project

The Mission Operations Project would be led from JSC. The Mission Operations Project would perform flight operations that plan the missions, including configuring the facilities and systems;

testing the facilities, systems, and procedures; training the crew, flight controllers, and others; and coordinating crew activities.

It is not anticipated that the Mission Operations Project would require any new buildings to be constructed or any existing buildings to be demolished at JSC or elsewhere. Any changes would be limited to modest renovations or internal modifications.

#### *2.1.5.1 Training and Testing Activities*

Facilities involved in training and test activities for the Mission Operations Project at JSC include:

- Constellation Training Facility
- Space Vehicle Mockup Facility
- Neutral Buoyancy Laboratory.

The Constellation Training Facility would consist of computer hardware and software systems and physical models of the Crew Module cockpit and would be accommodated within JSC's existing Jake Garn Simulator and Training Facility (Building 5) (JSC 2006d). Development unique to the Constellation Program (consisting of computer systems and spacecraft mockups) would use existing processes and capabilities and would be accommodated in existing facilities, including the Space Vehicle Mockup Facility (located within JSC's existing Systems Integration Facility [Building 9]) and would use existing mission planning capabilities (distributed information technology capabilities) at JSC.

Activities at the Space Vehicle Mockup Facility would include development of Orion spacecraft mockups, equipment to support real-time mission operations, flight crew training, operations/engineering evaluations and the development/verification of procedures for operating/maintaining onboard equipment and the Orion spacecraft systems. Figure 2-17 shows an Orion Mockup Facility.


Source: NASA 2005f

**Figure 2-17. Orion Mockup Facility**

The Neutral Buoyancy Laboratory (located within the Sonny Carter Training Facility [Building 920]) likely would be used for astronaut training and evaluation. The Neutral Buoyancy Laboratory consists of a large pool of water where astronauts perform simulated extravehicular tasks in preparation for future missions. The principle of neutral buoyancy is used to simulate the weightlessness of the space environment. The Constellation Program would develop, sustain, and maintain Neutral Buoyancy Laboratory mockups of spacecraft features unique to the Constellation Program (JSC 2006d). Figure 2-18 shows an astronaut training in the Neutral Buoyancy Laboratory.

**Figure 2-18. Astronaut Training in the Neutral Buoyancy Laboratory**

### *2.1.5.2 Mission Planning Activities*

Mission planning activities include preparation of pre-flight and flight schedules, flight integration, and defining ground systems. The Mission Control Center (within Building 30) at JSC has been utilized for monitoring NASA's crewed missions and would continue this function for the Constellation Program.

The Mission Control Center consists of a mission operations wing, an operations support wing, and an interconnecting lobby wing. There would be some remodeling of the Mission Control Center to accommodate the Constellation Program. Figure 2-19 illustrates the Mission Control Center at JSC.

**Figure 2-19. JSC Mission Control Center**

#### *2.1.5.3 Mission Operations*

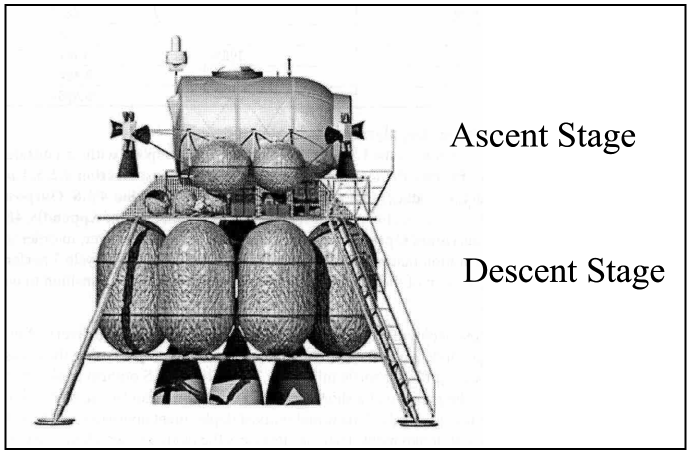
Soon after liftoff, Mission Control (located in the Mission Control Center at JSC) assumes control of the mission. Using mission plans developed prior to the mission, Mission Control coordinates mission activities with the crew and monitors the progress of the mission. Mission Control would also monitor the status of the crew, and monitor and perform health checks on the spacecraft (Orion, Earth Departure Stage, and lunar payload) and onboard systems during all mission phases, from liftoff to landing. The specific activities performed by Mission Control include the following:

- During ascent, Mission Control monitors the launch vehicles and tracking data to assess ascent performance, in part to assess the need for a mission abort. Mission Control and Launch Range Safety verify, independently, that the launch is nominal (within a prescribed path) and is not approaching safety limits.
- During lunar orbit, Mission Control monitors, evaluates, and performs maintenance on the Orion spacecraft. As currently planned, the entire crew would leave the Crew Module and descend to the Moon's surface during lunar missions. The Orion spacecraft is left in lunar orbit with many of its systems shutdown. Mission Control would be responsible for evaluating the health of the Orion spacecraft and would periodically perform remote maintenance activities as necessary. Mission Control would adjust Orion's orbit and prepare (position) the spacecraft for the return of the crew.
- When returning to Earth, Mission Control selects the actual landing location based primarily on weather forecasts.
- During all flight phases, Mission Control coordinates with the crew to adjust to any mission abnormalities and provide technical support and analysis to respond to any abnormal situations.

### 2.1.6 Lunar Lander Project

The Lunar Lander Project would be managed by JSC. This Project is in an early conceptual stage; therefore, NASA has not yet identified other government facilities or commercial organizations that would be involved in the Project. It is expected that additional NASA Centers would be involved in the Lunar Lander Project as it matures and NASA would prepare separate NEPA review and documentation, as appropriate.

The Lunar Lander would provide access to the lunar surface for crew and/or cargo via a Descent Stage and would return the crew via an Ascent Stage to the Orion spacecraft in lunar orbit. A cargo configuration of the Lunar Lander would be able to transport cargo to the lunar surface and may not include an Ascent Stage. Basic elements of the Lunar Lander would include the propellant tanks associated with the Ascent/Descent Stages, a living module (*i.e.*, pressure vessel), a landing gear system, internal power supplies (*e.g.*, rechargeable batteries) and provisions for crew access to the lunar surface. Propellants proposed for the Lunar Lander include LOX/LH for the Descent Stage and LOX/methane for the Ascent Stage, although a final decision on propellants has not been made. Figure 2-20 illustrates one conceptual design for the Lunar Lander.




Source: Adapted from NASA 2005e

**Figure 2-20. Concept for the Lunar Lander**

The Lunar Lander would be capable of using its Descent Stage to insert itself and the Orion spacecraft into lunar orbit upon arrival from Earth. At lunar orbit, the Lunar Lander would detach from the Orion spacecraft to carry crew and/or cargo to a landing site on the lunar surface. Once the surface mission is complete, the crew would return to the Ascent Stage in preparation for lift-off from the lunar surface. The Lunar Lander Ascent Stage would separate from the Descent Stage at the lunar surface and would dock with the Orion spacecraft. The Descent Stage would remain on the lunar surface. Once the crew has transferred to the Orion spacecraft, the Ascent Stage would be jettisoned and would fall to the lunar surface.

### 2.1.7 Extravehicular Activities Systems Project

The EVA Systems Project would be managed by JSC and would provide the spacesuits and necessary tools to work outside of the protective confines of a space vehicle. EVAs can be used for planned activities, such as assembly, maintenance, or site exploration, or for contingency tasks, such as inspection or vehicle repair (JSC 2006a). The EVA Systems Project is using resources at NASA's GRC to provide power, communications, informatics, and avionics support for the Project.

The EVA Systems Project requirements include both in-space and lunar or Mars surface operations. The EVA Systems Project would develop, certify, produce, process, and sustain flight and training hardware systems necessary to support EVA and crew survival. This includes the elements necessary to protect crew members and allow them to work effectively in pressure and thermal environments which exceed human capability during all mission phases.

The following capabilities would be required to support EVAs:

- Crew protection and survival capability for launch and atmospheric entry, landing, and abort scenarios
- Contingency zero-gravity in-space EVA capability for the Orion spacecraft
- Surface EVA capability for exploration of the Moon and Mars (JSC 2006a).

The spacesuit, called the Extravehicular Mobility Unit, currently being used by the Space Shuttle Program is not compatible with either the lunar or the Martian environments; thus, NASA would need to develop a new spacesuit system (JSC 2006a). The EVA Systems Project would develop a suit system that would be able to be used during launch, atmospheric entry, abort, and at zero-gravity. The spacesuit would need to be able to support long-duration (180 days) missions, perform multiple EVAs, and function under conditions expected at lunar landing sites. Although the design of the spacesuit is undetermined at this time, it is assumed that the suit would be composed of similar materials as the current spacesuit.

### 2.1.8 Future Projects

Additional elements and systems (future projects) for lunar missions and beyond would be defined by the Advanced Projects Office, managed by the Constellation Program. It is expected that the Advanced Projects Office would spin off new projects as the Constellation Program requirements mature and the Program is ready to initiate major procurements.

It should be noted that activities associated with the Advanced Projects Office would be expected to continually be defined as the Constellation Program matures. The Advanced Projects Office has not identified the facilities that would be required to support the development, test, and production of new systems. It is likely that other NASA Centers as well as commercial, academic, and government entities would be used. Newly defined advanced projects would be subject to separate NEPA review and documentation, as appropriate.

#### *2.1.8.1 Lunar Surface Systems*

The Lunar Surface Systems would include a wide range of systems to enable lunar surface exploration. Though not currently defined, these systems would be expected to include resource extraction and utilization equipment; habitation modules; and power generation, storage, and surface mobility systems. The Lunar Surface Systems are in early conceptual stages; thus, there is no clear definition of these systems at this time.

#### *2.1.8.2 Mars Systems*

The purpose of Mars missions would be to perform human exploration of the surface of Mars. As currently envisioned for a Mars mission, the Orion spacecraft with a crew of up to four would be launched by the Ares I towards low Earth orbit and would rendezvous and dock with a pre-deployed Mars Transfer Vehicle launched on an Ares V. Once crew and cargo are transferred, the Orion/Mars Transfer Vehicle would be placed on a trajectory to Mars. Similar to the Lunar Surface Systems, the Mars Systems are in early design stages and would be expected to evolve.

### 2.1.9 New, Modified, and/or Historic Facilities Associated with the Constellation Program

#### *2.1.9.1 Existing and Currently Planned Facilities*

The Constellation Program would require the use of many existing facilities at NASA Centers and other government facilities as well as the construction of several new facilities for specialized use. Several existing facilities identified for potential use would require modifications to meet Constellation Program needs. Many of the modifications would be relatively simple, such as upgrades to internal (electrical) wiring and moving interior walls. However, some modifications would be more extensive. In addition, some existing facilities proposed for Constellation Program use are designated as having historical significance (*i.e.*, either listed on the National Register of Historic Places or are eligible to be listed).

Table 2-10 summarizes the facilities being considered for use in the Constellation Program that would be newly constructed, would require substantial modifications in which NEPA documentation via an EA or EIS would be anticipated, and/or are considered a historic resource.

#### *2.1.9.2 Additional New Facilities*

While some aspects of the Constellation Program are relatively well defined, there are others that are not yet mature enough to be fully addressed in this Final PEIS, some potentially requiring the construction of new facilities. For example, NASA is considering the need to construct a new Vertical Integration Facility at KSC for Ares V integration to augment the capabilities of the VAB. Modification to or replacement of the crawler used to transport the Mobile Launch Platform at KSC or Mobile Launcher from the VAB to the Launch Complex also is being considered. These changes, as well as upgrades to the crawlerway over which these mobile facilities move to and from the launch pad, are being considered to improve reliability and may possibly be required to support the weight of the Ares V during transport. See Section 4.5 for a list of additional facilities that are not sufficiently defined at this time to be thoroughly evaluated in this Final PEIS.

While these facilities and modifications are not currently within the Constellation Program baseline, should the Constellation Program identify a need for these or other new facilities and pursue future development, such actions would be subject to separate NEPA review and documentation, as appropriate.

### 2.1.10 Launch System Testing

The Constellation Program would include a series of ground and flight tests to verify acceptable flight systems operations for the Orion spacecraft and the Ares launch vehicles under conditions that would simulate flight environments, from launch to atmospheric entry. These demonstration tests are required to verify vehicle performance and to human rate the Orion spacecraft and the Ares I launch vehicle. The following sections discuss the engine and flight tests that have been identified by the Constellation Program. The dates presented for these tests are those currently projected, but may change as the development of the systems to be tested progresses. Additional testing may be deemed necessary as the Constellation Program and the vehicle designs evolve.

#### *2.1.10.1 Engine Ground Tests*

All solid rocket motors and launch vehicle engines, J-2X and RS-68B, would undergo a series of ground tests prior to flight tests. The solid rocket motor tests would verify the operational parameters of the five-segment solid rocket motor design for the Ares I First Stage and would take place at ATK test facilities near Promontory, Utah. Ground tests, in which an engine is started and produces thrust, would take place primarily at SSC for both liquid fueled (LOX/LH) engines, the J-2X and RS-68B. Additional prototype and sub-system tests would occur at MSFC and GRC (see Table 2-11).

Engine tests for the J-2X and RS-68B also would be expected to be performed at contractor facilities. In addition, testing of smaller control rockets (*e.g.*, Orion and Ares Reaction Control System testing) would occur at selected NASA Centers (Reaction Control System testing is planned at WSTF) and at contractor facilities.

**Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program**

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **ARC** | | | |
| 11-foot Transonic Tunnel (Building N227A) (part of Unitary Plan Wind Tunnel [Building N227]) | Ares scale model testing. | None currently identified | NHL |
| Arc Jet Laboratory (Building N238) | Orion components and Thermal Protection System testing. Ares support. | Under evaluation to support Thermal Protection System testing | NRE |
| Unitary Plan Wind Tunnel (Building N227) | Orion components and Thermal Protection System testing. Ares support. | None currently identified | NHL |
| **GRC-Lewis Field** | | | |
| Instrument Research Laboratory (Building 77) | Miniature sensor and associated validation software development for LH and LOX leak detection. | None currently identified | NRE |
| 10-ft by 10-ft Supersonic Wind Tunnel Office and Control Building (Building 86) | Integrated design analysis and independent verification and validation in support of Orion vehicle design | None currently identified | NRE |
| **GRC-Plum Brook Station** | | | |
| Spacecraft Propulsion Research Facility (B-2 Facility) and associated buildings (Building 3211) | Alternate site option for Ares Upper Stage and/or Earth Departure Stage testing | If selected for testing, construction and/or modifications of test chamber, cold wall, cryogenic liquid and gas systems, spray chamber modifications, new boilers and ejector systems, and Building refurbishment | NHL |
| Space Power Facility (SPF) – Disassembly Area (Building 1411) | Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing | New seismic floor and shaker system and new acoustic chamber within disassembly highbay area. | NRE |
| **JSC** | | | |
| Crew Systems Laboratory, 3rd Floor (Building 7A) | Component and small unit bench top testing | None currently identified | NRE |
| Crew Systems Laboratory, 8- ft Chamber (Building 7) | Uncrewed integrated EVA life support system operational vacuum testing | None currently identified | NRE |
| Crew Systems Laboratory, 11- ft Chamber (Building 7) | Crewed EVA system vacuum testing | None currently identified | NRE |
| Crew Systems Laboratory, Thermal Vacuum Glovebox (Building 7) | Thermal vacuum testing of gloves and small tools | None currently identified | NRE |

**Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program (Cont.)**

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **JSC (Cont.)** | | | |
| Communications and Tracking Development Laboratory (Building 44) | Orion test and verification | None currently identified | NRE |
| Mission Control Center (Building 30) | Mission control activities, astronaut – ground personnel interface | Internal modifications, computer and communications systems upgrades | NRE and contains Apollo Control Room NHL |
| Jake Garn Simulator and Training Facility (Building 5) | Astronaut training | Construct new Constellation Training Facility within existing Building 5 complex | NRE |
| Systems Integration Facility (Building 9) | Astronaut training | New facility within existing structure | NRE |
| Sonny Carter Training Facility (Building 920) | Astronaut training | None currently identified | NRE (Neutral Buoyancy Lab only [Building 920N]) |
| Space Environment Simulation Laboratory – Chamber A (Building 32) | Crewed thermal vacuum testing and altitude chambers | None currently defined for thermal vacuum testing and no modifications to the altitude chamber | NHL |
| **KSC** | | | |
| Launch Complex-39, Pads A (Building J8-1708) and B (Building J7-0037) | Ares launch facilities | See Note 1 at end of table. Demolition, modification, and rehabilitation of the launch complex. | NRHP and contributes to Historic District |
| SRB Assembly and Refurbishment facilities: Buildings 66250, L6-247, K6-494, L6-247, L7-251, 66251, 66240, 66242, 66244, 66310, 66320, 66249, and 66340. | Recovery and refurbishment of Ares I and Ares V launch vehicle elements. | Modification and rehabilitation of facility structures, features, and systems to handle higher throughput of Ares I First Stage and Ares V SRBs. | NRE (Buildings 66250, L6-247, and K6-494 only) |
| Missile Crawler Transporter Facilities | Crawlers used to transport Ares I and Ares V launch vehicles from VAB to launch pad | None currently identified | NRHP |
| Crawlerway | Roadbed used by crawlers to transport Ares I and Ares V launch vehicles between the VAB and launch pads | None currently identified | NRHP |
| Mobile Launch Platform(s) | Transport Ares V launch vehicles from VAB to launch pad | Modification and rehabilitation of facility structures, features, and systems to support Ares V. | NRE |
| Mobile Launcher | Platform used to transport Ares I launch vehicles from VAB to launch pad | See Note 1 at end of table. New system. | NA |

**Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program (Cont.)**

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **KSC (Cont.)** | | | |
| Lightning Protection System – Launch Pad 39 A and B (Building J7-0037) | Launch vehicle lightning strike protection | See Note 1 at end of table. Install new Lightning Protection System (including 3 new lightning towers and catenary wires) | NA |
| Launch Control Center (Building K6-099) | Launch control | Firing room 1 internal modifications including walls, ceilings, floors, HVAC, power, fire protection system. | NRHP |
| | | Firing rooms internal modifications including walls, ceilings, floors, HVAC, power, fire protection system. | NRHP |
| Vehicle Assembly Building (VAB) (Building K6-0848) | Vehicle assembly and integration | Modification and rehabilitation of facility structures, features, and systems such as new high bay platforms, landing structures, utilities, *etc.*, to provide necessary access to assemble and integrate the Ares launch vehicles. | NRHP |
| Operations and Checkout (O&C) Building (Building M7-0355) | Orion assembly and integration | Modification and rehabilitation of facility structures, features, and systems such as new vacuum chamber and refurbishment. | NRHP |
| Space Station Processing Facility (SSPF) (Building M7-0360) | Candidate facility for processing of Lunar Lander | Modifications to processing stands. | NE |
| Hazardous Processing Facility (HPF) (MPPF proposed) | Processing of Orion Elements (Crew Module, Service Module, Spacecraft Adapter. Process hazardous materials for Crew Module and Service Module prior to integration with launch vehicle (loading of hazardous propellants and integration of Launch Abort System) | Potential modification and rehabilitation of facility structures, features, and systems to the Multi-Payload Processing Facility (MPPF) to meet hazardous code requirements and bi-propellant hypergol processing capabilities. | NE |
| Orbiter Processing Facilities (OPFs) (Buildings K6-894 and K6-696) | Ares V Core Stage assembly | Modification and rehabilitation of facilities' structures, features, and systems, including processing stands. | NRE |
| VAB Turning Basin Docking Facility | Perform maintenance activities to ensure structural and operational integrity. | Modification and rehabilitation of facility structures, features, and systems to refurbish the Turning Basin. | NE |
| Parachute Refurbishment Facility (PRF) (Building M7-0657) | Process and refurbish parachutes for SRB and Orion operations | None currently identified | NRE |

**Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program (Cont.)**

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **KSC (Cont.)** | | | |
| JJ Railroad Bridge | Transport SRB segments to KSC | Refurbishment of the existing JJ Railroad Bridge and ultimately the removal and replacement of the existing bridge with a new bridge at approximately the same location. | NE |
| **LaRC** | | | |
| Materials Research Lab (Building 1205) | Testing of materials and test components for Orion and Ares | None currently identified | TBD |
| Structures and Materials Lab (Building 1148) | Testing of materials and test components for Orion and Ares | None currently identified | TBD |
| COLTS Thermal Lab (Building 1256C) | Stress testing for Orion, small articles/thermal protective materials | None currently identified | TBD |
| Thermal Structures Lab (Building 1267) | Stress testing for Orion, small articles/thermal protective materials | None currently identified | TBD |
| Fabrication and Metals Technology Development Lab (Building 1232A) | Fabrication of models and test items for Orion and Ares | Floor modifications for new roll press. | TBD |
| CF4 Tunnel (Building 1275) | Scale model testing for Orion | None currently identified | TBD |
| Unitary Wind Tunnel (Building 1251) | Scale model wind tunnel testing for Orion and Ares | None currently identified | TBD |
| 31-Inch Mach 10 Tunnel (Building 1251) | Scale model testing for Orion | None currently identified | TBD |
| Vertical Spin Tunnel (Building 645) | Scale model testing for Orion, including the Launch Abort System | None currently identified | TBD |
| Transonic Dynamics Tunnel (Building 648) | Scale model wind tunnel testing for Orion and Ares | Modify test equipment for wind tunnel models | TBD |
| Gas Dynamics Complex – 20-inch Mach 6 Tunnel (Building 1247D) | Scale model wind tunnel testing for Orion and Ares | None currently identified | TBD |
| Impact Dynamics Facility (Gantry) (Building 1297) | Orion drop tests | Replace elevator, complete painting of upper section and repair/replacement of components | NHL |
| Hangar (Building 1244) | Possible assembly of some large Orion flight test articles inside hangar | None currently identified | TBD |

**Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program (Cont.)**

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **MAF** | | | |
| Manufacturing Building (Building 103) | Ares I Upper Stage structural welding, avionics, and common bulkhead assembly | Structural foundation improvements, pilings driven, tooling modifications, furnace stack addition | NE |
| Vertical Assembly Facility (Building 110) | Ares I Upper Stage and Orion Crew Module, Service Module, back shell, and heat shield fabrication | Interior modifications | NRE |
| Acceptance and Preparation Building (Building 420) | Ares I Upper Stage | Major modifications, new floors, doors, tool sets, reconfiguration of the test control room | NRE |
| Pneumatic Test Facility and Control Building (Building 451 and Building 452) | Pressure and dynamic testing | Tooling structure and internal control modifications | NRE |
| High Bay Addition (Building 114) | Ares I Upper Stage and Ares V Core Stage assembly and foam application | Potential internal modifications | NRE |
| **MSFC** | | | |
| Hardware Simulation Laboratory (Building 4436) | Ares Upper Stage engine control system and software testing and avionics and systems integration | Minor upgrades. May need to add air conditioning, walls, and power | NRE |
| Avionics Systems Testbed (Building 4476) | Ares Upper Stage avionics integration | Minor upgrades | NRE |
| Test Facility 116 (Building 4540) | Ares Upper Stage component testing. Subscale injector tests, RD-68 gas generator igniter tests, Main Injector Igniter Test Program | Modify test equipment to accommodate test requirements and component interfaces. | NRE |
| Structural Dynamic Test Facility (Building 4550) | Ares I and Ares V ground vibration testing | See Note 2 at end of table. Major modifications | NHL |
| Hot Gas Test Facility (Building 4554) | Ares I First Stage design configuration certification and Upper Stage hot gas testing | Improvements/repairs, minor modifications, and test equipment modifications | NRE |
| Propulsion and Structural Test Facility (Building 4572) | Testing Ares I First Stage and Ares Upper Stage pressure vessel components | Minor modifications | NHL |
| Materials and Processes Laboratory (Building 4612) | Materials testing | Minor upgrades to install equipment, plating facility may need minor modifications. | NRE |

## Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program (Cont.)

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **MSFC (Cont.)** | | | |
| Test and Data Recording Facility (Building 4583) | Ares Upper Stage spark igniter testing, turbo-pump and combustion devices testing | Modify propellant supply lines and vacuum chamber | NRE |
| Structures & Mechanics Lab (Building 4619) | Ares Upper Stage engine vibration testing, structural testing, avionics thermal/vacuum testing, and heat treatment processing | Minor upgrades including installation of test equipment and reconfiguration of equipment | NRE |
| Huntsville Operations Support Center (HOSC/NDC) (Building 4663) | Engineering support for Ares Upper Stage development operations; data gathering, processing and archiving for engine and propulsion behavior analysis | Minor modifications | NRE |
| Cyrogenic Structural Test Facility (Building 4699) | Ares Upper Stage structural load tests including cryogenic testing of the common bulkhead shared by liquid oxygen and liquid hydrogen tanks. | Major modifications, increase building height by 40 feet and run new liquid oxygen lines from Building 4670. CERCLA site access required. | NE |
| Advanced Engine Test Facility (Building 4670) | Ares Upper Stage engine testing | Major reactivation work, structural changes necessary | NRE |
| Multi-purpose High Bay and Neutral Buoyancy Simulator Complex (Building 4705) | Ares Upper Stage fabrication | Minor upgrades – new tooling, installation of equipment. | NHL |
| National Center for Advanced Manufacturing (Building 4707) | Ares Upper Stage support actions and evaluations | Substantial upgrades | NRE |
| Engineering and Development Laboratory (Building 4708) | Final assembly and preparation for Ares Upper Stage testing | Minor modifications | NRE |
| Wind Tunnel Facility (Building 4732) | Ares wind tunnel testing | None currently identified | NRE |
| **SSC** | | | |
| A-1 Rocket Propulsion Test Stand (Building 4120) | Ares I J-2X power pack and J-2X Upper Stage engine testing and Ares V J-2X Earth Departure Stage engine testing | Minor upgrades and reconfiguration | NHL |
| A-2 Rocket Propulsion Test Stand (Building 4122) | J-2X engine component testing | Minor repairs and modifications | NHL |
| B-1 Test Stand (Building 4220) | Ares V RS-68B engine testing | None currently identified | NHL |
| A-3 Test Stand Vacuum Facility | Ares Upper Stage testing | See Note 3 at end of table. New facility near A-1 Test Stand | NA |

**Table 2-10. New, Substantially Modified, and/or Historic Government Facilities Supporting the Constellation Program (Cont.)**

| Facility Name/Number | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status |
|---|---|---|---|
| **SSC (Cont.)** | | | |
| B-2 Test Stand (Building 4220) | Ares V RS-68B Core Stage engine testing | Major structural modifications – support structure, refurbishment, upgrades to structural steel | NHL |
| Building 9101 (assembly warehouse) | Assembly of Ares I Upper Stage engine and assembly of Ares V Core Stage and Earth Departure Stage engine | Minor modifications to low bay area. | NE |
| **WSMR** | | | |
| Launch Complex-32 (proposed location) | Launch Abort System pad abort and ascent abort testing | See Note 4 at end of table. New concrete launch pad<br>New launch tower system<br>New vehicle integration building | NA |
| Launch Complex-33 (alternate location to Launch Complex-32) | Launch Abort System pad abort and ascent abort testing | Unknown | NRHP |

NA = Assets that have not yet been built
NE = Not eligible for listing on the National Register of Historic Places (NRHP); asset surveyed and determined not eligible for listing
NRHP = Asset is on the NRHP
NRE = National Register Eligible (asset is eligible for listing on the NRHP)
NHL = National Historic Landmark
TBD = To Be Determined (awaiting final determination from the State Historic Preservation Officer)

Note 1: Modifications to Launch Complex-39 Pad B are addressed in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program at the John F. Kennedy Space Center Florida*. Future modifications to Launch Complex-39 Pad A and associated infrastructure are expected to be similar to those undertaken for Launch Complex-39 Pad B.

Note 2: The *Final Environmental Assessment for Modification and Operation of TS 4550 in Support of Ground Vibration Testing for the Constellation Program* has addressed this action.

Note 3: The *Final Environmental Assessment for the Construction and Operation of the Constellation Program A-3 Test Stand, Stennis Space Center, Hancock County, Mississippi* has addressed this action.

Note 4: The *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* has addressed this action.

## Table 2-11. Schedule of Major Vehicle Engine Tests, Flight Tests, and Initial Constellation Program Missions

| Test/Flight[1] | Location | Year | Estimated Number of Tests/Flights |
|---|---|---|---|
| **First Stage Ground Tests[2]** | | | |
| Development Motor-1, Hot Fire Test | ATK Promontory, Utah | 2008 | 1 |
| Development Motor-2, Hot Fire Test | ATK Promontory, Utah | 2009 | 1 |
| Qualification Motor, Hot Fire Test | ATK Promontory, Utah | 2011 | 2 |
| Qualification Motor, Hot Fire Test | ATK Promontory, Utah | 2012 | 1 |
| **Launch Abort System Tests** | | | |
| Pad Abort Test | WSMR | 2008 | 1 |
| Launch Abort Flight Test | WSMR | 2009 | 1 |
| Pad Abort Test | WSMR | 2010 | 1 |
| Launch Abort Flight Test | WSMR | 2010 | 1 |
| Launch Abort Flight Test[3] | WSMR | 2011 | 2 |
| **Upper Stage Engine (J-2X) Ground Tests** | | | |
| Upper Stage Engine Hotfire Test | SSC | 2010-2014 | 175 |
| Upper Stage Engine Hotfire Test (simulated altitude) | SSC | 2010-2014 | 100 |
| Upper Stage Engine Hotfire Test | GRC | 2011 | 2 |
| Main Propulsion Test Article Hotfire Test | MSFC | 2010-2013 | 24 |
| **Ares I Flights** | | | |
| Ares I Ascent Development Flight Test[3] | KSC | 2009 | 2 |
| Ares I Ascent Development Flight Test | KSC | 2012 | 1 |
| Orbital Flight Test | KSC | 2013 | 2 |
| Orbital Flight Test[4] | KSC | 2014 | 2 |
| Mission Flight[5] | KSC | 2015-2020 | up to 30 (total) |
| **Ares V Core Stage Engine Ground Tests** | | | |
| RS-68B Engine Hotfire Test | SSC | 2012-2018[6] | 160 |
| Main Propulsion Test Article Cluster Hotfire Test | SSC | 2012-2018[6] | 20 |
| **Earth Departure Stage Engine Ground Tests[1]** | | | |
| Upper Stage Engine Hotfire Test (simulated altitude) | GRC | 2012-2014 | 20 |
| Main Propulsion Test Article Hotfire Test | MSFC | 2015-2018 | 20 |
| **Ares V Flights** | | | |
| Flight Test | KSC | 2018 | 2 |
| Mission Flight[7] | KSC | 2019 | 2 |
| Mission Flight | KSC | 2020 | 1 |

Sources: MSFC 2006b, MSFC 2006d, WSTF 2006

Notes:

1. The Constellation test programs are evolving and the number, location, and types of tests are subject to change.
2. ATK would have an ongoing qualification test program. Once motor production for missions begins, it is expected that flight-like motors would continue to be tested.
3. The last launch abort flight test at WSMR may be combined with an Ares I ascent development flight test.
4. The third orbital flight test would be the first crewed launch of an Orion/Ares I.
5. Up to five Ares I flights per year would occur, although the actual number of launches could be lower.
6. Engine testing is expected to occur over a 3-year period within this timeframe.
7. The second flight in 2019 is the first planned to include landing a crew on the Moon.

#### *2.1.10.2 Launch Abort Flight Tests*

Beginning in late 2008 and lasting through 2012, flight test of the Orion Launch Abort System using a mass/dimension equivalent model of the Orion spacecraft would be conducted at WSMR. Potential launch complexes for these tests include LC-32, the Dog Site, LC-33, Lance Extended Range-4, and the Small Missile Range. Two types of uncrewed tests would be conducted, including pad abort tests to demonstrate Orion Crew Module escape on the launch pad at zero altitude and zero velocity and ascent abort tests to demonstrate a simulated crew escape during ascent.

Currently, two pad abort tests are planned at WSMR. These tests would demonstrate the capability of the Launch Abort System to boost the Crew Module to an altitude sufficient to allow safe parachute deployment and to a lateral separation from the launch site sufficient to prevent the descending Crew Module from landing in unextinguished propellant from the Upper Stage following a launch pad accident.

Up to four ascent abort tests are planned at WSMR, although this number may change. These tests would require development of a new launch vehicle using surplus Air Force Peacekeeper first stage and/or second stage motors. The launch vehicle would be built at a contractor facility.

The *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* addresses the potential environmental impacts associated with these tests at WSMR. NASA and WSMR have initiated the design and construction of a launch facility for Launch Abort System testing at WSMR, with construction estimated to be completed by mid-2008 (WSTF 2007b).

Pad abort testing would require minimal new construction and ancillary equipment/structures. It is expected that existing facilities could be utilized for pad abort testing; however, at a minimum, a new concrete launch pad would be required to incorporate the launch pad adapter ring and separation ring interface. For ascent abort testing, new construction would be required, including the launch tower system and a vehicle integration building (WSTF 2007b).

During the two planned pad abort tests, vehicle components (the Launch Abort System and the Orion Crew Module model) would land within 1.3 km (0.8 mi) downrange from the launch pad. The Crew Module and Launch Abort System would be recovered for post-flight inspections. The ascent abort tests would demonstrate separation and recovery of the Crew Module under various ascent conditions. Test vehicle flight components would be expected to land within 114 km (71 mi) downrange from the launch site. All flight components would land on WSMR property and would be recovered, thus meeting NASA Range Safety requirements (WSTF 2007b).

#### *2.1.10.3 Ascent Development and Orbital Flight Tests*

A series of ascent development flight tests and orbital flight tests would be performed to demonstrate ascent and orbit insertion of the Orion/Ares I configuration during a normal launch (see Table 2-11). All ascent development flight tests and orbital flight tests are planned to be conducted from KSC's LC-39 Pad B.

Flight test objectives would include demonstration of aerodynamic control of the launch vehicle (starting with a vehicle similar to the integrated Orion/Ares I configuration), First Stage/Upper Stage separation, atmospheric entry dynamics, First Stage parachute performance, First Stage flight performance, and First Stage recovery operations by KSC.

The ascent development flight tests would use various developmental versions of the Ares I launch vehicle. The first two ascent development flight tests would use a four-segment First Stage with an unfueled fifth segment, which together would be the mass equivalent of a five-segment First Stage. The Upper Stage and the Orion spacecraft would be simulated with mass/dimension equivalent models without an Upper Stage engine. The third ascent development flight test would use the full Ares I five-segment First Stage, but would still use mass/dimension equivalent models of an Orion spacecraft and an Upper Stage without an engine. The orbital flight tests would use the full Ares I launch vehicle, the five-segment First Stage, and an Upper Stage with a J-2X engine.

#### *2.1.10.4 Other Flight Tests*

Additional demonstration flight tests, not included in Table 2-11, may be incorporated into the Constellation Program test schedule, as needed. For example, test flights to evaluate the performance of the Orion Thermal Protection System during a high-speed atmospheric entry to simulate lunar return are under consideration. Data from these tests would be used to verify analytical models which would be used to design the Crew Module Thermal Protection System (JSC 2006e). The Constellation Program would evaluate the need for any additional tests and complete the appropriate NEPA review and documentation, as appropriate.

### 2.1.11 Range Safety

Range Safety addresses the measures taken by NASA to protect personnel and property during those portions of a mission (launch, atmospheric entry, and landing) that have the potential to place the general population at risk. The “range” is the land, sea, or airspace within or over which orbital, suborbital, or atmospheric vehicles are tested or flown. Range Safety addresses these areas and the potentially affected areas around the range. NASA’s Range Safety policy is specifically defined in NASA Procedural Requirements (NPR) 8715.5 “Range Safety Program.” NASA’s policy is designed to protect the public, employees, and high-value property and it is focused on the understanding and mitigation (as appropriate) of risk.

NASA mitigates and controls the hazards and risks associated with range operations from mission launch, atmospheric entry, and landing (NASA 2005c) and applies Range Safety techniques to range operations in the following order of precedence:

1. Preclude hazards, such as uncontrolled vehicles, debris, explosives, or toxics, from reaching the public, workforce, or property in the event of a vehicle failure or other mishap
2. Apply a risk management process when the hazards associated with range operations cannot be fully contained.

#### *2.1.11.1 Launch Range Safety*

The KSC/CCAFS Range Safety Office (generally referred to as Launch Range Safety), would establish predetermined flight safety limits prior to each Ares launch. Wind criteria, impacts from fragments that could be produced in a launch accident, exhaust cloud dispersion, and reaction of liquid and solid propellants (*e.g.*, toxic plumes and fire), human reaction time, data delay time, and other pertinent data would be considered when determining flight safety limits. The Mission Flight Control Officer would take any necessary actions, including destruction of the vehicle, if the vehicle's trajectory indicates a flight malfunction (*e.g.*, exceeding flight safety limits).

Launch Range Safety uses generally accepted models to predict launch risks to the public and to launch site personnel from several hazards prior to a launch. These models are periodically updated and improved to reflect increased understanding of launch risks. Prior to acceptance, all modifications to models are validated by the Range Safety community. The models calculate the risk of injury resulting from toxic exhaust gases from normal launches, and from potentially toxic plumes from a failed launch as well as risks from falling debris and blast overpressures. Launches may be postponed if the predicted collective public risk of injury exceeds approved levels (they may also be allowed to continue, given approval from the NPR 8715.5 designated authority, depending on the specific hazards posed and risk levels on the day of launch). Range Safety would monitor launch surveillance areas to ensure that risks to people, aircraft, and surface vessels are within acceptable limits. Controlled surveillance areas and airspace would be closed to the public, as required (USAF 1998).

During Launch Abort System tests (both pad abort and ascent abort tests) at WSMR, Range Safety would be ensured through cooperation between personnel at WSTF and WSMR. WSMR Regulation 385-17, "Missile Flight Safety" and NASA's Range Safety Policy (NASA 2005c) governs Launch Abort System tests at WSMR.

Beginning with pre-launch activities for the Launch Abort System test, WSMR Range Safety would assess a variety of factors in their assessment of safe operating procedures. These factors include the status of the missile range (whether or not the range is cleared for test activities), launch complex, and range assets. The range control safety team also would monitor meteorological conditions to determine effects on the test event and the general public. During launch, the Range Safety Officer would monitor the trajectory of the launch vehicle. If the vehicle is found to be straying outside its assigned flight corridor, the Range Safety Officer would activate the flight termination sequence. Under normal launch conditions, the range control safety team would monitor the impact site and determine when it is safe for recovery crews to locate the Launch Abort System test article and flight components (NASA 2005c).

The U.S. Army uses accepted models to analyze launch hazard (*e.g.*, toxics, debris, and blast/overpressure) risks to the public, WSMR/WSTF personnel, and the launch site. Range Safety criteria and practices currently in place at WSMR are similar to those currently employed at both KSC and CCAFS. The range (land area and airspace) would be closed to the general public during Launch Abort System tests and these tests would be monitored for any anomaly which would result in non-acceptable risk levels.

### *2.1.11.2 Entry Range Safety*

Potential impacts from catastrophic incidents involving entry vehicles are continually assessed as part of the overall Range Safety evaluation. The most significant potential health hazard during an Earth atmospheric entry accident would be the hazard posed by falling debris.

#### 2.1.11.2.1 Overflight of the Orion Crew Module

For a normal atmospheric entry and terrestrial landing of the Orion Crew Module, the vehicle would land within a pre-designated restricted landing zone. This area would be cleared of personnel until after the Crew Module and any other items jettisoned during its descent and landing are on the ground (these other items are addressed below). The Crew Module would descend through U.S. National Air Space in near-vertical flight; essentially the Crew Module would remain in a small vertical cylinder that extends from the ground to approximately 15,200 m (50,000 ft) of altitude. This airspace would be controlled with the assistance of the Federal Aviation Administration (FAA). The confines of the landing location are currently defined as a 10 km (6.2 mi) diameter circle.

For an ocean landing, all items jettisoned during descent and landing of the Crew Module would follow descent trajectories intended to result in an ocean splash down. As with the terrestrial landing, the Crew Module would descend through commercial air space in a near-vertical flight and land (splashdown) in a pre-selected area of the Pacific Ocean off the west coast of the continental United States. NASA would coordinate with the appropriate agencies (*e.g.*, FAA) to announce the time and location of the Crew Module entry and splashdown, enabling the public to avoid this airspace and impact areas.

If the Crew Module were to have a catastrophic failure during Earth atmospheric entry, the primary hazard would be that of falling debris. For the Space Shuttle Program, JSC Range Safety uses models to predict atmospheric entry hazards to the public and onsite personnel prior to every launch. These models calculate the risk of injury resulting from falling debris from potential entry failures. The orbital ground track is sometimes modified as the mission nears its completion if the upcoming landing opportunities have a predicted offsite collective public risk of injury due to falling debris that exceeds acceptable limits. This approach takes into account the probability of a catastrophic failure, the size of the resultant debris field, the resultant amount of debris that would survive to ground impact, the distribution of harmful debris within the debris field, the population distribution on the ground, and the population sheltering. While the hazard of falling debris is judged to comprise the vast majority of the public risk, JSC Range Safety is nevertheless developing the capability to assess the hazards posed by exposure to toxic gases and blast overpressure for use in the Constellation Program.

#### 2.1.11.2.2 Ocean Disposal of Objects

During Orion entry, the Service Module would be jettisoned (as well as the docking mechanism if returning from the International Space Station) as part of the normal mission sequence in order for the crew to land safely. These objects would break into many smaller debris pieces upon atmospheric entry, some of which would survive to ocean impact. In accordance with NPR 8715.6 “NASA Procedural Requirements for Limiting Orbital Debris” (NASA 2007d), this disposal would be carried out such that the resulting debris field boundaries are no closer than

370 km (230 mi) from foreign landmasses, and at least 46 km (29 mi) from U.S. territories and the continental U.S., at least 46 km (29 mi) from the permanent ice pack of Antarctica. Prior to atmospheric entry, NASA would estimate when and where the debris fields would occur, and would ensure that Notices to Airmen and Notices to Mariners are disseminated in a timely fashion. NASA would continue to focus on falling debris as the primary hazard and would compute risk estimates based on aircraft and mariner traffic given the release of such notices and expected deviation from normal aircraft and mariner routes.

2.1.11.2.3 In-Flight Disposal of Objects over the Landing Site

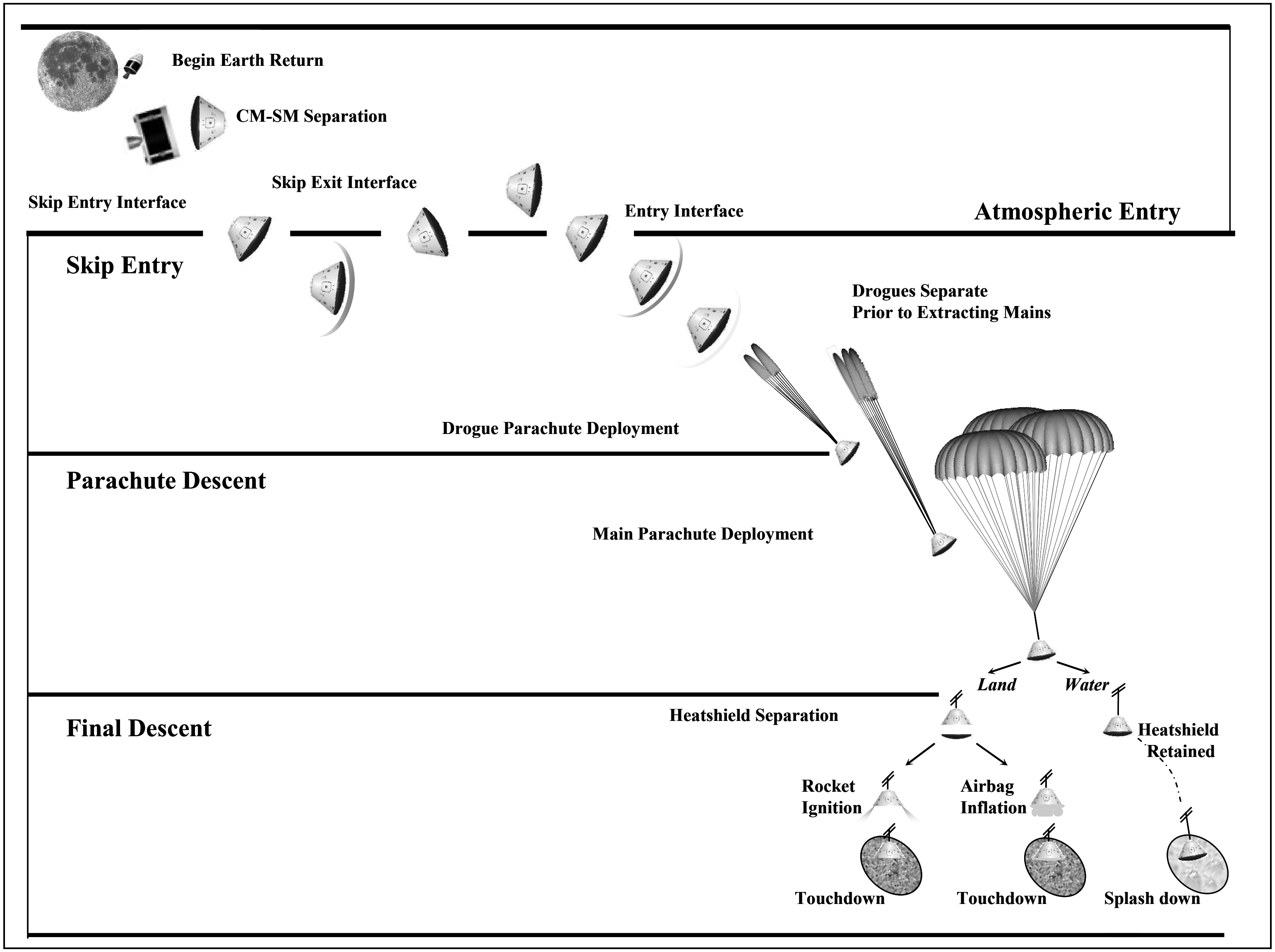
The Orion spacecraft would jettison some objects during the final phases of descent and landing as part of the normal mission sequence, such as the drogue parachutes and the heat shield. The only hazard in these instances is that due to falling debris. Due to the near-vertical descent and landing trajectory of the Crew Module, this debris is expected to land within a pre-designated unpopulated landing zone.

### 2.1.12 Landing Sites

The selection of terrestrial landing sites for the Crew Module would be subject to separate NEPA review and documentation, as appropriate. Constellation Program requirements include the ability of the Orion spacecraft to use both water (*i.e.*, ocean) landing sites and terrestrial landing sites. The Constellation Program is in the process of establishing the criteria for selecting landing sites. These criteria would be expected to include, but not be limited to, feasibility for lunar and International Space Station mission return, safety of public and crew, available existing infrastructure to support landing operations, and environmental sensitivities for each candidate landing site.

In the case of a terrestrial landing in the western continental U.S., the Service Module would first direct the Crew Module to the desired set of landing sites and then would be jettisoned. The Service Module (and the docking mechanism if returning from the International Space Station) would splash down in the Pacific Ocean. It is expected that components of the Service Module that survive atmospheric entry would sink, although some components (including fuel tanks) may survive sufficiently intact to remain afloat. The fuel tanks would be expected to vent fully prior to ocean impact, although trace amounts of propellant could be contained within some surviving components. The Crew Module would approach the landing zone and at an appropriate altitude, the heat shield would be jettisoned, and the landing attenuation systems (*e.g.*, parachutes, retrorockets, and airbags) would be activated, enabling a soft touchdown at the landing zone (see Figure 2-21). It is expected that the heat shield and the parachute systems would land within the confines of the landing zone.

In the case of a water landing, a similar sequence of events would occur with the exception that the heat shield would be retained and the parachute system, once jettisoned, would sink to the ocean bottom. The normal landing zone would be expected to be off the western coast of the continental United States.




Source: JSC 2007a

**Figure 2-21. Crew Module Entry from a Lunar Mission**

### 2.1.13 Representative Payloads

The Constellation Program would be responsible for providing the necessary hardware (launch systems) for human space exploration. Payloads would be dependent upon the destination and purpose at these destinations. Lunar and Martian payloads could include science experiments, rovers, landers, and habitation modules. These payloads would be designed to meet specific and unique mission requirements, which are largely undefined at this point in the Constellation Program. It is assumed that exploration would occur with the larger goal of habitation. As demonstrated from past missions, most payloads would involve subsystems made up of materials and components commonly used in the space industry. As the Constellation Program matures, these systems would be subject to additional environmental review and documentation, as appropriate, to address any environmental concerns regarding the payloads.

## 2.2 DESCRIPTION OF THE NO ACTION ALTERNATIVE

Under the No Action Alternative, NASA would not continue preparations for nor implement the Constellation Program. NASA would forego the opportunity for human missions to the Moon, Mars, and beyond using U.S. launch vehicles. The U.S. would continue to rely upon robotic missions for space exploration activities beyond Earth orbit. The opportunity for commercial entities in the U.S. to provide crew and cargo service to the International Space Station would be unaffected by a decision not to implement the Constellation Program. Other than the potential for commercial crew and cargo service to the International Space Station, the U.S. would depend upon our foreign partners to deliver crew and cargo to and from the International Space Station.

## 2.3 ALTERNATIVES CONSIDERED BUT NOT EVALUATED FURTHER

This Section discusses alternatives to the Proposed Action that were considered but not evaluated further; including modifying the Space Shuttle fleet, purchasing space transportation services from foreign governments, varied designs and configurations for the CEV (*i.e.*, Orion) and multiple launch vehicle options for crew launches and cargo launches.

These alternatives were eliminated from further evaluation based on various considerations, including safety, technical feasibility, cost, development time and risk, and consistency with Presidential and Congressional directives.

### 2.3.1 Space Shuttle Modifications

Modifying/refurbishing the Space Shuttle fleet for long-term cargo delivery and human access to the International Space Station was considered impractical. The Columbia Accident Investigation Board (CAIB) noted that major modifications to the Space Shuttle fleet to significantly improve crew safety (*e.g.*, a crew escape system) cannot be implemented easily (NASA 2003). The CAIB report made clear that if the Space Shuttle flights are extended beyond 2010 the fleet would require recertification, which would be a costly and lengthy process (NASA 2003, TPS 2004). Moreover, the Space Shuttle was not designed to withstand the atmospheric entry speeds of a lunar mission (NASA 2005d). President Bush made the determination that the Space Shuttle fleet would not be used beyond the completion of the International Space Station (TWH 2004).

### 2.3.2 Purchasing Services from Foreign Governments

Purchasing space transportation services from foreign governments is viewed as an enhancement to, but not a substitute for, U.S. human space exploration capability. Since its founding in 1958, NASA has engaged in many cooperative projects with foreign nations, with perhaps none more visible than the ongoing construction of the International Space Station. Furthering such cooperation will be an important feature of renewed commitment by the U.S. for human space exploration. However, as a matter of public policy, the U.S. does not plan to abandon its capability to launch and sustain humans in space (TPS 2004, TWH 2004). Furthermore, the NASA Authorization Act of 2005 provided explicit Congressional endorsement of the President's exploration initiative, authorizing NASA to "…establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations" (Pub. L. 109-155).

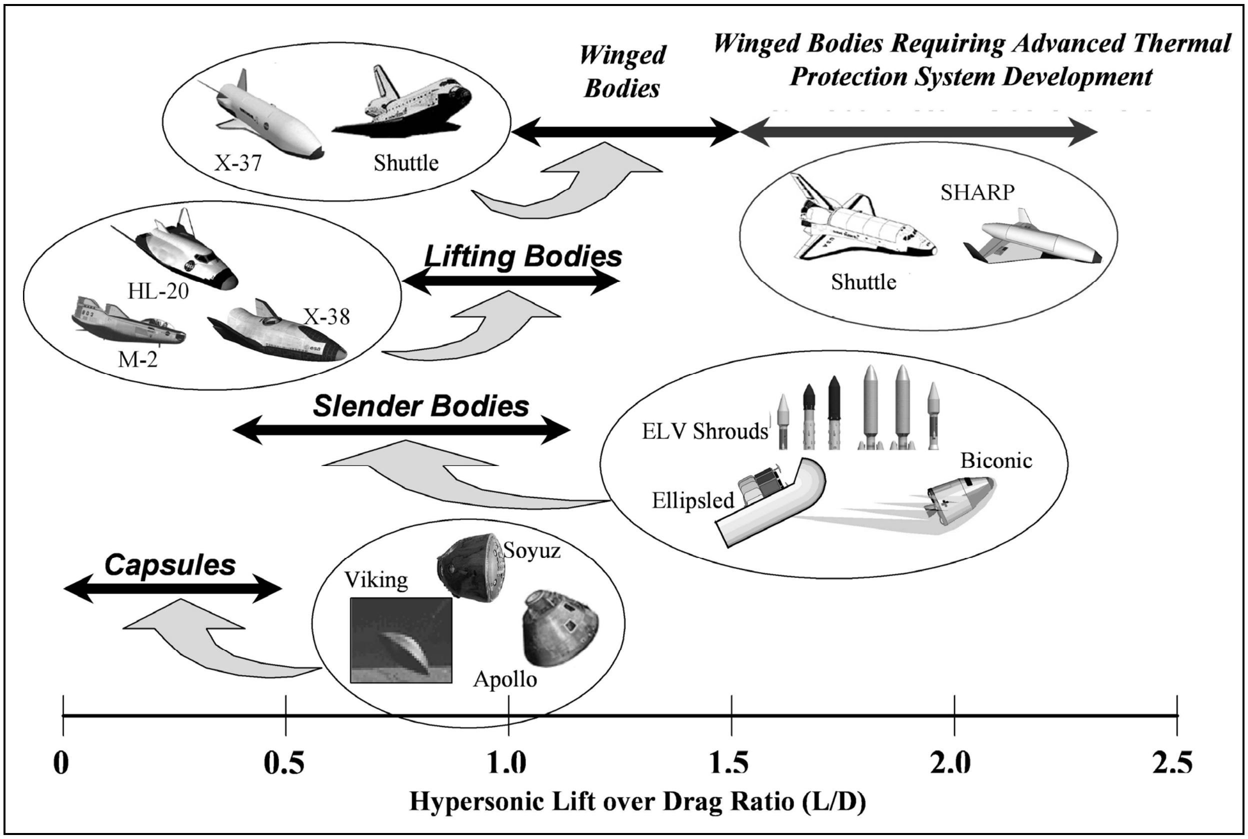
### 2.3.3 Crew Exploration Vehicle Designs

Designs and configurations for the CEV (since named Orion), other than the present blunt-body design, were considered by NASA as part of studies performed in support of the ESAS. Key factors evaluated in considering alternatives included cost, mission requirements, ground operations, mission operations, human systems, reliability, and safety (NASA 2005e).

Studies conducted by NASA prior to the ESAS considered winged vehicles, lifting bodies, slender-body vehicles, and blunt-body shapes (see Figure 2-22). Lifting bodies and winged bodies were removed from consideration due to: 1) poor volumetric efficiency, 2) problems with launch vehicle integration, 3) high lunar return heating rates on fin and wing leading edges, and 4) the mass penalty of carrying the additional mass of fins and wings (useful only for aerodynamic flight) to the Moon and back.

The ESAS primarily focused on slender bodies vs. blunt bodies at the outset, using a biconic and an ellipsled as representative of the slender body class, and an Apollo capsule to represent the blunt body class. The ESAS downselected to the blunt body class of vehicles, which were then further evaluated across all types of blunt bodies (NASA 2005e).

An evaluation of environmental advantages and burdens of a blunt-body Crew Module versus a slender-body vehicle indicated that the designs differed in noise generated during atmospheric entry/landing and upper atmosphere air emissions. The ESAS Team concluded that there were no significant environmental differences between the present blunt-body design and the slender-body vehicle shape. Overall, it was determined that the present Orion spacecraft configuration was best suited to the long-term safety and success of the human spaceflight systems needed for exploration of the Moon and near-Earth planetary bodies (*i.e.*, Mars). Therefore, no other vehicle-shape systems were considered in detail in the *Final Environmental Assessment for the Development of the Crew Exploration Vehicle* (KSC 2006a), for which a Finding of No Significant Impact (FONSI) was published in the *Federal Register* on September 1, 2006 (71 *FR* 52169).



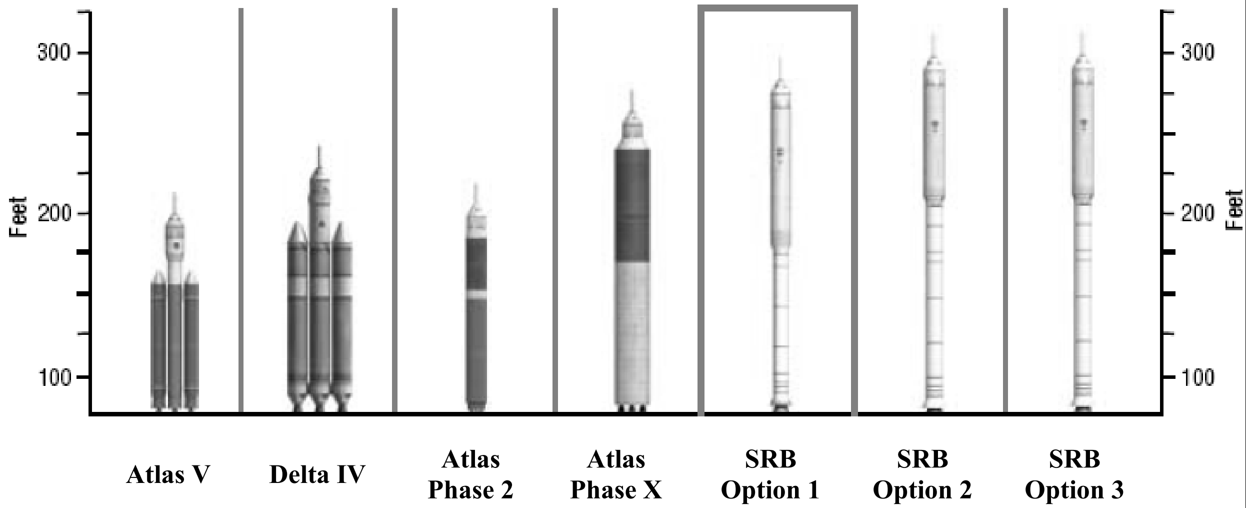

Source: Modified from JSC 2007h

**Figure 2-22. Examples of CEV Shapes Evaluated by NASA**

### 2.3.4 Crew Launch Vehicle Designs

For the CLV (since named Ares I), the ESAS Team examined the costs, schedule, reliability, safety, and risk of using either of the current families of Evolved Expendable Launch Vehicles; or Space Shuttle-derived vehicles. To determine the CLV crew and cargo transportation requirements, the team examined multiple lunar surface missions and systems and different approaches to constructing a lunar outpost. The principal study conducted by the ESAS Team was an examination of various mission models for transporting crew and cargo to the Moon, including docking in lunar and Earth orbits, and direct return from the lunar surface. Figure 2-23 provides a summary of the most promising CLV candidates assessed by the ESAS Team.

In assessing the capabilities of current launch systems, the ESAS Team focused on the heavy-lift versions of both Delta and Atlas families. None of the medium lift versions of either family of vehicles (with lower mass lift capabilities) have the capability to accommodate CEV lift requirements. Even augmented with solid strap-on boosters, the medium-lift launch vehicles would not provide adequate capability and would pose an issue for crew safety based on small strap-on solid rocket motor reliability (NASA 2005e).




| | |
|---|---|
| **Atlas V** | Human-rated version of the current Atlas V heavy-lift launch vehicle |
| **Delta IV** | Human-rated version of the current Delta IV heavy-lift launch vehicle |
| **Atlas Phase 2** | Atlas-based launch vehicle with a new Core Stage |
| **Atlas Phase X** | Atlas-based launch vehicle with a new, larger, Core Stage |
| **SRB Option 1** | Current Space Shuttle four-segment SRB as First Stage with one Space Shuttle main engine for Upper Stage |
| **SRB Option 2** | Five-segment modified Space Shuttle SRB as First Stage with one J-2S+ engine for Upper Stage |
| **SRB Option 3** | Five-segment modified Space Shuttle SRB as First Stage with four LR-85 engines for the Upper Stage |

Source: NASA 2005e

**Figure 2-23. Comparison of Crew Launch Systems for Low Earth Orbit**

The Atlas and Delta heavy-lift vehicles would require modification for human-rating, particularly in the areas of avionics, telemetry, structures, and propulsion systems (NASA 2005e). The proposed human-rated Atlas V and Delta IV vehicles shown in Figure 2-23, would require new Upper Stages to provide sufficient lift capability to low Earth orbit. The Atlas V and Delta IV single-engine Upper Stages fly highly lofted trajectories, which can produce high deceleration loads on the crew during an abort and, in some cases, can exceed crew load limits as defined by NASA. Depressing the trajectories flown by these vehicles to reduce crew loads sufficiently would require reducing First Stage acceleration. Since this would reduce the altitude to which the First Stage could lift the crew, additional Upper Stage thrust would be required. Neither the Atlas V nor the Delta IV, with their existing Upper Stages, possess the performance capability to support CEV missions to the International Space Station, falling short of the needed lift requirements by 5 and 2.6 metric tons (mt) (5.5 and 2.8 tons), respectively (NASA 2005e).

Another limitation in both heavy lift vehicles is their very low thrust-to-weight ratio at liftoff, which limits the additional mass that can be added to improve performance. The RD–180 First Stage engine of the Atlas V heavy-lift vehicle would require modification to be certified for human-rating. The RS-68 engine powering the Delta IV heavy-lift vehicle First Stage would also require modification prior to human launch.

Assessments were made of two new Core Stages, the Atlas Phase 2 and Atlas Phase X (See Figure 2-23), with improved performance as an alternative to modifying and certifying the current Atlas V Core Stages for human flight. These assessments revealed that any new Core Stage would be too expensive and exhibit an unacceptable development risk to meet NASA's then desired goal of CEV operability by 2011 (NASA 2005e).

The CLV options derived from Space Shuttle elements focused on configurations that used an SRB-derived First Stage. These configurations included a four-segment version nearly identical to the SRB currently flown or a higher-performance five-segment version of the SRB using either PBAN or Hydroxyl Terminated Polybutadiene as the solid propellant. New Core Stages with Space Shuttle External Tank-derived First Stages (without SRBs), similar to the new core options for the Atlas V and Delta IV, were briefly considered but were judged to have the same limitations and risks and, therefore, were not pursued by the ESAS Team.

To meet the CEV lift requirement, the ESAS Team initially focused on five-segment SRB-based solutions. Three classes of Upper Stage engine were assessed: 1) Space Shuttle Main Engine, 2) a single J-2S+ engine, and 3) a four-engine cluster of a new expander cycle engine. Technical risks associated with the development of a new Upper Stage engine (Option 3) were deemed to significantly impact the ability to meet the then proposed CEV flight schedule.

Options that could meet the lift requirement using a four-segment SRB were also evaluated. To achieve this, a 2.2 million N (500,000-lbf) vacuum thrust class propulsion system would be required. Two types of Upper Stage engine were assessed, including a two-engine J-2S cluster and a single Space Shuttle Main Engine. The Space Shuttle Main Engine option offered the advantage of an extensive and successful flight history with no gap between the Space Shuttle Program and Constellation Program missions, although the costs associated with the future development and use of the Space Shuttle Main Engine would be higher than for the development and use of a J-2 derived engine. Based on this advantage and past studies that showed that the Space Shuttle Main Engine could be air-started, the ESAS Team initially recommended the four-segment SRB with one Space Shuttle Main Engine for the CLV (SRB Option 1 in Figure 2-23) (NASA 2005e). Derivatives of the current Evolved Expendable Launch Vehicles were not selected; however, commercial launch vehicle providers continue to pursue human rating of their vehicles.

It was determined subsequent to ESAS that the J-2X engine would be a more producible and cost effective option to the Space Shuttle Main Engine in this non-reusable application. Due to the comparatively lower thrust of the J-2X, this resulted in the replacement of the four-segment SRB in the Ares I baseline design with the five-segment SRB. Both the J-2X and the five-segment SRB would be common to the Ares I and V launch vehicles, enabling NASA to reduce the number of vehicle elements and associated development costs (MSFC 2007a). This configuration most closely corresponds to SRB Option 2 of the ESAS study (see Figure 2-23).

### 2.3.5 Cargo Launch Vehicle Candidates

A summary of CaLV (since named Ares V) candidates considered by the ESAS Team is provided in Figure 2-24. The cargo vehicle options are shown in conjunction with corresponding CLV options that utilize common launch vehicle elements, except for the 3+ launch option (see box at right for definition of numbered launch configurations). The 1.5 and 2 launch configurations are based on CLV and CaLV designs which utilize common launch vehicle elements. A requirement for four or fewer launches per mission was defined for the ESAS analysis, driven in part by lowered mission reliability and greater mission complexity for missions consisting of a large number of individual launches. This resulted in the need for a minimum payload lift class of 70,000 kg (154,000 lb). To enable a 2- or 1.5-launch configuration, a 100,000- or 125,000-kg (220,000- or 275,000-lb) class launch system, respectively, would be required.

**LAUNCH CONFIGURATIONS**

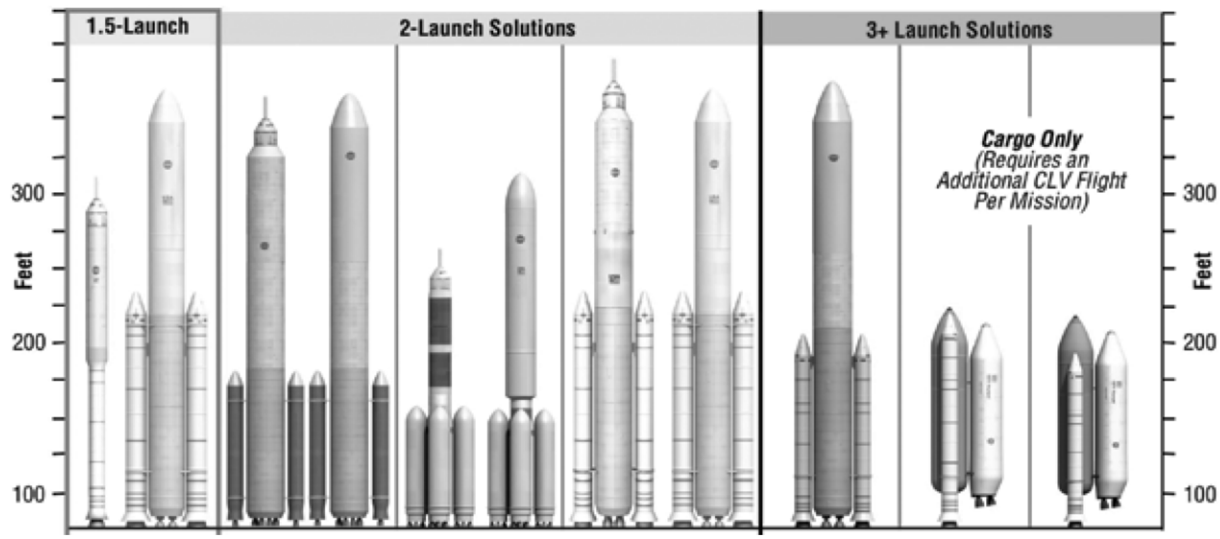
1.5 Two launches per mission; one with a smaller human-rated CEV and one with a larger CaLV. Some commonality between CLV and CaLV First Stage components.

2 Two launches per mission with similar CEV and CaLV vehicles. The CLV would be a human-rated version of the CaLV.

3+ Three or more launches per mission, CLV and CaLV commonality could be similar to that of the 1.5 or 2 launch configurations.

The Atlas and Delta heavy-lift launch vehicle derived options evaluated for the CaLV (represented by the Atlas Phase 3A and Atlas Phase X in Figure 2-24) included those powered by RD-180 and RS-68 engines, respectively, with Core Stage diameters of 5.4 and 8 m (17.7 and 26 ft), respectively. First Stage cores powered by LOX/LH-fueled RD-180 engines with solid rocket boosters proved in the ESAS analysis to be more effective in delivering the desired low Earth orbit payload.

A limitation exhibited by the Atlas/Delta-derived vehicles was the low liftoff thrust-to-weight ratios for optimized cases. While the Atlas/Delta-derived CaLVs were able to meet low Earth orbit payload requirements, the low liftoff thrust-to-weight ratio restricted the size of the Earth Departure Stage thereby restricting suborbital burns. As a result, the Earth-escape performance of these options was limited. The Atlas Phase 3A configuration had an advantage in lower development costs, mainly due to the use of a single diameter core (derived from the CLV) for both the CaLV core and strap-on boosters. However, the CLV costs for this option were unacceptably high. In addition, there would be a large impact to the launch infrastructure due to the configuration of the four solid rocket boosters on the CaLV with modifications required to the launch pad and flame trench. Also, no Atlas/Delta-derived concept was determined to have the performance capability required for a lunar 1.5-launch configuration. Finally, to meet performance requirements (*i.e.*, payload lift requirements), all Atlas/Delta-derived CaLV options required a dedicated LOX/LH Upper Stage in addition to the Earth Departure Stage, which would result in increased cost and decreased safety/reliability.




| SRB Option 1 | Atlas Phase X | Atlas Phase 3A | SRB Option 2 | SRB Option 3 | SRB Option 4 | SRB Option 5 |
|---|---|---|---|---|---|---|

| | |
|---|---|
| **SRB Option 1** | CaLV – Five Space Shuttle Main Engines power the Core Stage with two five-segment SRBs. Payload in-line with Core Stage. CLV – SRB-powered First Stage with J-2X-powered Upper Stage. |
| **Atlas Phase X** | CaLV and CLV – 8-m (26.2-ft) diameter LOX/LH-fueled Core Stage, LOX/LH-fueled boosters, possible liquid fueled Upper Stage. CaLV payload and CEV in-line with Core Stage. |
| **Atlas Phase 3A** | CaLV and CLV – 5.4-m (17.7-ft) diameter LOX/LH-fueled Core Stage, four LOX/LH-fueled boosters, possible liquid fueled Upper Stage. CaLV payload and CEV in-line with Core Stage. |
| **SRB Option 2** | CaLV and CEV – Four Space Shuttle Main Engines power the Core Stage with two five-segment SRBs. CaLV payload and CEV in-line with Core Stage. |
| **SRB Option 3** | CaLV – Three Space Shuttle Main Engines power the Core Stage with two four-segment SRBs. Payload in-line with Core Stage. No specific CLV design associated with this option. |
| **SRB Option 4** | CaLV – Three Space Shuttle Main Engines power the Core Stage with two five-segment SRBs. Payload side-mounted. No specific CLV design associated with this option. |
| **SRB Option 5** | CaLV – Three Space Shuttle Main Engines power the Core Stage with two four-segment SRBs. Payload side-mounted. No specific CLV design associated with this option. |

Source: NASA 2005e

**Figure 2-24. Comparison of Lunar Cargo Launch Systems**

The Space Shuttle-derived options considered were of two configurations: 1) a vehicle configured much like the Space Shuttle, with the Orbiter replaced by a side-mounted expendable cargo carrier (SRB Options 4 and 5 in Figure 2-24) and 2) an in-line configuration using a Space Shuttle External Tank-diameter Core Stage with a reconfigured thrust structure on the aft end of the core and a payload shroud on the forward end (SRB Options 1, 2 and 3 in Figure 2-24). For the in-line configurations, the Space Shuttle External Tank would be replaced by a conventional cylindrical tank with ellipsoidal domes, above which the payload shroud would be attached. In both the side-mounted and in-line mounted cargo carrier configurations, three Space Shuttle Main Engines were initially considered. Several variants of these vehicles were examined. Four- and five-segment SRBs were evaluated on both configurations and the side-mounted version was evaluated with two RS-68 engines in place of the Space Shuttle Main Engines. No variant of the side-mount Space Shuttle-derived vehicle was found to meet the lunar lift requirements with less than four launches. The side-mount configuration would also most likely prove to be very difficult to human-rate, with the placement of the CEV in close proximity to the main propellant tank, coupled with a restricted CEV abort path as compared to an in-line configuration. Proximity to the External Tank also exposes the CEV to tank debris during ascent, with the possibility of debris contacting the Thermal Protection System, Launch Abort System, and other critical components. The development costs for the side-mounted Space Shuttle-derived options would be lower than the in-line configurations, but per-flight costs would be higher; thus, resulting in a higher per-mission cost. The side-mount configuration was also judged to be unsuitable for upgrading to the low Earth orbit payload capability needed for Mars missions (100 to 125 mt [110 to 138 tons]).

The four-segment SRB/three-Space Shuttle Main Engine in-line configuration (shown as SRB Option 3 in Figure 2-24) demonstrated the performance required for a three-launch lunar mission at lower development and per-flight costs. The in-line configuration with five-segment SRBs and four Space Shuttle Main Engines in a stretched core stage (shown as SRB Option 2 in Figure 2-24) with approximately one-third more propellant than SRB Option 3 enables a two-launch mission configuration for lunar missions, greatly improving mission reliability.

A variation of the Space Shuttle-derived in-line CaLV enabling a 1.5-launch mission configuration was also considered (shown as SRB Option 1 in Figure 2-24). This concept added a fifth Space Shuttle Main Engine to the First Stage core, increasing its thrust-to-weight ratio at liftoff; thus, increasing its ability to carry a large, suborbitally-ignited Earth Departure Stage. This option was selected in the ESAS as the reference design for the CaLV.

After completion of the ESAS study, the mission costs associated with Space Shuttle Main Engine use, including configuring the Space Shuttle Main Engines for vacuum ignition, were found to be higher than costs associated with the use of RS-68 engines. The RS-68 was subsequently baselined in the current planning configuration for the Ares V Core Stage in the Proposed Action (MSFC 2007a).

## 2.4 SUMMARY COMPARISON OF ALTERNATIVES

This section summarizes and compares the potential environmental impacts, presented in detail in Chapter 4, of the No Action Alternative and the Proposed Action. The discussion is presented for five areas of impacts:

1. Programmatic socioeconomic impacts
2. Construction activities needed to modify existing or build new facilities, focusing on modifications to test facilities and operational facilities needed to support the Ground and Mission Operations Projects
3. Major test activities, focusing on engine ground tests and flight tests for the Orion spacecraft and the Ares launch vehicles
4. Missions, focusing on the Ares mission launches and the return of the Orion Crew Module to Earth
5. Cumulative impacts.

### 2.4.1 Programmatic Socioeconomic Impacts

#### *2.4.1.1 No Action Alternative*

As this time, a prediction cannot be made as to how the President or Congress would redirect funding and personnel that would otherwise support the proposed Constellation Program. As indicated earlier, the President has directed NASA to retire the Space Shuttle fleet by 2010. Without new programs and projects to fill the void left by the close-out of the Space Shuttle Program, substantial adverse socioeconomic impacts would be experienced by localities that host NASA Centers heavily involved in the Space Shuttle Program.

#### *2.4.1.2 Proposed Action*

The distribution of work related to the proposed Constellation Program across NASA's Centers reflects NASA's intention to productively use personnel, facilities, and resources from across the Agency to accomplish NASA’s exploration initiative. Assignments align the work to be performed with the capabilities of the individual NASA Centers. The diversity of projects to be performed at each NASA Center would vary considerably; however, it is NASA’s intent to retain a major socioeconomic footprint at each Center.

A detailed analysis of socioeconomic impacts of implementing the Constellation Program and the consequent significant conclusions are limited by the fact that the Constellation Program is at an early stage of development and would be subject to adjustments and changes as Program requirements become better defined. However, NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center.

### 2.4.2 Impacts from Facility Modifications and New Construction

#### *2.4.2.1 No Action Alternative*

Under the No Action Alternative, new construction and facility modifications that are described in Section 2.1.9 and identified in Table 2-10 would not occur, nor would there be any construction at possible Crew Module landing sites. NASA and the Constellation Program would not modify existing facilities or build new facilities in support of Constellation Program developmental activities required to carry out human exploration missions. Consequently, the environmental impacts associated with these modifications would not be incurred. However, needed facility maintenance which would be funded by the Constellation Program may not be performed, such as maintenance to the Gantry (Building 1297) at LaRC, a National Historic Landmark. Such facilities could be placed under consideration for demolition.

#### *2.4.2.2 Proposed Action*

Under the Proposed Action, modifications to existing facilities and some new facility construction would be needed at various NASA Centers and other government sites to implement the proposed Constellation Program. Most modifications would be limited to internal modifications such as changes to electrical systems or construction of internal walls that would have little or no environmental impacts. In general, the modifications would augment capabilities that already exist at these facilities. As such, the activities that would be performed in the modified facilities would be similar to activities that are already performed there.

Modifications to testing facilities at several NASA Centers and other government sites also are proposed. Several vacuum chambers and wind tunnels would be modified to accommodate full size or scaled models of various Orion spacecraft and Ares launch vehicle components or to simulate the conditions under which these components would operate. The tests performed in these modified vacuum chambers and wind tunnels would be similar to tests performed at these facilities in support of past and present NASA programs. These facilities also would be expected to be used for other current and future NASA programs.

At KSC, the infrastructure needed to support Constellation Program ground operations would be somewhat different than that for the Space Shuttle Program. Modifications to facilities currently being used for Space Shuttle Program operations are being considered to accommodate the Orion spacecraft and Ares launch vehicle processing, retrieval, and refurbishment of the Ares I First Stage and Ares V SRBs. Modifications such as these would be expected to have little or no environmental impacts. Land use and the impact on biota, water resources, or air emissions would continue at the levels currently seen at these facilities.

There are several new facilities being considered in support of the Constellation Program. At KSC, new lightning protection systems would be required at both LC-39 Pads A and B. As part of this system, three new free-standing lightning towers would be installed at both LC-39 Pads A and B. These towers would be illuminated at night for airspace safety purposes and lighting could potentially impact sea turtle nesting and hatchlings during the hatching season (May to October). In addition, migratory birds and bats could potentially collide with the high standing towers and associated grounding cables. The *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in support of the Constellation Program* (KSC 2007f) has identified mitigation measures that the Constellation Program would implement for both LC-39 Pads A and B if the Proposed Action is selected for implementation in the Record of Decision (ROD).

Impacts associated with other construction activities at KSC and at other NASA Centers would be typical of construction projects. Construction of new structures or modifications to existing buildings would be expected to generate noise, which would principally impact workers located on the site (*i.e.*, within a Center's boundaries). Air emissions would be released from construction equipment and construction wastes would be generated. Potential impacts to biota and wetlands would be considered and all construction activities would be performed in compliance with applicable licenses and permits.

Construction may be required at the selected terrestrial (land) Crew Module landing sites. Such construction could include preparation of the landing site, building access roads, and constructing new or modifying existing buildings and structures to aid recovery of crew, preserve on-board samples, or facilitate Crew Module recovery and transportation. This activity would be subject to separate NEPA review and documentation, as appropriate.

Construction of the new A-3 Test Stand at SSC required a U.S. Army Corps of Engineers wetlands disturbance authorization, a Mississippi Department of Environmental Quality Large Construction Storm Water Permit, and certification by the Mississippi Department of Marine Resources for the construction of mooring dolphins or any other work that is necessary within the SSC Access Canal.

Table 2-10 identifies historic resources at each NASA and other government sites that would be utilized for the Constellation Program. Construction in support of the Constellation Program has the potential to impact several of these facilities. For example, the fixed and rotating towers at LC-39 at KSC would be removed, and modifications are proposed for the Launch Control Center, VAB, and Orbiter Processing Facility. Any alterations or modifications that affect these or other historic properties or resources would be managed in accordance with the appropriate site Cultural Resources Management Plan, and in consultation with the State Historic Preservation Office (SHPO). Mitigation activities that NASA would perform for historic facilities as a consequence of any construction activity are discussed in Chapter 5 of this Final PEIS.

### 2.4.3 Impacts from Test Activities

#### *2.4.3.1 No Action Alternative*

Under the No Action Alternative, the test activities associated with the development of the Ares launch vehicles and the Orion spacecraft would not be required. Consequently, the impacts associated with the preparation for and performance of these tests would not be incurred.

#### *2.4.3.2 Proposed Action*

Under the Proposed Action, development of the Ares launch vehicles and the Orion spacecraft would involve extensive testing of components and integrated vehicles. The tests with the greatest potential to have environmental impacts would include ground and flight tests of liquid fueled engines and solid rocket motors. These tests would occur at contractor facilities (solid rocket motor tests at ATK); at several NASA Centers, primarily SSC (J-2X and RS-68B engine tests) and KSC (ascent development flight tests and orbital flight tests); and other government facilities, primarily at WSMR (Launch Abort System on-pad and at-altitude tests).

All of these facilities currently perform activities of a similar nature to those proposed in support of the Constellation Program.

Ares test launches at KSC (ascent development flight tests and orbital flight tests) would have essentially the same impacts as mission launches.

Environmental impacts associated with test firing of solid rocket motors at ATK's Promontory facility would principally be expected to be air quality impacts and short-term, localized noise impacts. Test firings of five-segment solid rocket motors have been conducted at the Promontory facility under an existing air permit issued by the State of Utah. An air impact analysis in support of the air permit indicated that offsite air contaminant concentrations were well below regulatory limits.

The impacts of J-2X and RS-68B liquid engine testing at SSC would principally be noise impacts. Predicted maximum offsite sound levels for any single engine or cluster of engines firing at SSC would be below 77 decibels (dBA) for the 24-hour time-weighted average at the perimeter of the buffer zone, within the confines of SSC. These noise levels are expected to have an insignificant impact to the public due to the short duration of engine tests and the relatively large buffer zone at SSC. Peak offsite noise levels from engine testing at MSFC could reach 94 dBA. Testing of the Main Propulsion Test Article (a full-scale fully functional prototype of the Upper Stage propulsion system) would generate offsite noise at this level in tests that would last as long as 7 minutes, longer than current or past tests performed at MSFC. The longer duration may increase the nuisance impact of the tests, but would not result in health impacts to the public. The Wildlife Manager for the adjoining Wheeler Wildlife Refuge has reviewed the proposed Main Propulsion Test Article test plan and concurred that proposed test activities would not adversely affect wildlife.

Exhaust from J-2X and RS-68B engine testing consists primarily of water vapor; however, operation of the equipment supporting test activities at the new A-3 Test Stand at SSC would generate carbon monoxide (CO) at levels (greater than 100 tons per year) which would require a Prevention of Significant Deterioration (PSD) air permit application. This could necessitate changes to the Clean Air Act Title V operating permit for SSC. A modification to the Mississippi Department of Environmental Quality National Pollutant Discharge Elimination System Permit for SSC would be needed to include thermal waste water from the new A-3 Test Stand.

Impacts on airspace from Launch Abort System testing at WSMR would be minimal. Testing would involve overflights of the range from LC-32 to the downrange landing sites. For the two pad abort tests, the test articles are estimated to land within 1.3 km (0.8 mi) downrange from the launch pad. The test article would be recovered for post-flight inspections. For the four ascent abort flight tests proposed to demonstrate separation and recovery under flight conditions, the test articles are estimated to land within 114 km (71 mi) downrange from the launch pad. In all cases, the test articles would land within WSMR. The use of WSMR controlled airspace would ensure that there would be no impact on commercial air traffic. The launch of test articles fall within the scope of normal activities in WSMR-controlled airspace. Coordination efforts would minimize any airspace conflicts with other concurrent testing or training operations being conducted on WSMR.

## 2.4.4 Impacts from Missions

### *2.4.4.1 No Action Alternative*

Under the No Action Alternative, the U.S. would continue to rely upon robotic missions for space exploration activities beyond Earth orbit. Other than the potential for commercial crew and cargo service to the International Space Station, the U.S. would depend upon our foreign partners to deliver crew and cargo to and from the International Space Station. Furthermore, NASA would forego the opportunity for human missions to the Moon, Mars, and beyond using U.S. space vehicles. Consequently, the impacts associated with conducting such missions would not be incurred.

### *2.4.4.2 Proposed Action*

Under the Proposed Action, impacts associated with missions to the International Space Station or to the Moon would primarily be from Ares launch activities at KSC. Combustion products from burning solid propellant in the Ares I First Stage would release hydrogen chloride (HCl), aluminum oxide ($Al_2O_3$), oxides of nitrogen ($NO_x$), and particulate matter, which would be hazardous to the environment and the public. In addition to combustion products, Ares launches also would produce noise, which would be expected to be at levels comparable to that of a Space Shuttle or Saturn V launch. These and other impacts associated with the Ares launches are discussed in the following paragraphs.

#### 2.4.4.2.1 Air Quality

The impacts at and around the launch facility from a launch exhaust cloud depend primarily on the amount of water used at the launch pad for sound suppression and on the time that the ascending launch vehicle remains near the launch pad. The potential ground level effects of Ares I or Ares V launch vehicle exhaust clouds are likely to be similar to those documented for the Space Shuttle. Specifically, acidic deposition from an Ares launch would be expected to be similar to a Space Shuttle launch. Within a few hundred meters of the launch pad, which is well within KSC/CCAFS, potential environmental impacts include destruction of sensitive plant species followed by regrowth and possibly deaths of burrowing animals in the path of the exhaust cloud.

The potential impacts more than a few kilometers from the launch pad (far-field impacts) would be similar to the Space Shuttle and would be negligible. When launches are planned, Launch Range Safety uses models and launch criteria to ensure that far-field effects are negligible.

#### 2.4.4.2.2 Noise

In general, the noise produced by a launch vehicle is proportional to its thrust. The total thrust of the Ares V (in its current planning configuration) at launch could exceed that of the Saturn V and Space Shuttle by as much as 40 and 50 percent, respectively. Therefore, an Ares V launch in support of a lunar mission would be expected to generate noise, including vibration and ground waves, in excess of that experienced with the Space Shuttle and likely of the magnitude of or exceeding that of the Saturn V.

The highest offsite noise during an Ares launch would be expected to be generated as the vehicle starts to rise as the noise would travel unimpeded. Noise modeling for the Ares V was performed using a bounding launch configuration with a total thrust of about 54.7 million N (12.3 million lb) rather than the current planning configuration thrust of about 44 million N (10 million lb). A bounding launch configuration was used to consider potential variations in future engine designs and configurations. The calculated noise at the city of Titusville and at the KSC Visitor Center/Industrial Area would be about 78 to 82 and 88 to 92 dBA, respectively, for an Ares V launch. At a 4.8 km (3 mi) radius from the launch pad (the approximate distance to the VAB), Ares V noise levels would be in the range of 99 to 102 dBA. Most KSC employees would be stationed beyond this distance. Noise levels of about 98 dBA would occur at the Saturn V viewing site with this bounding the Ares V launch vehicle configuration. For Ares I launches, noise levels are predicted to be approximately 5 to 9 dBA lower at these locations (KSC 2007c).

#### 2.4.4.2.3 Biota

Space Shuttle launches typically result in a temporary startle response from nearby birds and other wildlife; however, no long-term adverse impacts have been documented. Space Shuttle launches also result in fish kills of up to several hundred individual fish in nearby impoundments. These periodic events do not appear to have had a long-term adverse impact on fish populations in these shallow waters. It is anticipated that Ares launches from LC-39 would result in similar impacts.

#### 2.4.4.2.4 Water Quality

Some adverse effects to surface waters would be expected within a few hundred meters of the launch area. LC-39 is in the vicinity of the Mosquito Lagoon, Banana Creek, Banana River, and Indian River and an Ares exhaust cloud could impact any of these water bodies, depending on the wind direction (KSC 2003). Water quality near the launch area could be affected by the launch exhaust cloud; however, long-term adverse impacts would not be expected.

#### 2.4.4.2.5 Hazardous Materials and Waste Processing

Processing and launch activities would generate waste streams from propellant servicing, and launch and recovery operations. Processing solid rocket motors for Ares launch vehicles would be very similar to ongoing operations for the Space Shuttle fleet, except for the number of booster segments per launch. All waste management activities would be within current permit requirements.

#### 2.4.4.2.6 Launch Area Accidents

The KSC/CCAFS Range Safety Office uses models to predict launch hazards to the public and onsite personnel prior to every launch. These models calculate the risk of injury resulting from HCl (generated as a product of solid fuel combustion), as well as from debris, and blast overpressure from potential launch failures. Launches may be postponed if the predicted collective public risk of injury exceeds approved levels (they may also be allowed to continue, given approval from the NPR 8715.5 designated authority, depending on the specific hazards posed and risk levels on the day of launch). This approach takes into account the probability of a catastrophic failure; the resultant exhaust cloud's toxic concentration, direction, and dwell time; and emergency preparedness procedures.

NASA's Range Safety Policy is designed to protect the public, employees, and high-value equipment, and is focused on the understanding and mitigation (as appropriate) of risk. Potential impacts from catastrophic incidents involving launch vehicles are assessed as part of the overall Range Safety evaluation.

The results of a launch area accident, including extreme heat, fire, flying debris, and HCl deposition, could damage adjacent vegetation. Based on past experience from normal launches and launch accidents, damaged vegetation would be expected to re-grow within the same growing season because no lingering effects would expected to be present. The most sensitive nearby vegetative community, dune strand, was observed to sustain damage from a Space Shuttle launch, but recovered within six months (USAF 1998).

#### 2.4.4.2.7 Post-Launch Impacts

The Ares I First Stage and the Ares V SRBs would be jettisoned during ascent and recovered from the Atlantic Ocean using the same processes as used for the Space Shuttle. The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. As with the Space Shuttle's External Tank, other Ares jettisoned sections would splash down through targeted atmospheric entry into the ocean and not be recovered. Potential environmental impacts from similar Space Shuttle operations have been demonstrated as negligible.

The landing sites for the return of the Orion Crew Module have not been identified. The return would result in a sonic boom, the magnitude of which would be expected to remain below the magnitude of sonic booms from Space Shuttle atmospheric entries. Any potential environmental impacts from the sonic boom of returning the Orion Crew Module to a terrestrial landing site would be addressed in separate NEPA review and documentation, as appropriate.

If the Orion Crew Module were to have a catastrophic failure en route to the landing site (during atmospheric entry), the primary hazard would be from falling debris. JSC Range Safety uses models developed after the Space Shuttle *Columbia* accident to predict entry hazards to the public. These models calculate the risk of injury resulting from falling debris from potential atmospheric entry failures. This approach takes into account the probability of a catastrophic failure, the size of the resultant debris field, the resultant amount of debris that would survive to ground impact, the distribution of harmful debris within the debris field, the population distribution on the ground, and population sheltering.

Preliminary analyses of the risk of potential debris falling on the public while the Orion Crew Module is en route to the landing site have been completed. The results of these analyses indicate that, regardless of the terrestrial landing sites selected, the Constellation Program is expected to meet NASA's public safety criteria.

A catastrophic failure in the vicinity of the designated landing zone during the final phases of flight would be expected to result in impact of the Crew Module in the designated landing zone. Therefore, the risk associated with debris would be anticipated to be negligible.

2.4.4.2.8 Global Commons Impacts

Launch emissions would include ozone-depleting substances; however, the rate of deposition would depend on the launch profile and the rate at which propellant is consumed within the stratosphere. In general, data from Space Shuttle launches indicate that short-term impacts include a temporary hole in the ozone layer, but that ozone concentrations would return to pre-launch levels within two hours. It is estimated that the annual emissions of HCl and $Al_2O_3$ from Ares vehicles would induce less than 0.0012 percent of the estimated annual global average ozone reduction for corresponding years.

The production of the solid rocket motors currently requires the use of hydrochlorofluorocarbons (HCFC) 141b, an ozone depleting substance, and the Ares I Upper Stage and Ares V Core Stage LOX/LH tanks may also require the use of HCFC 141b blown foam insulation. To comply with EPA requirements to phase out Ozone Depleting Substances, and to reduce the long-term supportability risk posed by the use of Ozone Depleting Substances (due to the manufacturing phase-out), NASA intends to develop cryoinsulation replacements for the Ares I Upper Stage that do not contain HCFC 141b. NASA might continue to use relatively small amounts of HCFC 141b-blown foam for use in research and development replacement activities. In addition, ATK also uses small quantities of HCFC 141b in foam used to fill test holes in foam insulation on the exterior surface of the SRB. ATK is currently working with NASA to determine the requirements for the Ares I First Stage.

The global warming potentials for many greenhouse gases (expressed in metric tons of carbon dioxide [$CO_2$] equivalent) have been developed to allow comparisons of heat trapping in the atmosphere. The principal source of carbon emissions that would be associated with the Constellation Program would be from NASA's energy use in support of the Program. Ares launches also would contribute to the production of CO and $CO_2$. The total global warming potential from Constellation Program activities would be no more than approximately $2.5 \times 10^5$ mt ($2.8 \times 10^5$ tons) of carbon-equivalent from energy consumption annually, 100 mt (110 tons) of $CO_2$ equivalent annually from insulation foam blowing at Space Shuttle levels and, over the 2009 to 2020 timeframe, no more than 1,200 mt (1,300 tons) of $CO_2$ and 8,100 mt (9,000 tons) of CO from rocket exhaust and up to 3,200 mt (3,500 tons) CO emissions from simulated high altitude testing at the SSC A-3 Test Stand. These total to less than 0.004 percent of the projected annual U.S. carbon emissions over that time period.

### 2.4.5 Compilation of Impacts by Affected Sites

The anticipated impacts associated with implementation of the Proposed Action and the No Action Alternative are summarized, by site, in Table 2-12. The last column of this table addresses the collective (all sites) impact of the No Action Alternative by resource area.

## Table 2-12. Summary Comparison of Impacts from the Proposed Action and the No Action Alternative for Affected Sites

| Impact Area | Proposed Action<br>KSC |
|---|---|
| Land Resources | No change from current conditions. |
| Air Resources | **Construction**: Slight increase in fugitive dust anticipated.<br>**Launch**: Ares launches would produce HCl, $Al_2O_3$, $NO_x$, and particulate matter. Impacts expected to be temporary and localized near the launch pad. Any long-term incremental changes in automobile emissions would be proportional to the size of the workforce and are not known at this time. Automobile emissions created by visitors on launch days would be similar to those created during Space Shuttle launches.<br>**Launch Accident**: Potential for temporarily elevated levels of HCl near accident site. |
| Water Resources | **Construction**: No change from current conditions.<br>**Launch**: Potential temporary impacts to nearby lagoons and impoundments from acid deposition on surface waters.<br>**Launch Accident**: Acidic deposition anticipated to be similar to a normal launch. Solid propellant chunks would temporarily elevate water toxicity in the immediate vicinity. |
| Noise | **Construction**: Localized elevated noise levels near construction activities.<br>**Launch**: Comparable to Space Shuttle and Saturn V. Ares V estimated peak noise level from a bounding launch vehicle of approximately 78 to 82 dBA at Titusville, Ares I levels about 5 to 9 dBA less. Potential exists for localized noise damage (broken windows and cracked plaster). Sonic booms expected to strike ground level over the Atlantic Ocean, no associated impact.<br>**Launch Accident**: Noise levels would be similar to or possibly slightly higher than a normal Ares launch. |
| Geology and Soils | **Construction**: No substantial impacts anticipated.<br>**Launch/Launch Accident**: Similar to Space Shuttle launch, deposition of pollutants. No substantial impacts anticipated. |
| Biological Resources | **LC-39 Construction and Operation**: Potential for bird and bat strikes on new Lightning Protection System towers. Potential impact on sea turtle nesting and hatchlings due to tower lights.<br>**Launch**: Short-term startle effect on local animals from noise of launch, no long-term impact. Local fish kills from acid deposition in waters, no long-term impact on population.<br>**Launch Accident**: Similar to normal launch impacts, plus 1) extreme heat, fire, and flying debris could damage, with no long-term impact, vegetation and animal habitats; and 2) dispersal of perchlorates with localized impacts, including morbidity to terrestrial or aquatic biota. |
| Socioeconomics | The economic benefits associated with NASA's continued commitment to the Nation's leadership in space and aeronautics research are expected to continue through 2012 and beyond. It is NASA's intent to retain a major socioeconomic footprint at each NASA Center. Furthermore, NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center. |
| Historical and Cultural Resources | Adverse effects to several historic facilities anticipated (*e.g.*, LC-39, Launch Control Center, Orbiter Processing Facility). Would be mitigated in accordance with the KSC Cultural Resources Management Plan and in consultation with the Florida SHPO. |
| Hazardous Materials and Hazardous Wastes | **Construction/Launch Activities**: Distribution controls in place to handle hazardous materials. Hazardous wastes disposed of by a licensed contractor.<br>**Launch Accident**: Unburned solid propellant and other recovered launch vehicle components would need to be disposed of as hazardous waste. |
| Transportation | No change from current conditions. |
| Environmental Justice | No disproportionately high or adverse human health or environmental effects on low-income or minority populations anticipated. |
| Human Health and Safety – Launch Accident | Range Safety Policy intends to protect individual members of the public and the general population from the risk of casualty from either blast, debris, or toxic gases and is focused on the understanding and mitigation of risk. |

## Table 2-12. Summary Comparison of Impacts from the Proposed Action and the No Action Alternative for Affected Sites (Cont.)

| Impact Area | Proposed Action | | |
|---|---|---|---|
| | SSC | MAF | JSC |
| Land Resources | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Air Resources | Additional emissions expected from A-3 Test Stand engine testing, chemical steam generators (predominantly CO), and flare stacks. | No change from current conditions. | No change from current conditions. |
| Water Resources | **Construction:** Construction within SSC access canal requires multiple permits and authorizations.<br>**Engine tests:** Potable water usage would increase during operation of steam generators at the new A-3 Test Stand. Thermal waste water release from A-3 Test Stand would be regulated. | No additional impacts to surface water or groundwater. | No additional impacts to surface water or groundwater. |
| Noise | **Construction**: Negligible noise impacts offsite.<br>**Engine tests**: Offsite noise levels less than 80 dBA.<br>Slight chance of structural damage to structures near the buffer zone around SSC during RS-68B engine cluster tests. | No additional impacts to offsite populations. | No additional impacts to offsite populations. |
| Geology and Soils | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Biological Resources | No adverse impacts, local wildlife temporarily disturbed during engine tests; 118.54 ac (47.9 ha) wetlands credits charged against mitigation bank for construction of new A-3 Test Stand. | No change from current conditions. | No change from current conditions. |
| Socioeconomics | The economic benefits associated with NASA's continued commitment to the Nation's leadership in space and aeronautics research are expected to continue through 2012 and beyond. It is NASA's intent to retain a major socioeconomic footprint at each NASA Center. Furthermore, NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center. | | |
| Historical and Cultural Resources | No adverse effects to historic facilities currently identified. Identified impacts would be mitigated in consultation with the Mississippi SHPO. | Possible adverse effects to NRHP-eligible facilities. Would be mitigated in consultation with the Louisiana SHPO. | Possible adverse effects to historic facilities. Would be mitigated in consultation with the Texas SHPO. |
| Hazardous Materials and Wastes | Hazardous waste streams are expected to be similar to those from current operations. | Hazardous waste streams are expected to be similar to those from current operations. | Generation of small amounts of construction waste due to facility modifications. |
| Transportation | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Environmental Justice | No disproportionate impacts. | No disproportionate impacts. | No disproportionate impacts. |

## Table 2-12. Summary Comparison of Impacts from the Proposed Action and the No Action Alternative for Affected Sites (Cont.)

| Impact Area | Proposed Action | | |
|---|---|---|---|
| | MSFC | GRC | LaRC |
| Land Resources | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Air Resources | Potential modification to the existing CAA Title V air permit for emissions from new spray-on foam insulation booth. | **Facility Modifications**: Small additional quantities of emissions at Lewis Field and PBS.<br>**Operations**: No change from current conditions. | **Facility Modifications**: Small additional quantities of emissions.<br>**Operations**: No change from current conditions. |
| Water Resources | No additional impacts to surface water or groundwater. | No additional impacts to surface water or groundwater. | No additional impacts to surface or ground water. |
| Noise | **Construction:** Additional minor noise.<br>**Operations:** Engine testing is predicted to generate peak offsite noise levels of 94 dBA, nuisance potential increases with longer test durations. | **Construction**: Additional minor noise at Lewis Field and PBS.<br>**Operations**: Similar to existing activities. | **Construction**: Additional minor noise.<br>**Operations**: Similar to existing activities. |
| Geology and Soils | Particulate deposition of engine exhaust products similar to deposits from existing programs. | **Construction**: Minor soil disturbance at PBS due to modifications.<br>**Operations**: No change from current conditions. | No change from current conditions. |
| Biological Resources | No change from current conditions, startle response to test noise. | No change from current conditions. | No change from current conditions. |
| Socioeconomics | The economic benefits associated with NASA's continued commitment to the Nation's leadership in space and aeronautics research are expected to continue through 2012 and beyond. It is NASA's intent to retain a major socioeconomic footprint at each NASA Center. Furthermore, NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center. | | |
| Historical and Cultural Resources | Possible adverse effects to historic facilities. Would be mitigated in consultation with the State of Alabama SHPO. | Adverse effects to PBS historic facility anticipated. Would be mitigated in consultation with the State of Ohio SHPO. | Consultations have been conducted with Virginia SHPO, NPS, and NCHP with regards to any adverse effects to NRHP sites, no adverse effects identified. |
| Hazardous Materials and Wastes | Similar to existing hazardous materials usage and waste generation. | Similar to existing hazardous materials usage and waste generation. | Similar to existing hazardous materials usage and waste generation. Removal of paint from Gantry would generate lead paint waste. |
| Transportation | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Environmental Justice | No disproportionate impacts. | No disproportionate impacts. | No disproportionate impacts. |

## Table 2-12. Summary Comparison of Impacts from the Proposed Action and the No Action Alternative for Affected Sites (Cont.)

| Impact Area | Proposed Action | | |
|---|---|---|---|
| | ARC | WSTF/WSMR | DFRC, GSFC, JPL |
| Land Resources | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Air Resources | No change from current conditions. | Emissions associated with construction, portable generators, Launch Abort System testing, and abort system test booster. | No change from current conditions. |
| Water Resources | No additional impacts to surface water or groundwater. | No additional impacts to surface water or groundwater. | No change from current conditions. |
| Noise | **Operations**: Similar to existing activities, which have resulted in public complaints. | **Construction**: Additional minor noise from Launch Complex modifications.<br>**Launch Abort System tests**: Similar to existing activities, noise levels of up to 65 dBA at 4 miles (within site buffer zone). | No change from current conditions. |
| Geology and Soils | No change from current conditions. | No change from current conditions | No change from current conditions. |
| Biological Resources | No change from current conditions. | **Construction**: Collision risk for migratory birds from tall structures.<br>**Launch Abort System tests**: No change from current conditions. | No change from current conditions. |
| Socioeconomics | The economic benefits associated with NASA's continued commitment to the Nation's leadership in space and aeronautics research are expected to continue through 2012 and beyond. It is NASA's intent to retain a major socioeconomic footprint at each NASA Center. Furthermore, NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center. | | |
| Historical and Cultural Resources | No adverse effects to historic facilities currently identified. Identified adverse effects would be mitigated in consultation with the California SHPO. | An archeologist would be consulted if artifacts are found during launch pad construction at WSMR. | No change from current conditions. |
| Hazardous Materials and Wastes | Similar to existing hazardous materials usage and waste generation. | **Construction**: Potential for small amounts of hazardous waste.<br>**Launch Abort System abort tests**: Small amounts of solvents and cleaners used, waste generation associated with solid propellant use. | No change from current conditions. |
| Transportation | No change from current conditions. | No change from current conditions. | No change from current conditions. |
| Environmental Justice | No disproportionate impacts. | No disproportionate impacts. | No disproportionate impacts. |
| Human Health and Safety – Launch Accident | Not applicable | Range Safety Policy intends to protect individual members of the public and the general population from the risk of casualty from either blast, debris, or toxic gases and is focused on the understanding and mitigation of risk. | Not applicable |

**Table 2-12. Summary Comparison of Impacts from the Proposed Action and the No Action Alternative for Affected Sites (Cont.)**

| Impact Area | Proposed Action | No Action Alternative |
|---|---|---|
| | ATK | All Sites |
| Land Resources | No change from current conditions. | No change from current conditions. |
| Air Resources | **Production Activities**: No change from current conditions.<br>**Motor tests**: Emissions from individual tests (TSP, $PM_{10}$, $NO_x$, and HCl) below regulatory limits. | No change from current conditions. |
| Water Resources | No change from current conditions. | No change from current conditions. |
| Noise | **Production Activities**: No change from current conditions.<br>**Motor tests**: Similar to current conditions, maximum sound level exposure to public calculated to be 95 dBA at Promontory. | No change from current conditions. |
| Geology and Soils | No change from current conditions. | No change from current conditions. |
| Biological Resources | No change from current conditions. | No change from current conditions. |
| Socioeconomics | Constellation Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded; therefore, a complete analysis of socioeconomic impacts would not be possible or meaningful at this time. | Without new programs to fill the void left by the close of the Space Shuttle Program, substantial adverse socioeconomic impacts would be experienced. |
| Historical and Cultural Resources | No adverse effects to historic facilities currently identified. | Needed facility maintenance which would be funded by the Constellation Program may not be performed. |
| Hazardous Materials and Wastes | No change from current conditions. Solid rocket motor manufacture uses the ozone depleting substances 1,1,1-trichloroethane (TCA) (approx. 98 gal per motor) and HCFC 141b (26 lb per year). | No change from current conditions. |
| Transportation | No change from current conditions. Minor rail incidents during solid rocket motors transport between ATK and KSC have not resulted in ignition of the solid propellant. | No change from current conditions. |
| Environmental Justice | Not Applicable for commercial sites. | No change from current conditions. |

Note: In the event an ocean landing is selected, specific Pacific Ocean landing sites would be selected as part of the mission plan. Impacts from an ocean landing include sonic booms over the ocean at pressure levels lower than experienced for Space Shuttle returns, debris impact risks (expected to be small) with most debris expected to sink to the ocean bottom, and the release of relatively small amounts of residual propellants into the ocean.

### 2.4.6 Cumulative Impacts

Cumulative impacts are the impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The principal activities associated with the Proposed Action that would result in potential environmental impacts include rocket engine tests, rocket launches, construction of new facilities, modifications of existing facilities, and other direct actions. In addition, there may be secondary impacts associated with the workforce engaged in supporting activities, including maintaining the support infrastructure (*e.g.*, structures, utilities, and roads). Such workforce-related secondary impacts could include wastes, waterborne effluents, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

### *2.4.6.1 Cumulative Localized Impacts*

Since the proposed Constellation Program would be largely built upon the ongoing Space Shuttle Program, including the processes, technologies, and facilities at each of the potential sites that would have Constellation Program-related activities, the potential environmental impacts would be either very small when compared to past, ongoing, or future activities, or very similar to the current impacts associated with the Space Shuttle Program. For most of the sites, activities that would be undertaken under the Proposed Action would be expected initially to overlap with the Space Shuttle Program until the Space Shuttle fleet is retired. As a result, the incremental impacts of the Proposed Action and other past, present, and reasonably foreseeable future actions would be small or negligible. At most sites, the nature of the principal Constellation Program activities (*e.g.*, engineering development, testing, research, and vehicle assembly) implies that the primary environmental impacts (*e.g.*, impacts from infrastructure development and operations, traffic volumes, and socioeconomic) would be directly related to the size of the workforce.

At KSC, launches of Ares development vehicles and missions to support the Constellation Program would release combustion products, principally $Al_2O_3$ and HCl, to the atmosphere, and ultimately the surrounding grounds and waters. While the highest concentrations would be within a few hundred meters of the launch pad, some of the exhaust cloud would ultimately deposit in the KSC/CCAFS region. These deposits would be in addition to similar deposits from past and anticipated future launches in the KSC/CCAFS region. Various monitoring studies (AIAA 1993, CCAFS 1998, and KSC 2003) have found that because of the nature of the soil in the area, having high concentrations of calcium carbonate, the acid deposits are quickly neutralized, and the long-term effects of HCl deposition are minimal. Deposits of $Al_2O_3$ are not soluble and previous launch deposits have not migrated away from the launch site.

Additional engine and motor testing at SSC, ATK's Promontory facility, and MSFC, and the Launch Abort System tests at WSMR, which are planned to support the Constellation Program, would result in local impacts typical of such tests. These impacts consist primarily of short-term noise and the engine exhaust cloud. The exhaust cloud would be principally water vapor for the engines that would be tested at SSC and MSFC; $Al_2O_3$ and HCl for those tested at WSMR and ATK's Promontory facility. The loud noise from past and ongoing engine tests has not had a major long-term impact on the local and regional areas surrounding these sites. The noise associated with the Constellation Program tests would be similar to noise levels from previous, on-going, and anticipated future engine testing at these sites associated with other programs with testing durations on the order of minutes, and the associated impact to surrounding population or wildlife would generally be limited to startle responses with no cumulative effect. Engine tests would result in the deposition of exhaust products at WSMR (products deposited downrange from the test site) and at ATK's Promontory facility (products deposited near the test stands).

### *2.4.6.2 Cumulative Global Impacts*

Implementation of NASA's Constellation Program would result in very small contributions to global warming and very small impacts to stratospheric ozone levels, those impacts stemming from continued energy use and rocket launches. Many studies have been conducted on the cumulative global environmental effects of launches worldwide. The American Institute for Aeronautics and Astronautics convened a workshop (AIAA 1991) to identify and quantify the key environmental issues that relate to the effects on the atmosphere from launches. The conclusion of the workshop, based on evaluation of scientific studies performed in the U.S., Europe, and Russia, was that the effects of launch vehicle propulsion exhaust emissions on stratospheric ozone depletion, acid rain, toxicity, air quality, and global warming were extremely small compared to other anthropogenic factors (AIAA 1991).

#### 2.4.6.2.1 Global Warming

The cumulative contribution to global warming from energy use under the Constellation Program would be expected to be similar to NASA's historical energy use impact under the Space Shuttle Program.

The total global warming potential from Constellation Program activities would be annually no more than $2.5 \times 10^5$ mt ($2.8 \times 10^5$ tons) carbon-equivalent from energy consumption at the NASA Centers (total annual consumption for all NASA activities), and no more than 100 mt (110 tons) of $CO_2$ equivalent annually from insulation foam blowing at Space Shuttle levels and, over the 2009 to 2020 timeframe, no more than 1,200 mt (1,300 tons) of $CO_2$ and 8,100 mt (9,000 tons) of CO from rocket exhaust, and 3,200 mt (3,500 tons) CO emissions from the simulated high altitude testing at the SSC A-3 Test Stand. This is less than 0.004 percent of the projected annual U.S. carbon emissions over that time period.

#### 2.4.6.2.2 Stratospheric Ozone Depletion

Based on the proposed Constellation Program's 12-year vehicle engine and flight test schedule (*i.e.*, approximately from 2009 to 2020), the implementation of the Proposed Action would potentially add no more than 33,900 mt (37,300 tons) of solid propellant emissions (equivalent to 33 Space Shuttle launches) to the atmosphere over that period. This would include approximately 7,000 mt (7,700 tons) of HCl and 10,000 mt (11,000 tons) of $Al_2O_3$.

The FAA estimated that about 1,136 launches would occur worldwide between 2000 to 2010, resulting in approximately 16,209 mt (17,867 tons) of HCl and 29,329 mt (32,329 tons) of $Al_2O_3$ deposited in the troposphere, and an equal amount deposited in the stratosphere (FAA 2001). If the FAA estimated worldwide launch rate and emissions were to stay constant for the 2011 to 2020 timeframe, based on Constellation Program proposed test rates about 13 percent of the total amount of HCl and about 10 percent of the total amount of $Al_2O_3$ that would be deposited in the stratosphere would be from Ares launches.

# 3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The affected environmental conditions described in this Chapter provide the context for understanding the environmental consequences described in Chapter 4. As such, they serve as a baseline from which any environmental changes that may be brought about by implementing the Proposed Action (Preferred Alternative) and No Action Alternative can be identified and evaluated; the baseline conditions are the currently existing conditions. The affected environments at each facility are described for the following impact areas: land resources, air resources, water resources, ambient noise, geology and soils, biological resources, socioeconomics, cultural resources, and hazardous materials and waste.

For this *Final Constellation Programmatic Environmental Impact Statement*, the U.S. Government and commercial facilities that are described in detail in this Chapter include John F. Kennedy Space Center (KSC), John C. Stennis Space Center (SSC), Michoud Assembly Facility (MAF), Lyndon B. Johnson Space Center (JSC), George C. Marshall Space Flight Center (MSFC), John H. Glenn Research Center (GRC) at Lewis Field and at Plum Brook Station (PBS), Langley Research Center (LaRC), Ames Research Center (ARC), White Sands Missile Range (WSMR)/Johnson Space Center White Sands Test Facility (WSTF), and Alliant Techsystems-Launch Systems Group (ATK) facilities at Clearfield and Promontory, Utah. Other U.S. Government facilities that would be involved in the Constellation Program, but are not discussed in detail, include Dryden Flight Research Center (DFRC), Goddard Space Flight Center (GSFC), and the Jet Propulsion Laboratory (JPL). The Constellation Program also would be supported by various other commercial facilities throughout the U.S. which are not discussed in detail. Figure 3-1 provides the locations of the facilities discussed in detail, along with DFRC, GSFC, and JPL.

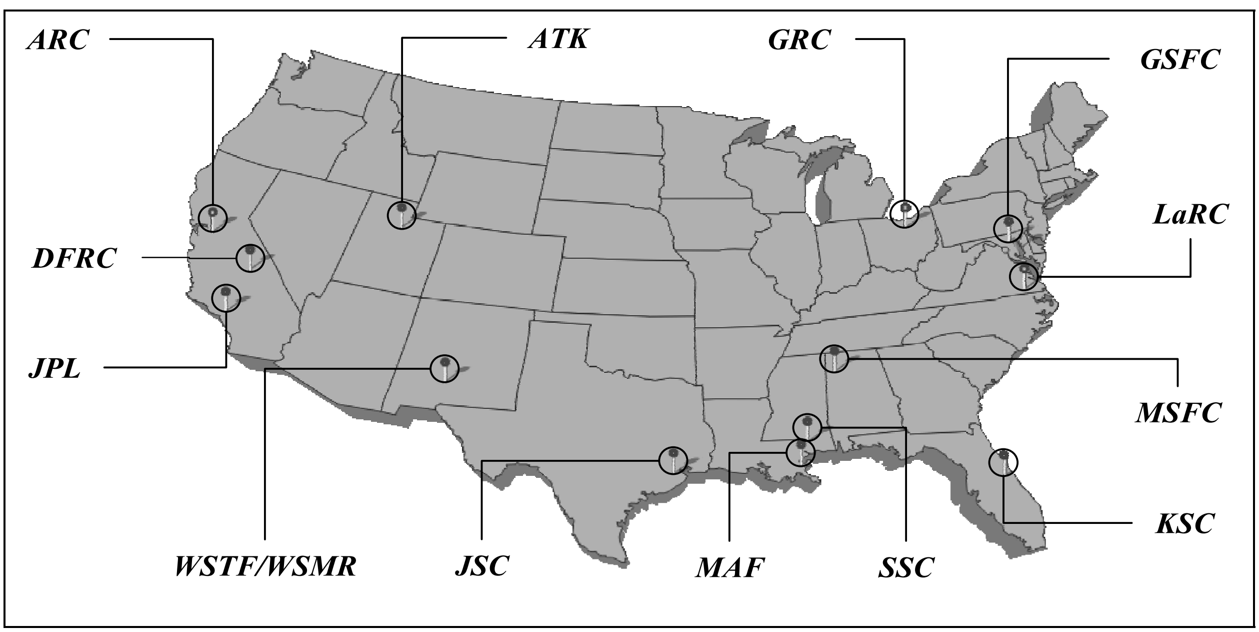



**Figure 3-1. Principal U.S. Government and Commercial Facilities Contributing to the Constellation Program**

A description of the proposed activities at each facility is provided in Section 2.1. These activities would be expected to be within the scope of activities normally undertaken at each facility. Any activities that are determined to be outside the scope of activities that would normally be undertaken at a facility, and are not addressed in this Final Programmatic Environmental Impact Statement (PEIS), would be subject to separate NEPA review and documentation, as appropriate.

This Chapter also describes at a high level the oceans that could be impacted as a result of jettisoned components from an Ares launch and from a returning Orion Crew Module/Service Module, and an Orion water landing. Terrestrial landing sites are currently under study and therefore are not addressed in this Chapter. Impacts associated with terrestrial landing sites would be addressed in separate NEPA documentation, as appropriate.

## 3.1 U.S. GOVERNMENT FACILITIES

### 3.1.1 John F. Kennedy Space Center

The primary mission of the National Aeronautics and Space Administration's (NASA's) KSC is to process and launch the Space Shuttle and future generations of crewed space vehicles and to process payloads for various expendable launch vehicles launched from Cape Canaveral Air Force Station (CCAFS). Launches from KSC are coordinated with Launch Range Safety at CCAFS. For the Constellation Program, KSC would manage the Ground Operations Project, including pre- and post-launch ground processing, launch support, and landing and recovery planning and execution.

#### *3.1.1.1 Land Resources*

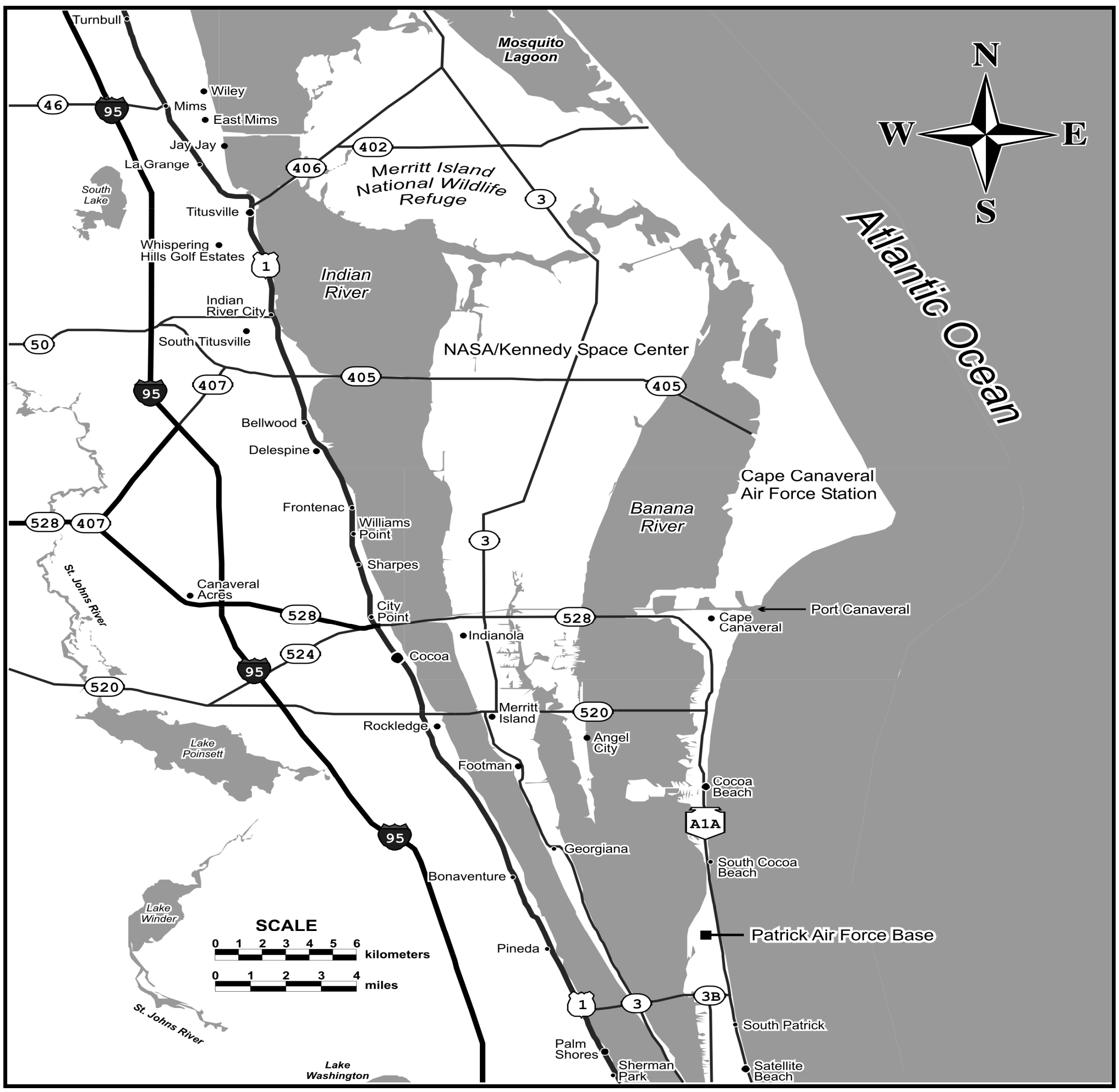
KSC is located on the east coast of Florida approximately 242 kilometers (km) (150 miles [mi]) south of Jacksonville and 64 km (40 mi) due east of Orlando on the north end of Merritt Island, which forms a barrier island complex adjacent to Cape Canaveral. KSC is composed of 56,000 hectares (ha) (139,490 acres [ac]) of land and open water resources in Brevard and Volusia Counties (KSC 2003).

KSC is bordered on the west by the Indian River and on the east by the Atlantic Ocean and CCAFS (see Figure 3-2). The southern boundary of KSC runs 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 (KSC 2003).

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 1,806 ha (4,463 ac) of KSC. NASA's operational area contains developed facility sites, roads, lawns, and maintained right-of-ways (see Figure 3-3). 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. The areas outside the NASA operational control area, including the Canaveral National

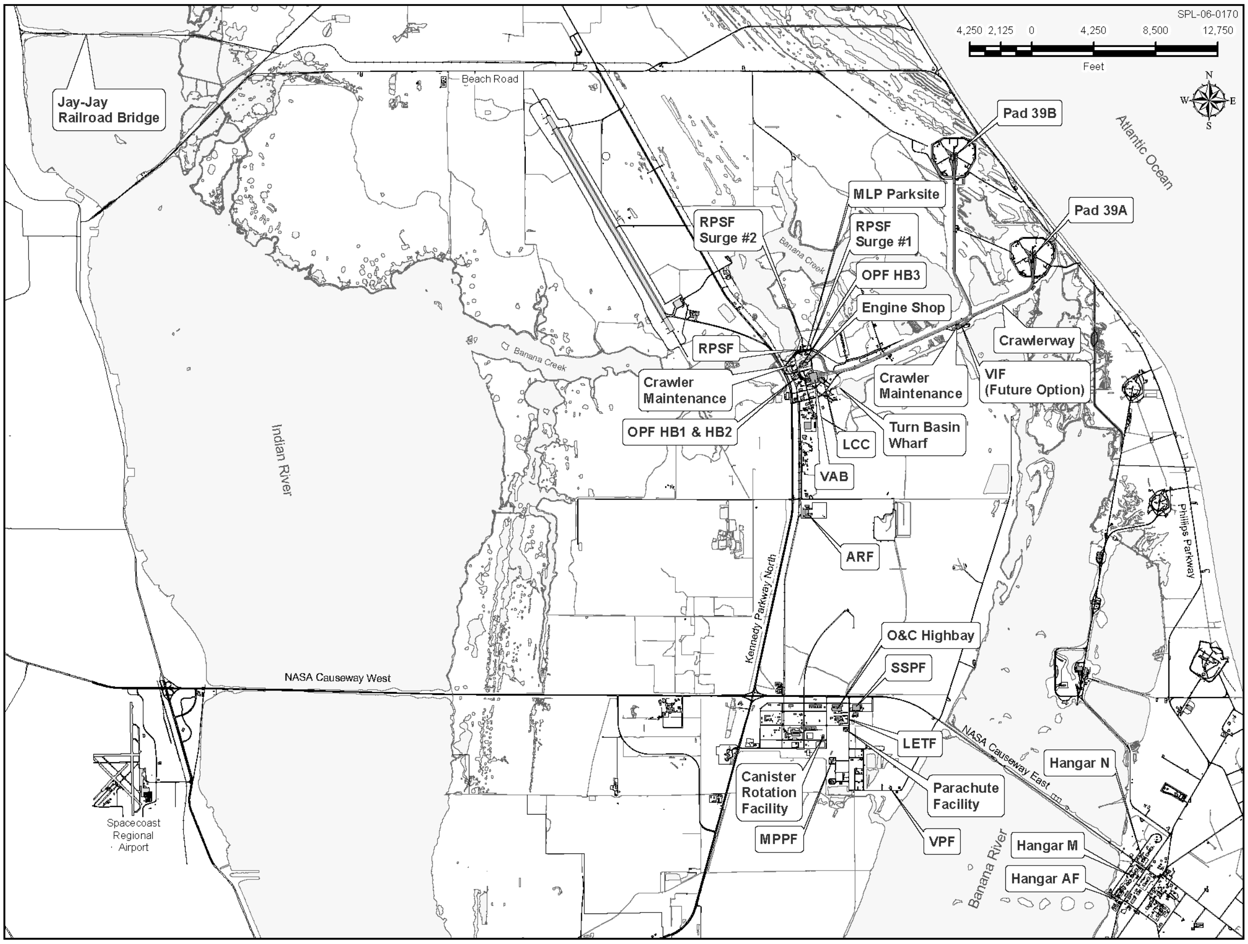
Seashore and Merritt Island National Wildlife Refuge (MINWR), are managed by the National Park Service and U.S. Fish and Wildlife Service (USFWS) (KSC 2003). In December 2006, USFWS issued the *Draft Comprehensive Conservation Plan and Environmental Assessment for Merritt Island National Wildlife Refuge* to better manage MINWR (71 *Federal Register* [*FR*] 77783).

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 15.2 km (9.5 mi) from the KSC Industrial Area and the city of Cape Canaveral, which is approximately 13.6 km (8.5 mi) from the KSC Industrial Area.




Source: NASA 2006d

**Figure 3-2. KSC and the Surrounding Area**




Source: KSC 2006b

**Figure 3-3. KSC Facilities Map**

### *3.1.1.2 Air Resources*

#### 3.1.1.2.1 Climate

The climate at KSC can be classified as subtropical with hot, humid summers and short, mild, and dry winters. Average annual temperatures range from approximately 57 to 80 degrees Fahrenheit (°F) (13.9 to 26.7 degrees Celsius [°C]) and rainfall averages more than 114 centimeters (cm) (45 inches [in]) per year. Seasonal wind directions are primarily influenced by continental temperature changes. In general, fall winds are predominantly from the east to northeast. Winter winds are predominantly from the north to northwest, shifting to the southeast in the spring and then to the south in the summer (KSC 2003). KSC is vulnerable to hurricanes and tornados and associated storm tides (NOAA 2007).

#### 3.1.1.2.2 Air Quality

The Clean Air Act (CAA), as amended (42 United States Code [U.S.C.] 7401 *et seq*.), requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) (40 Code of Federal Regulations [CFR] part 50) for pollutants considered harmful to public health and the environment. The CAA established two types of national air quality standards. *Primary standards* set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (EPA 2006f).

The Clean Air Act requires EPA to designate areas as *nonattainment* for any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the primary or secondary NAAQS for the pollutant; *attainment* for any area (other than an area identified in clause [i]) that meets the primary or secondary NAAQS for the pollutant; and unclassifiable for any area that cannot be classified on the basis of available information as meeting or not meeting the primary or secondary NAAQS for the pollutant (EPA 2007c).

EPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants (see Table 3-1). Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter ($mg/m^3$) of air, and micrograms per cubic meter ($\mu g/m^3$) of air (EPA 2006f). Air quality standards for the State of Florida are the same as the NAAQS except for sulfur dioxide ($SO_2$) and nitrogen dioxide ($NO_2$). The annual arithmetic mean for $SO_2$ is 0.02 ppm and is 0.05 ppm for $NO_2$ under the Florida standard (Florida Administrative Code [FAC] 62-204.240).

Brevard and Volusia Counties are considered to be in attainment or unclassifiable for all criteria pollutants regulated under the NAAQS and state standards (EPA 2007c, FDEP 2004).

Ambient air quality at KSC is influenced by NASA operations, land management practices, vehicle traffic, and emission sources outside KSC. Daily air quality conditions are influenced primarily by vehicle traffic, combustion sources (*e.g.*, boilers), and standard refurbishment and maintenance operations. Air quality at KSC also is influenced by emissions from two regional power plants, which are located within 16.1 km (10 mi) of KSC. Space launches, wildfires, and controlled burning operations influence air quality as episodic events (KSC 2003).

Title V of the CAA requires facilities that have the potential to emit more than 90.72 metric tons (mt) (100 tons) per year of criteria pollutants, more than 22.68 mt (25 tons) per year of hazardous air pollutants (HAP), or more than 9.072 mt (10 tons) per year of any one HAP to obtain a major source or synthetic minor source operating permit. Sources with the potential to exceed these thresholds are classified as major unless they accept operating permit conditions limiting their emissions below these levels (in which case they are classified as synthetic minor sources). KSC is permitted as a major source of air emissions and operates under a Title V permit (KSC 2003).

**Table 3-1. National Ambient Air Quality Standards**

| Pollutant | Primary Standards | Averaging Times | Secondary Standards |
|---|---|---|---|
| Carbon Monoxide | 9 ppm (10 mg/m$^3$) | 8-hour[(a)] | None |
| | 35 ppm (40 mg/m$^3$) | 1-hour[(a)] | None |
| Lead | 1.5 µg/m$^3$ | Quarterly Average | Same as Primary |
| Nitrogen Dioxide | 0.053 ppm (100 µg/m$^3$) | Annual (Arithmetic Mean) | Same as Primary |
| Particulate Matter ($PM_{10}$) | 150 µg/m$^3$ | 24-hour[(b)] | — |
| Particulate Matter ($PM_{2.5}$) | 15.0 µg/m$^3$ | Annual[(c)] (Arith. Mean) | Same as Primary |
| | 35 µg/m$^3$ | 24-hour[(d)] | — |
| Ozone | 0.08 ppm | 8-hour[(e)] | Same as Primary |
| Sulfur Dioxide | 0.03 ppm | Annual (Arith. Mean) | — |
| | 0.14 ppm | 24-hour[(a)] | — |
| | — | 3-hour[(a)] | 0.5 ppm (1,300 µg/m$^3$) |

Source: EPA 2006f

(a) Not to be exceeded more than once per year.

(b) Not to be exceeded more than once per year on average over 3 years.

(c) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m$^3$.

(d) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m$^3$.

(e) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

### *3.1.1.3 Water Resources*

#### 3.1.1.3.1 Potable Water

KSC obtains its potable water under contract from the city of Cocoa, which draws its supplies from the Floridan Aquifer. KSC uses approximately 4.9 million liters (l) (1.3 million gallons [gal]) of water per day. The water distribution system at KSC is sized to accommodate the short-term, high-volume flows required for launches (KSC 2003).

#### 3.1.1.3.2 Surface Water

Major water bodies surrounding KSC include the Atlantic Ocean and the inland estuary consisting of the Indian River, the Banana River, and the Mosquito Lagoon (see Figure 3-2). The inland estuary has been designated as an Estuary of National Significance, and contains Outstanding Florida Waters and Aquatic Preserves (KSC 2003, EPA 2007a). Freshwater inputs to the estuary include direct precipitation, stormwater runoff, discharges from impoundments, and groundwater seepage (KSC 2003).

The surface drainage pattern of Merritt Island is multibasinal and typically internal, being trapped in the ponds, lakes, sloughs, burrows, and constructed canals on the Island. External drainage is conducted primarily by constructed drainage systems (*i.e.*, Industrial Area to the

Banana River via Buck Creek) and by way of grove management pumps to the Indian River. These drainage systems are most prevalent in the developed areas and surrounding uplands adjacent to the bordering water bodies previously mentioned (KSC 2003).

KSC transports its raw domestic wastewater to the CCAFS Regional Treatment Plant located on CCAFS. KSC 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. Stormwater runoff is controlled by more than 100 onsite surface water management systems and a National Pollutant Discharge Elimination System (NPDES) storm water permit for industrial activities.

The majority of KSC lies within the 100-year floodplain and the areas adjacent to LC-39 Pads A and B and the Industrial Area are within the 500-year floodplain. LC-39 Pads A and B are excluded from both floodplains (KSC 2003). There are no national or state-designated wild or scenic rivers on or near KSC or CCAFS; however, the Banana and Indian Rivers and the Mosquito Lagoon makeup the Indian River Lagoon which has been designated an Estuary of National Significance (DOI 2006).

Surface water quality at KSC and CCAFS has been characterized as generally good. The waters tend to be alkaline and have good buffering capacity. Water samples from inland bodies of water near KSC and CCAFS have indicated that some polyaromatic hydrocarbons, one pesticide (dieldrin), and some metals were measured above detection limits (KSC 2003).

#### 3.1.1.3.3 Groundwater

KSC is underlain by three aquifers, including the surficial aquifer, the secondary semi-confined aquifer, and the Floridan Aquifer. The surficial aquifer is largely recharged by rainfall percolation and surface runoff and is used by the areas near KSC for nonpotable uses; however, Mims and Titusville, located approximately 16 km (10 mi) northwest of KSC, and Palm Bay, located approximately 64 km (40 mi) 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 (KSC 2003, USAF 1998).

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 (USAF 1998).

#### 3.1.1.3.4 Offshore Environment

From the coastline, sandy shoals lead to a deepening sea floor. Offshore currents usually reflect the general northern flow of the Gulf Stream (NOAA 1980). Studies of water movements in the area indicate surface to bottom shoreward currents, although wind generally determines current flow at the surface.

#### *3.1.1.4 Ambient Noise*

The 24-hour average ambient noise level on KSC is appreciably lower than the EPA recommended upper level of 65 decibels (dBA). Noise generated at KSC can be attributed to six general sources, including Space Shuttle atmospheric entry sonic booms, launches, aircraft movement, industrial operations, construction, and traffic noise (KSC 2003). Sonic booms associated with Space Shuttle entry at KSC are not expected to occur after 2010. The areas of KSC/MINWR that are away from operational areas are exposed to relatively low ambient noise levels in the range of 35 to 40 dBA (KSC 2003).

#### *3.1.1.5 Geology and Soils*

##### 3.1.1.5.1 Geology

Merritt Island and the adjacent Cape Canaveral form a barrier island complex of Pleistocene and Recent Age. Surface deposits consist primarily of sand and sandy coquina (a coarse grained, porous limestone composed principally of mollusk shell and coral fragments). The topography is marked by a series of ridges and swales derived from relict dunes deposited as the barrier islands were formed. Erosion has reduced the western side of Merritt Island to a nearly level plain. Elevation ranges from sea level to approximately 3 meters (m) (10 feet [ft]) in the inland areas and to 6 m (20 ft) on the recent dunes. KSC is in an area that exhibits high seismologic stability with very few confirmed earthquakes (KSC 2003).

##### 3.1.1.5.2 Soils

Soils of the area have been derived primarily from deposits of sand and sandy coquina, but vary greatly with landscape position, drainage, and age of parent material (KSC 2003). In general, soils around KSC are highly permeable, allowing water to quickly percolate into the ground and have a high buffering capacity (CCAFS 1998).

#### *3.1.1.6 Biological Resources*

The KSC 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 approximately 405,000 ha (1 million ac) of the total land and water area in the surrounding region (KSC 2003).

The majority of the land at and near KSC, including CCAFS, MINWR, Mosquito Lagoon, and the Cape Canaveral National Seashore, is undeveloped and in a near-natural state. More than 50 percent of KSC is classified as wetlands. These areas host a variety of plant communities that support many resident and transient animal species. The aquatic environment surrounding KSC provides diverse fish habitat, which supports many shore bird species, and sport, commercial, and recreational fishing. The Atlantic beaches at KSC, CCAFS, and the Canaveral National

Seashore are important to nesting sea turtles. In addition, the Mosquito Lagoon is considered among the best oyster and clam harvesting areas on the east coast (KSC 2003).

The Magnuson Fishery Conservation and Management Act of 1976, as amended (16 U.S.C. 1801 *et seq*.), mandates the conservation of essential fish habitat.

USFWS currently recognizes 113 endangered or threatened and 27 candidate animal and plant species in the State of Florida (FWS 2007). The State of Florida considers 118 animal species as threatened, endangered, or of special concern (FFWCC 2007) and 55 plant species as threatened or endangered (FDACS 2007). Brevard County has listed 53 plant species as threatened, endangered, or commercially exploited (BCBCC 2003).

Many of these threatened, endangered, or species with special designations are known to occur at KSC, including four amphibian and reptile state species of special concern (Florida gopher frog [*Rana capito aesopus*], American alligator [*Alligator mississippiensis*], gopher tortoise [*Gopherus polyphemus*], and Florida pine snake [*Pituophis melanoleucus mugitus*]), four state and/or federally threatened species (Atlantic salt marsh snake [*Nerodia clarkii taeniata*], loggerhead turtle [*Caretta caretta*], American alligator, and eastern indigo snake [*Drymarchon couperi*]) and two state and federally endangered species (Atlantic green sea turtle [*Chelonia mydas*] and leatherback sea turtle [*Dermochelys coriacea*]). Protected birds include eight state species of concern (black skimmer [*Rynchops niger*], Eastern brown pelican [*Pelecanus occidentalis carolinensis*], little blue heron [*Egretta caerulea*], reddish egret [*Egretta rufescens*], roseate spoonbill [*Ajaia ajaja*], snowy egret [*Egretta thula*], tricolored heron [*Egretta tricolor*], and white ibis [*Eudocimus albus*]), three state and federally threatened species (Florida scrub-jay [*Aphelocoma coerulescens*], least tern [*Sterna antillarum*] and Southeastern American kestrel [*Falco sparverius paulus*]), and two state and federally endangered species (wood stork [*Mycteria Americana*] and Arctic peregrine falcon [*Falco peregrinus tundrius*]). Protected mammals at KSC include one state species of special concern (Florida mouse [*Podomys floridanus*]), one state and federally threatened species (Southeastern beach mouse [*Peromyscus polionotus niveiventris*]), and one state and federally endangered species (West Indian manatee [*Trichechus manatus*]). The federally protected bald eagle (*Haliaeetus leucocephalus*) is also known to occur at KSC (KSC 2003).

#### *3.1.1.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the KSC regional area. The KSC regional area is defined here as the land area within an 80.5 km (50 mi) radius of KSC, which consists of Seminole, Brevard, Orange, and portions of Osceola, and Volusia Counties (USBC 2006a).

##### 3.1.1.7.1 Population

The total population within the KSC regional area was approximately 1,983,260 persons in 2000 (see Table 3-2) (USBC 2006a). The total population is expected to increase to approximately 2,324,050 by 2010 and to approximately 2,691,970 by 2020. Similar increases are anticipated in Brevard County, where the total population was approximately 476,230 persons in 2000 and is expected to increase to approximately 558,060 by 2010 and to approximately 646,410 by 2020 (USBC 2000).

**Table 3-2. Population of the KSC Regional Area and Brevard County for 2000, 2010, and 2020**

| Population | KSC Regional Area | | | Brevard County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 1,548,175 | 1,735,630 | 1,933,261 | 413,411 | 463,467 | 516,241 |
| Black or African American | 254,244 | 307,256 | 361,212 | 40,000 | 48,340 | 56,829 |
| American Indian and Alaska Native | 6,773 | 8,462 | 10,184 | 1,765 | 2,205 | 2,654 |
| Asian | 44,636 | 60,686 | 78,295 | 7,152 | 9,724 | 12,545 |
| Native Hawaiian and Other Pacific Islander | 1,328 | 1,806 | 2,329 | 305 | 415 | 535 |
| Some other race | 77,616 | 100,802 | 126,430 | 5,168 | 6,712 | 8,418 |
| Two or more races | 50,492 | — | — | 8,429 | — | — |
| Hispanic or Latino (of any race) | 258,769 | 357,307 | 471,020 | 21,970 | 30,336 | 39,991 |
| **Total Population** | **1,983,264** | **2,324,048** | **2,691,967** | **476,230** | **558,061** | **646,407** |
| **Percent Minority** | **21.94** | **25.32** | **28.18** | **13.19** | **16.95** | **20.14** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

In 2000, minority race populations represented approximately 22 percent of the total population within the KSC regional area and approximately 13 percent of the total population within Brevard County. Hispanic or Latino (of any race) and Black or African American populations were the largest minority groups living within the KSC regional area and Brevard County in the year 2000. Between 2000 and 2020, minority race populations are expected to increase to 28 percent of the total population within the KSC regional area and approximately 20 percent of the total population within Brevard County. The Hispanic or Latino (of any race) population is expected to be the largest resident minority group within the KSC regional area, while the Black or African American population is expected to be the largest minority group within Brevard County in 2020 (USBC 2006a, USBC 2000).

#### 3.1.1.7.2 Economy

Industrial sectors in the KSC regional area that provide significant employment include education, health and social services; arts, entertainment, recreation, accommodation and food services; retail trade; and professional, scientific, management, administrative, and waste management services. An estimated 1,567,361 people were employed in the KSC regional area in 2000 with an estimated unemployment rate of 5.1 percent. The national and Florida unemployment rates during the same period were estimated at 5.8 and 5.6 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Florida – 12.5 percent, KSC regional area – 10.6 percent, and Brevard County – 9.3 percent (USBC 2006a). KSC's regional area 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 addition, the cruise and cargo industries at Port Canaveral contribute to the Central Florida economy (Central Florida includes Brevard, Flagler, Lake, Orange, Osceola, Seminole, and Volusia Counties).

The space industry also contributes significantly to the local, state, and national economies. In fiscal year 2005, KSC and other NASA space operations created a total economic impact in Florida of $3.7 billion in output, $1.8 billion in income, and 35,000 jobs. The total economic impact was highly concentrated in Central Florida with an output impact of $3.2 billion, an income impact of $1.6 billion, and an employment impact of 32,000 workers. These activities generated $197 million of Federal taxes and $85 million of state and local taxes (KSC 2005). In 2006, KSC was Brevard County's largest single employer with more than 15,640 employees. The vast majority of KSC's workforce lives in Brevard County (KSC 2006c).

#### 3.1.1.7.3 Transportation

KSC has fully developed infrastructure, including road access and all utilities to support its occupational needs. The region is supported by a network of Federal, state, and county roads, rail service, three major airports, and a seaport with cargo and cruise terminals (KSC 2003). Both KSC and CCAFS have runways to support government aircraft, delivery of launch vehicle components, and air freight associated with the operation of launch complexes (USAF 2002).

#### 3.1.1.7.4 Public and Emergency Services

Emergency medical services for KSC and CCAFS personnel are provided by the Occupational Health Facility at KSC. Additional health care services are provided by nearby public hospitals located outside KSC. Fire protection is provided by three onsite fire stations. Police protection is provided by the joint base operations support contractor at KSC and CCAFS (KSC 2003). In addition, a mutual-aid agreement exists between KSC, the city of Cape Canaveral, Brevard County, and the range contractor at CCAFS for reciprocal support in the event of an emergency or disaster (USAF 1998). Further, CCAFS and the Brevard County Office of Emergency Management have agreements for communications and early warning in the event of a launch accident.

During launch periods, Launch 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 and Notice to Airmen (NOTAM) and Notice to Mariners are disseminated prior to launch. In addition, warning signs are posted in various Port Canaveral areas for vessels leaving port. Patrick Air Force Base (AFB) also maintains an Internet website and toll-free telephone number with launch hazard area information for mariners and restricted airspace information for pilots.

#### *3.1.1.8 Cultural Resources*

The following sites at KSC would be associated with the Constellation Program and are listed in the National Register of Historic Places (NRHP): Crawlerway, LC-39 Pad A (Building J8-1708) and Pad B (Building J7-0037), Launch Control Center (Building K6-099), Operations and Checkout Building (Building M7-0335), Vehicle Assemble Building (VAB) (Building K6-0848), and the Missile Crawler Transporter Facilities. In addition, Pad A and Pad B at LC-39 are each designated Historic Districts.

Facilities at KSC that would be associated with the Constellation Program and are eligible for individual listing in the NRHP include the Hangar AF (Building 66250), Manufacturing Building (Building L6-247), Rotation Processing and Surge Facility (Building K6-494), Parachute Refurbishment Facility (Building M7-657), and the Orbiter Processing Facility (Building K6-894) and the Orbiter Processing Facility High Bay 3 (Building K6-696).

There are no known archeological resources associated with Constellation Program activities.

#### *3.1.1.9 Hazardous Materials and Waste*

KSC uses hazardous materials for various institutional activities, which in turn generate hazardous wastes. Such waste is managed in accordance with applicable Federal, state, and local rules and regulations and the KSC plan for managing hazardous materials and waste. KSC is classified as a large-quantity generator of hazardous wastes and is regulated by a Resource Conservation and Recovery Act (RCRA) permit (number FL68000014585) for the storage, treatment, and disposal of such hazardous waste (NASA 2007a). Facilities that generate 1,000 kilograms (kg) (2,200 pounds [lb]) or more of hazardous waste per calendar month, or more than 1 kg (2.2 lb) of acutely hazardous waste per calendar month are classified as large-quantity generators (40 CFR 262). In 2006, KSC generated 119,422 kg (263,278 lb) of hazardous wastes (KSC 2006d).

NASA submits annual reports under the Emergency Planning and Community Right-to-Know Act (EPCRA) Toxic Release Inventory Program for the release of pollutants at KSC. In 2001, reports were submitted for epichlorohydrin, methyl hydrazine, Freon® 113, tetrachloroethylene, and lead (NASA 2007a).

KSC operates a permitted Class III landfill that is expected to handle the solid waste (construction and demolition debris only) disposal needs of KSC for an estimated 13 to 49 years, based on assumed disposal rate scenarios of 82 mt (90 tons) to 318 mt (350 tons) per week. The landfill is unlined and does not accept putrescible household waste (KSC 2003). All other nonhazardous solid wastes are shipped to the Brevard County Landfill.

### 3.1.2 John C. Stennis Space Center

NASA's SSC is responsible for testing and flight-certifying large rocket propulsion systems for the Space Shuttle and future generations of space vehicles. For the Constellation Program, SSC would be responsible for liquid hydrogen/liquid oxygen propulsion engine testing and verification for the Ares Upper Stage and Ares V Core Stage.

#### *3.1.2.1 Land Resources*

SSC is located along the northern edge of the Gulf of Mexico in western Hancock County, Mississippi, approximately 89 km (55 mi) northeast of New Orleans and approximately 48 km (30 mi) west of Biloxi/Gulfport, Mississippi. SSC encompasses approximately 5,585 ha (13,800 ac) of land that constitute the “Fee Area” or the confines within the gates of SSC (see Figure 3-4). Land use within the Fee Area consists primarily of general institutional facilities, industrial and test areas, laboratories, recreational and open areas, and roadway and parking areas (see Figure 3-5) (SSC 2005).

A restrictive easement extends 9.7 km (6 mi) in all directions from the Fee Area, which acts as a “Buffer Zone” (see Figure 3-4). Provisions of the restrictive easement prohibit maintenance or construction of dwellings and other buildings suitable for human habitation. The purpose of the 50,588 ha (125,001 ac) Buffer Zone is to provide an acoustical and safety protection zone for NASA testing operations. Predominant land use in the Buffer Zone includes sand and gravel mining, timber production, and recreational activities. Urban areas interspersed with open space, such as coastal wetlands, adjoin the perimeter of the Buffer Zone (SSC 2005).

Test Complex “A” includes two single position test stands (A-1 and A-2); a test control center; observation bunkers; and support systems for high pressure gas (air, helium, and nitrogen), water, electrical, and propellants (liquid oxygen and liquid hydrogen). Test Complex “B” includes one dual position test stand, a test control center, a machine shop, similar support systems as Complex “A”, and docking and transfer for liquid propellant barges (SSC 2005).

#### *3.1.2.2 Air Resources*

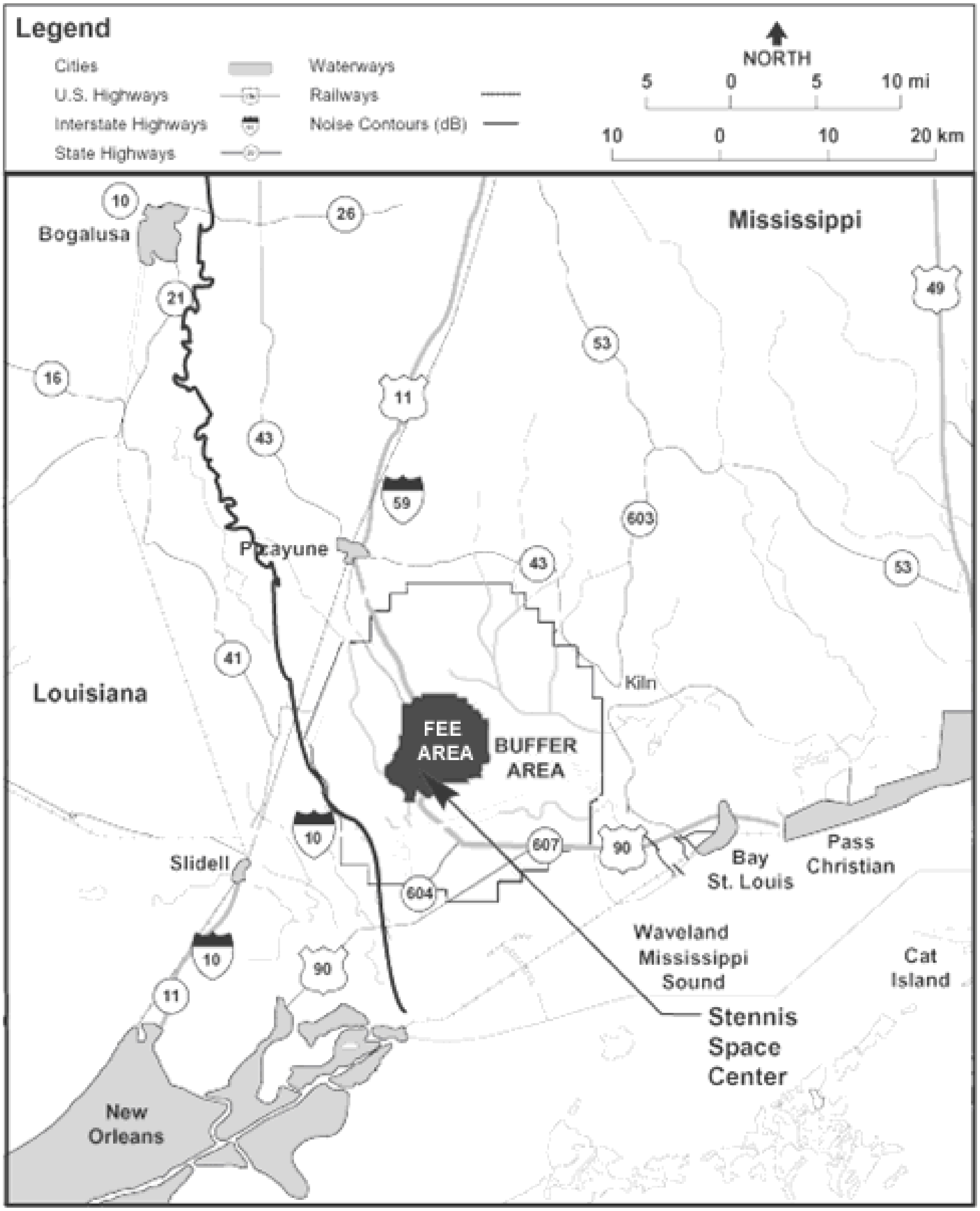
##### 3.1.2.2.1 Climate

The climate at SSC can be classified as temperate and rainy with hot summers. Average annual temperatures range from approximately 53 to 79°F (12 to 26°C). Rainfall averages approximately 1.5 m (60 in) per year. Prevailing surface winds are from the south and southwest through two-thirds of the year and from the north for the rest of the year. Upper level winds generally prevail from the west and southwest. The Gulf Coast averages one tropical cyclone per year; approximately two thirds of these are of hurricane force with winds greater than 119 km (74 mi) per hour (SSC 2005).

##### 3.1.2.2.2 Air Quality

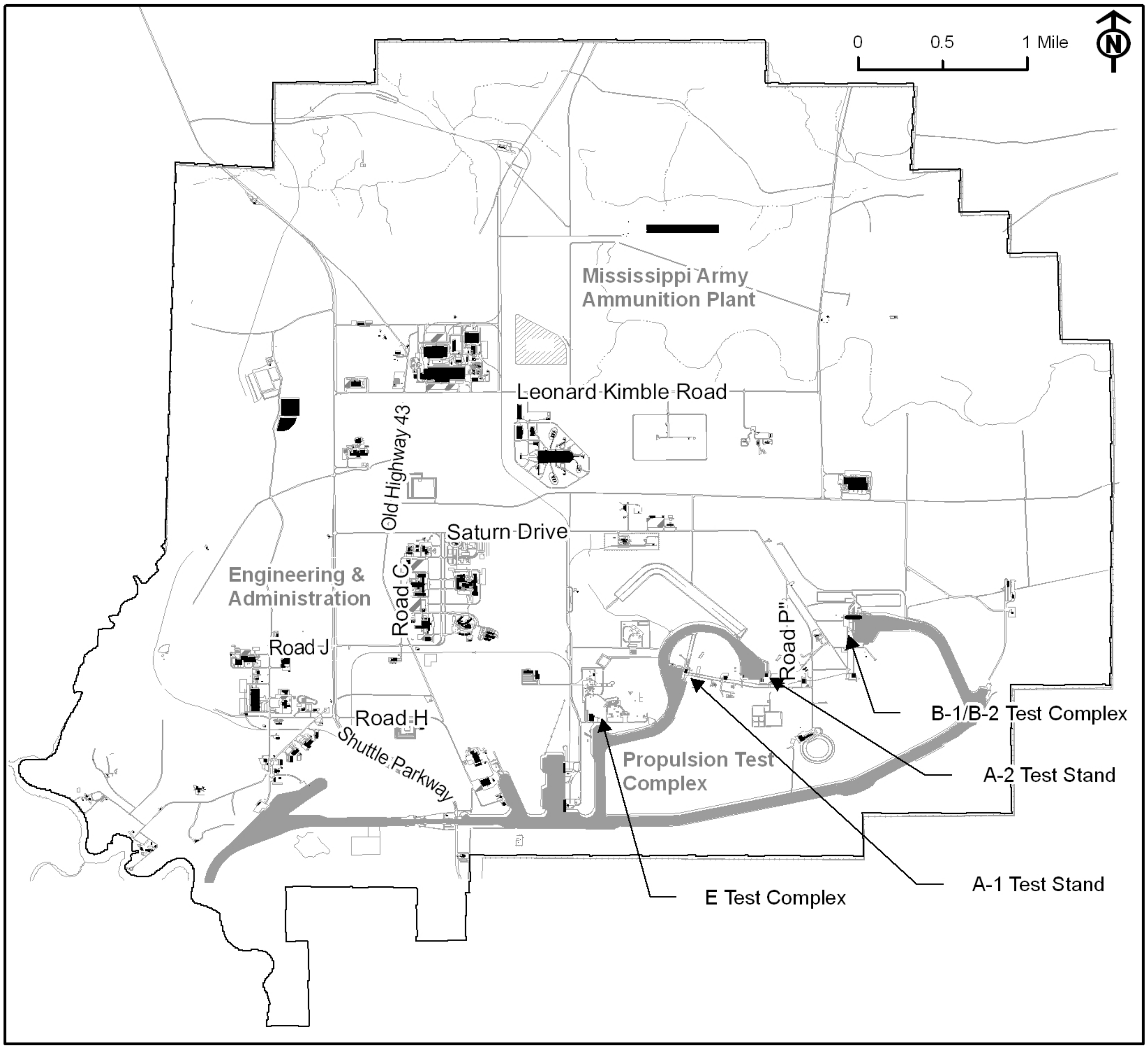
Air quality at SSC is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. Mississippi Ambient Air Quality Standards (MAAQS) are the same as the NAAQS (SSC 2005).

SSC is classified as a major source of air emissions and operates under a CAA Title V permit. Air emission sources, other than mobile sources such as automobiles and construction equipment, include combustion sources (*e.g.*, boilers), surface coating activities, fuel dispensing, abrasive (grit) blasting, rocket testing, flare stacks, metal parts cleaning, and other fugitive emissions due to chemical product usage at various locations (SSC 2005).




Source: MSFC 1997a

**Figure 3-4. SSC Fee and Buffer Areas**




Source: SSC 2007c

**Figure 3-5. SSC Facilities Map**

The State of Mississippi is classified as an attainment area for all criteria pollutants regulated under the NAAQS (EPA 2007c). Visibility in federally designated Class I areas is protected under the EPA's Regional Haze Rule. The CAA defines a Class I air quality area to include the following types of areas that were in existence as of August 7, 1977: national parks more than 2,428 ha (6,000 ac), national wilderness areas and national memorial parks more than 2,024 ha (5,000 ac), and international parks. There is one Class I air quality area within 62 mi (100 km) of SSC, the Breton National Wildlife Refuge in Louisiana. The refuge is approximately 50 mi (80 km) from the SSC test areas (MSFC 1997a).

### *3.1.2.3 Water Resources*

#### 3.1.2.3.1 Potable Water

Potable water for use at SSC is supplied through two large capacity wells onsite. A third well is currently not used and held in standby condition. All wells are permitted for withdraw of water by the Mississippi Department of Environmental Quality, Office of Land and Water Resources. In 2005, SSC used approximately 448 million l (118 million gal) of potable water (SSC 2007b).

#### 3.1.2.3.2 Surface Water

SSC is located in an area with many surface water bodies. The East Pearl River flows along the southwest boundary of the Fee Area and the Jourdan River flows in a southeasterly direction through the eastern portion of the Buffer Zone. Tributaries that drain the Fee Area and are hydraulically conducted to these two rivers are Mike's River and Turtleskin Creek in the East Pearl River Basin, and the Lion and Wolf Branches of Catahoula Creek in the Jourdan River Basin. Approximately 12.1 km (7.5 mi) of constructed canals in the Fee Area also are connected through locks to the East Pearl River. The canal system provides a means of transporting large rocket engines, propellants, and other heavy equipment and materials to the facility.

Portions of the Pearl River that extend through the Buffer Zone and the Jourdan River from the confluence of Catahoula Creek to the Bay of St. Louis are listed on the Nationwide Rivers Inventory under the Wild and Scenic Rivers Act. The Nationwide Rivers Inventory is a listing of more than 3,400 free-flowing river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance (DOI 2006). The Jourdan River has been identified as having significant recreational and archaeological resources and the Pearl River, used for SSC barge traffic, has been identified as having numerous endangered, threatened, and rare species, and as being an excellent example of a large Gulf Coastal Plain river with extensive swamplands (SSC 2005).

Water quality in the Fee Area is similar to the regional surface water quality with the exception of slightly higher concentrations of dissolved solids, with slight alkalinity in the canal. The surface waters in area streams are generally suitable for most uses (SSC 2005).

SSC operates under a Mississippi Land Disposal Stormwater General NPDES permit (number MSR500069). The land disposal stormwater permit is applicable to the operation of the SSC nonhazardous waste landfill, which allows stormwater associated with the industrial activity to be discharged into state waters. A stormwater pollution prevention plan is also in place to identify potential sources of pollution that may be expected to affect water quality from stormwater discharges associated with SSC industrial activities (NASA 2007a).

In May 2004, SSC was reissued a surface water discharge permit (number MS0021610) by the State of Mississippi under the NPDES program. SSC also maintains a surface water quality monitoring program in the Fee Area. The primary surface water discharges include domestic wastewater and rocket testing deluge water. A wastewater pre-treatment facility and four permitted sewage treatment facilities are located at SSC (NASA 2007a).

NASA also holds a permit (number MS-SW-02432) at SSC to divert or withdraw from the public waters of the State of Mississippi for beneficial use. This permit covers an inlet and pumps that withdraw water from the East Pearl River into an elevated portion of the facility's Access Canal. The Access Canal is the primary source of industrial water at the facility. Industrial water is used for deluge water for the test stands, cooling water, and fire control. Three industrial wells are also maintained as a back-up system for the surface water withdrawal system (NASA 2007a).

A detention pond exists at Test Complex "B" to receive runoff of cooling water from engine testing. Runoff cooling water at Test Complex "A" drains directly to the Access Canal (MSFC 1997a).

The documented floodplains at SSC include a 100-year floodplain along the East Pearl River at the western edge of the Fee Area and 100-year floodplains along the Wolf Branch and along the Lion Branch at Catahoula Creek in the northeast portion of the Fee Area. The majority of SSC is in an area of minimal flooding and there is little development in the documented floodplains at SSC. The U.S. Army Corps of Engineers has delineated a large percentage of both the Fee Area and Buffer Zone as jurisdictional wetlands. SSC is undergoing wetland mitigation in several areas to compensate for the filling of wetlands during construction activities in the Fee Area (SSC 2005).

3.1.2.3.3 Groundwater

SSC is located in an area of Hancock County that is underlain by fresh water-bearing sands. Within these fresh water-bearing sands, one unconfined aquifer is found near the surface with 10 or more confined aquifers at varying depths. Individual aquifers range 30 to 140 m (100 to 450 ft) in thickness. The aquifers have plentiful, almost untapped supplies of fresh water (SSC 2005).

Active groundwater remediation is being conducted at seven localized sites at SSC where historical spills, releases, and disposal incidents have occurred. The groundwater at six of the sites is contaminated with volatile organic compounds (VOCs), including trichloroethene (TCE) and vinyl chloride. The groundwater at the seventh site is contaminated with low levels of dioxin and TCE. The treated water is released to SSC's sanitary sewer system (SSC 2005).

### *3.1.2.4 Ambient Noise*

Ambient noise levels at SSC are generally low with primarily continuous sources of noise, including diesel generators, pumps, boilers, and automotive traffic. However, due to the nature of rocket engine ground testing, noise, and to a small extent, vibrations, have always been an issue at SSC. Although the Buffer Zone is intended to provide enough distance for noise to dissipate to 125 dB or less at the boundary, there have been noise complaints by citizens in the communities surrounding the facility during periods of rocket engine testing. During the Saturn V rocket testing program, NASA logged 160 complaints, of which 57 resulted in formal administrative claims to NASA. Eighteen of the complaints resulted in financial settlements. While seismic effects have been minimal at SSC, years of testing the Saturn V rocket motor in the 1960s and 1970s showed that rocket engine testing can result in swaying and falling objects at SSC and in the surrounding areas (SSC 2005).

The nearest permanent public dwellings to the test sites are on the boundary of the Buffer Area, approximately 6 mi (10 km) from the test areas. A child day care center is located on the SSC property approximately 1 mi (1.6 km) east of the test areas (MSFC 1997a).

### *3.1.2.5 Geology and Soils*

#### 3.1.2.5.1 Geology

SSC is located on flat low-lying terrain, with elevations in the Fee Area ranging from 1.5 to 9.1 m (5 to 30 ft) above mean sea level and approximately 1.5 to 21 m (5 to 70 ft) above mean sea level in the Buffer Area. SSC is underlain by a thick sequence of sedimentary deposits with bedrock thought to be as much as 3,000 to 3,700 m (10,000 to 12,000 ft) below the surface. SSC is considered to be under low to moderate danger from earthquakes. The facility is listed in seismic zone 0 by the Uniform Building Code, which indicates no specific design considerations (SSC 2005).

#### 3.1.2.5.2 Soils

Soils in the Fee Area are generally composed of poorly to somewhat poorly drained silty and loamy soils. They are generally acidic with other significant characteristics of wetness, high organic matter, and weathered clay mineralogy. Some of the soils around building complexes have been modified through fill and constructed drainage (SSC 2005).

Active soil remediation is being conducted at various localized sites at SSC where past spills, releases, and disposal incidents have occurred (SSC 2005).

### *3.1.2.6 Biological Resources*

SSC is located in an area that supports a wide array of undisturbed aquatic and biotic resources. These resources provide a broad range of natural habitat for hundreds of species of flora and fauna. The predominant types of plant communities within the SSC area include pine flatwoods, bottomland hardwood, pitcher plant bogs and swamps, and grasslands and marshes. Aquatic fauna include fish, as well as some amphibians and reptiles. Terrestrial fauna include a large variety of mammals and birds, and several species of amphibians and reptiles (SSC 2005).

The test stands that would be used to support the Constellation Program are located within an area of developed land covered by pavement or lawns and surrounded by canals and wetlands. Wildlife habitat in the immediate area of the test stands is considered marginal because of the ongoing use of the facility. This area may be a suitable foraging area for various species (*e.g.*, deer, mice, song birds, and raptors). However, activity associated with current engine tests and operations limits its suitability as a nesting or roosting habitat (MSFC 1997a).

Currently, 142 plant species that occur in the site area (Hancock County and/or St. Tammany Parish) receive special protection by the Mississippi Department of Wildlife, Fisheries and Parks and the Louisiana Department of Wildlife and Fisheries. The majority of these species are listed as “special concern” because they are known or suspected to occur in low numbers. Fifty-two of these plant species are listed as critically imperiled because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making them vulnerable to extinction. The Louisiana quillwort (*Isoetes louisianensis*) is the only plant species in the site area that is listed as endangered by the USFWS (SSC 2005).

Seventy-two animal species are listed as “special concern” by either the Mississippi Department of Wildlife, Fisheries and Parks and/or the Louisiana Department of Wildlife and Fisheries and have ranges that include Hancock County and/or St. Tammany Parish. Twenty of these animal species are listed as critically imperiled. Six animal species that have ranges specifically within SSC are listed as either endangered or threatened by the Mississippi Department of Wildlife, Fisheries and Parks and/or the Louisiana Department of Wildlife and Fisheries, including the Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), eastern indigo snake (*Drymarchon corais couperi*), Florida panther (*Felis concolor coryi*), gopher tortoise (*Gopherus polyphemus*), bald eagle (*Haliaeetus leucocephalus*), red-cockaded woodpecker (*Picoides borealis*), and American peregrine falcon (*Falco peregrinus*). The Gulf sturgeon, eastern indigo snake, and gopher tortoise are listed as threatened by the USFWS and the red-cockaded woodpecker and the Florida panther are listed as endangered by the USFWS. The bald eagle also is a federally protected species (SSC 2005).

#### *3.1.2.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the SSC regional area. The SSC regional area is composed of Hancock, Harrison, and Pearl River Counties in Mississippi and St. Tammany and Washington Parishes in Louisiana (SSC 2005).

##### 3.1.2.7.1 Population

The total population within the SSC regional area was approximately 510,840 persons in 2006 (see Table 3-3) (USBC 2006a). The total population is expected to increase to approximately 519,970 by 2010 and to approximately 541,670 by 2020. Similar increases are anticipated in Hancock County where the total population was approximately 35,130 persons in 2006 and is expected to increase to approximately 35,760 by 2010 and to approximately 37,250 by 2020 (USBC 2000, USBC 2006a, USBC 2006b).

In 2006, minority race populations represented approximately 19 percent of the total population within the SSC regional area and approximately 10 percent of the total population within Hancock County. The Black or African American population was the largest minority group living within the regional area and Hancock County in the year 2006. By 2020, minority race populations are expected to increase to 20 percent of the total population within the SSC regional area and approximately 11 percent of the total population within Hancock County. The Black or African American population is estimated to remain the largest resident minority group within the SSC regional area and Hancock County in 2020 (USBC 2000, USBC 2006a).

**Table 3-3. Population of the SSC Regional Area and Hancock County for 2006, 2010, and 2020**

| Population | SSC Regional Area | | | Hancock County | | |
|---|---|---|---|---|---|---|
| | 2006 | 2010* | 2020* | 2006 | 2010* | 2020* |
| White | 414,585 | 420,426 | 433,240 | 31,686 | 32,133 | 33,112 |
| Black or African American | 77,618 | 79,307 | 83,469 | 2,389 | 2,441 | 2,569 |
| American Indian and Alaska Native | 2,238 | 2,238 | 2,238 | 211 | 211 | 211 |
| Asian | 6,166 | 6,575 | 7,755 | 316 | 337 | 398 |
| Native Hawaiian and Other Pacific Islander | 2 | 2 | 3 | 0 | 0 | 0 |
| Some other race | 2,999 | 3,071 | 3,256 | 105 | 108 | 114 |
| Two or more races | 6,734 | — | — | 386 | — | — |
| Hispanic or Latino (of any race) | 11,328 | 12,386 | 15,789 | 632 | 691 | 881 |
| **Total Population** | **510,839** | **519,970** | **541,674** | **35,129** | **35,757** | **37,249** |
| **Percent Minority** | **18.84** | **19.14** | **20.02** | **9.80** | **10.14** | **11.11** |

Sources: USBC 2000, USBC 2006a, USBC 2006b

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

#### 3.1.2.7.2 Economy

Industrial sectors in the SSC regional area that provided significant employment include education, health and social services; retail trade; arts, entertainment, recreation, accommodation and food services; and manufacturing (USBC 2006a). An estimated 195,150 people were employed in the SSC regional area in 2006 with an estimated unemployment rate of 7.9 percent (MDES 2006, LDOL 2007). The national and Mississippi unemployment rates during the same period were estimated at 4.6 and 7.6 percent, respectively (BLS 2007). The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Mississippi – 19.9 percent, SSC regional area – 13.6 percent, and Hancock County – 14.4 percent (USBC 2006a).

SSC contributes significantly to the local, state, and national economies. In 2006, SSC had a direct economic impact of $488 million on the SSC regional area, approximately $209 million (43 percent) of which was associated with NASA-related activities. It is estimated that SSC's activities generated $87.6 million of local taxes and $811.4 million in personal income, and supported approximately 19,500 direct and indirect jobs. NASA's onsite workforce consisted of 1,973 civil servants and support contractors in 2006 (SSC 2007a). The vast majority of SSC's workforce lives in Pearl River County, followed by Hancock and Harrison Counties and St. Tammany Parish (SSC 2007a).

3.1.2.7.3 Transportation

SSC has fully developed infrastructure, including road access and all utilities to support its occupational needs. The SSC area is served by Interstate 10 and 59, U.S. Highway 90, and Mississippi Highway 607. Direct access to SSC, from Interstate 10 and Interstate 59, is provided by Mississippi Highway 607, which passes through SSC. The highway is closed to the general public within the Fee Area (SSC 2005).

Approximately 13.7 km (8.5 mi) of canals inside the Fee Area are available to transport material, including large volumes of propellants and heavy cargo within SSC. The SSC canal system links to the East Pearl River through a lock system. The East Pearl River links SSC to the national waterway transportation system. It is 33.8 km (21 mi) from the main canal entrance to the Gulf Intracoastal Waterway (MSFC 1997a).

3.1.2.7.4 Public and Emergency Services

Fire protection at SSC is provided 24 hours per day for all areas and activities in the Fee Area. SSC has mutual aid agreements with landowner corporations in the Buffer Area and with several nearby municipalities whereby the fire fighting organizations of each entity agrees to lend equipment and personnel to one another when the need for assistance arises. Each county/parish in the area is currently serviced by law enforcement agencies. In addition to a medical facility at SSC, there are multiple hospitals and clinics in the surrounding county/parish area.

### *3.1.2.8 Cultural Resources*

Three test stands at SSC, the A-1 Rocket Propulsion Test Stand (Building 4120), the A-2 Rocket Propulsion Test Stand (Building 4122), and the B-1/B-2 Rocket Propulsion Test Complex (Building 4220), have been designated as National Historic Landmarks (DOI 2007b).

The old Town of Gainesville, bounded by Fraizer Street, Blackman Street, Smyth Street, and the East Pearl River and located within the Fee Area, is NRHP-eligible and has been nominated for listing in the NRHP. The NASA-owned land within Logtown is eligible for listing in the NRHP.

### *3.1.2.9 Hazardous Materials and Waste*

NASA maintains large-quantity status under RCRA Subtitle C at SSC for generating hazardous waste and having it transported offsite for treatment, storage, or disposal. Generating activities include research and development operations, facilities maintenance, construction, aerospace testing, cleaning and maintenance, equipment cleaning and degreasing, and photographic processes. Such wastes are disposed of offsite at certified hazardous waste disposal facilities by a licensed contractor. Six other agencies at SSC have small-quantity generator status, four of which are classified as “Conditionally Exempt” (NASA 2007a). All hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations and the SSC plan for managing hazardous materials and waste.

Nonhazardous solid waste generated within the Fee Area is disposed of onsite in a permitted Class A solid waste landfill (number SW02401B0376). In 2005, the SSC landfill received approximately 94,349 kg (208,000 lbs) of solid waste per month. A closed landfill is located southeast of the operating landfill at SSC (NASA 2007a).

### 3.1.3 Michoud Assembly Facility

MAF is a Government-owned, contractor-operated component of MSFC. MAF's primary activities involve the manufacturing of the Space Shuttle External Tank. For the Constellation Program, MAF would manufacture, assemble, and test components of the Orion Crew Module and Service Module and the Ares I Upper Stage. In addition, MAF is a candidate facility under consideration for the manufacture and assembly of the Ares V Core Stage and/or the Earth Departure Stage.

#### *3.1.3.1 Land Resources*

MAF operates on approximately 337 ha (833 ac) located in southeastern Louisiana, 25.7 km (16 m) east of downtown New Orleans (see Figure 3-6). MAF is within the boundaries of Orleans Parish in the eastern section of metropolitan New Orleans. MAF is bounded by the Gulf Intracoastal Waterway to the south, the Michoud Canal to the east, Old Gentilly Road to the north, and a commercial electricity generating facility and the New Orleans Fire Training Academy to the west (MAF 2006b).

Existing land use for MAF includes administration and management, offices and laboratories, services and support facilities, industrial/manufacturing and test areas, storage, open areas, and circulation and parking areas (see Figure 3-7). Approximately 60 percent of the buildings onsite are devoted to manufacturing activities, 20 percent are used for offices, and the remaining 20 percent are used as storage and support facilities. Most of the onsite development at MAF is located in the northeastern portion of the site and approximately 78 percent of the total site area is vacant land, consisting primarily of mowed grasslands and canals. MAF is also home to one of the largest manufacturing plants in the world with 17.4 ha (43 ac) under one roof (MAF 2006b).

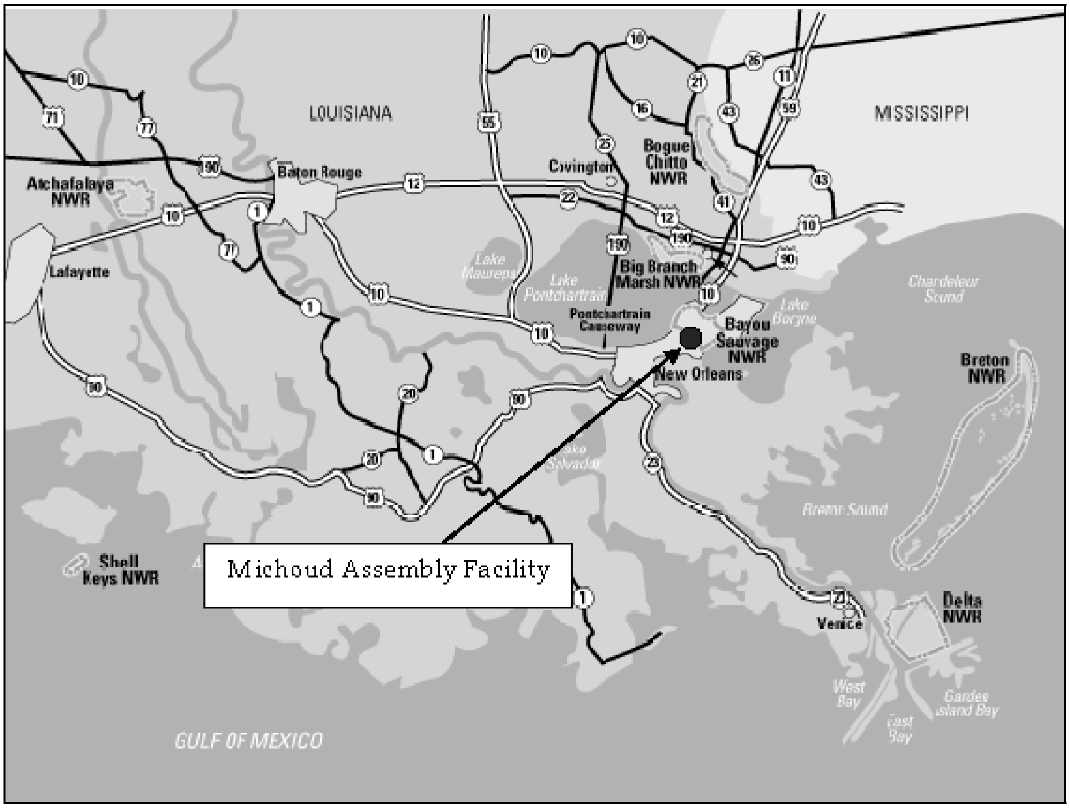
#### *3.1.3.2 Air Resources*

##### 3.1.3.2.1 Climate

The climate at MAF can be classified as subtropical and humid with average annual temperatures ranging from 62 to 78.8°F (16.6 to 26°C). The average annual precipitation at MAF is 163 cm (64.2 in), and average humidity is approximately 76 percent. The average annual wind speed is 12.9 km per hour (8.0 mi per hour). Winds are predominantly from the south, but westerly and northerly winds are common during periods of hotter and drier weather (MAF 2006b).

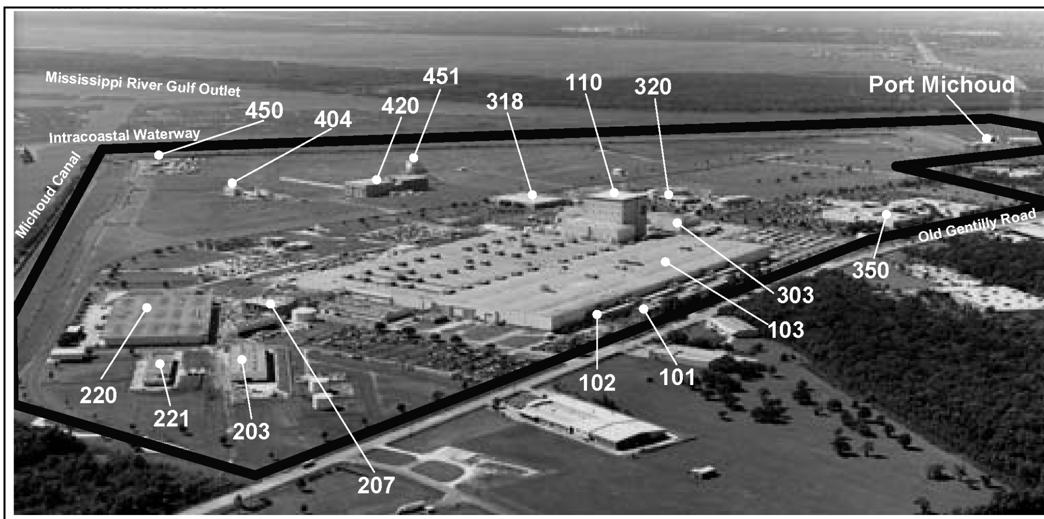
##### 3.1.3.2.2 Air Quality

Air quality at MAF is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. The NAAQS for criteria pollutants have been adopted by the State of Louisiana.




Source: MAF 2006b

**Figure 3-6. MAF Location and Vicinity Map**




**Major Buildings at MAF**

| | | | |
|---|---|---|---|
| 101 Admin Bldg | 203 Reclamation Storage | 303 X-Ray Mod & Staging | 404 Structures Test |
| 102 Engr Bldg | 207 Boiler House | 318 Component Ablator Fac. | 420 Acceptance & Prep |
| 103 MFG Bldg. | 220 Vehicle Component Supply Bldg | 320 Facilities Ops. Bldg | 450 Main Pumping Station |
| 110 Vert Assy Bldg | 221 Hazard Mats Storage | 350 Office & Engr. Bldg | 451 LH2 Pneumatic Test |

Source: MAF 2006a

**Figure 3-7. MAF Facilities Map**

MAF does not operate under a CAA Title V permit. MAF currently has four Louisiana Department of Environmental Quality Air Emission Permits (NASA 2007a). Primary sources of air pollutants at MAF, other than mobile sources such as automobiles and construction equipment, include combustion sources (*e.g.*, boilers), production processes, and groundwater air strippers (MAF 2006b). New Orleans is classified as an attainment area for all criteria pollutants regulated under the NAAQS (EPA 2007c).

#### *3.1.3.3 Water Resources*

##### 3.1.3.3.1 Potable Water

MAF receives its potable water supply from the Sewerage and Water Board of New Orleans. There are no active drinking wells at MAF or within 1.6 km (1 mi) of the site boundary (MAF 2006b).

##### 3.1.3.3.2 Surface Water

MAF lies within the New Orleans coastal area of Southern Louisiana. In addition to being adjacent to the Michoud Slip, the Gulf Intercoastal Waterway, and the Michoud Canal, MAF is also located near the major water bodies of Lake Pontchartrain and Lake Borgne.

No natural streams or rivers pass through MAF and there are no rivers in the area that are designated as wild or scenic under the Wild and Scenic Rivers Act or designated as having the potential for inclusion under the Act. The nearest surface water body to MAF is the Michoud Canal (MAF 2006b).

MAF's drainage system is composed of open drainage ditches, catch basins, and underground pipes that deliver stormwater into the Borrow Canal. The Borrow Canal runs parallel to the flood protection levees that surround the facility to the east, south, and west. There is no natural surface drainage system within 305 m (1,000 ft) of MAF. Surface water is pumped from the Borrow Canal into the Michoud Canal under the authority of a Louisiana Discharge Elimination System Permit (number LA0052256) (NASA 2007a).

Most of the wastewater generated at MAF is associated with the manufacture of the Space Shuttle External Tank. Other operations, such as manufacturing support and research, developmental, and educational activities, generate minor amounts of wastewater. All wastewaters generated in production, quality control, laboratory research, and testing areas are discharged to the Industrial Wastewater Treatment Facility onsite for treatment before being discharged to the Borrow Canal under a Louisiana Department of Environmental Quality Wastewater Discharge Permit. Sanitary wastewater is collected in a separate system in a network of above and below-ground sewer lines and is treated at the Sewerage and Water Board of New Orleans' publicly owned treatment works. No treatment is performed before the discharge of utility waters to the onsite Borrow Canal (MAF 2006b).

Orleans Parish is included entirely within the coastal zone management boundary and, as such, must comply with the coastal zone management policy, which includes obtaining coastal use permits for specific activities (MAF 2006b).

Most of MAF is outside the 100-year flood plain. The industrial area at MAF is within the 500-year floodplain (MAF 2001). The hurricane storm surge that hit the MAF hurricane protection levees during Hurricane Katrina in 2005 caused some damage, although the flood damage was limited in comparison to the surrounding areas. There are no identified wetland areas within the MAF boundary (MAF 2006b).

3.1.3.3.3 Groundwater

MAF is underlain by four groundwater aquifers, including a semi-confined shallow (alluvial) aquifer, a confined 30.5-m (100-ft), 213-m (700-ft), and 366-m (1,200-ft) sand aquifers. There are no active drinking water wells at MAF or within 1.6 km (1 mi) of the site boundary, due to unsuitable shallow groundwater quality. In addition, there are no sole or principal drinking water aquifers in the area surrounding MAF. All of the aquifers, with the exceptions of the 213-m (700-ft) sand aquifer, do not meet drinking water standards.

MAF is involved with several RCRA corrective action projects regarding groundwater contamination. Remediation efforts to remove chlorinated organics are ongoing (MAF 2006b).

### *3.1.3.4 Ambient Noise*

There is no source of excessive noise, sonic booms, or vibration originating from activities at MAF. Typical sources of noise at MAF include traffic and cooling towers. During peak traffic hours, noise levels are estimated to be between 70 and 74 dBA at 30 m (94.4 ft) from Old Gentilly Road. Cooling towers are estimated to have noise levels of between 85 and 100 dBA at 1 m (3.3 ft), and between 61 and 83 dBA at 15 m (49.2 ft). Furthermore, there is no population that is affected by these noise sources, as all manufacturing and office areas that are onsite and all residential areas offsite are very distant from these sources (MAF 2006b).

### *3.1.3.5 Geology and Soils*

3.1.3.5.1 Geology

MAF is located on a flat area with minimal elevation change, ranging from 4.6 m (15 ft) above mean sea level on top of the flood protection levee along the Gulf Intercoastal Waterway to 0.6 m (2 ft) to 1.5 m (5 ft) above mean sea level along the northern edge of the site. Subsurface deposits at MAF typically consist of deltaic deposits of gravel, sand, silt, clay, and organic materials. There are at least 366 m (1,200 ft) of sediments beneath MAF. Bedrock beneath the facility consists of shale and sandstones. No active faults have been detected within 3.2 km (2 mi) of MAF. In addition, there are no known fractures or solution channels existing in the area (MAF 2006b).

3.1.3.5.2 Soils

The surface soils in the vicinity of MAF, where land forms are principally swamps, marsh, and natural levee, vary from highly organic to inorganic silts, highly plastic clays, lean clays, sandy silts, and minor amounts of sand. MAF is entirely located on reclaimed marshland, with surficial materials composed entirely of constructed fill (a mixture of topsoil and river sand). No land within the boundaries of MAF is considered prime farmland (MAF 2006b).

MAF is involved with several RCRA corrective action projects regarding soil contamination. Past waste management disposal practices and accidents have contaminated soils with TCE, VOCs, metals, diesel fuel, and other contaminants. Remediation efforts are ongoing (MAF 2006b).

#### *3.1.3.6 Biological Resources*

The area surrounding MAF is primarily brackish coastal marsh, which has been extensively transformed by human development, and virtually all naturally occurring vegetation has been altered. A significant portion of MAF also has been altered from its natural state to support buildings, parking, and industrial operations. The undeveloped portions of MAF (approximately 263 ha [650 ac], or 78 percent of the site) consist primarily of manicured lawns, common weeds, shrubs, and trees. Although natural habitat is limited, MAF does support a variety of amphibian, reptile, bird, and mammal species. The aquatic biota in the freshwater reservoirs (*e.g.*, Borrow Canal) is reported to be plentiful and diverse. In addition, the area often is frequented by a large variety of birds due to the proximity of the Mississippi Flyway for migratory birds (MAF 2006b).

One critical habitat, described by the Louisiana Natural Heritage Program as a “submergent vascular vegetation (estuarine)” habitat, has been identified at MAF. This vegetation is located around the Michoud Slip (southwest corner of the site) and along the outer perimeter of the MAF levee system. This habitat is considered critical for the gulf sturgeon (MAF 2006b).

Although several threatened and endangered species could occur in the vicinity of MAF, the lack of appropriate habitat at MAF makes their presence onsite unlikely. Species that potentially could be transient at MAF include the federally protected bald eagle (*Haliaeetus leucocephalus*), the federally endangered brown pelican (*Pelecanus occidentals*), and the state protected American white pelican (*Pelecanus erythrorhynchos*) and diamond back terrapin (*Malaclemys terrapin*) (NASA 2007a).

#### *3.1.3.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the MAF regional area. The MAF regional area is defined here as the New Orleans-Metairie-Kenner, LA Metropolitan Statistical Area, which includes Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. John the Baptist, and St. Tammany Parishes (USBC 2005).

##### 3.1.3.7.1 Population

The total population within the MAF regional area was approximately 914,745 persons in 2006 (see Table 3-4). The total population is expected to increase to approximately 1,026,410 by 2010 and to approximately 1,099,270 by 2020. Similar increases are anticipated in Orleans Parish, where the total population was approximately 158,350 persons in 2006 and is expected to increase to approximately 248,320 by 2010 and to approximately 265,950 by 2020 (USBC 2000, USBC 2006a, USBC 2006b). The population of Orleans Parish is expected to rise rapidly through 2010, as the area continues to recover from Hurricane Katrina in 2005.

**Table 3-4. Population of the MAF Regional Area and Orleans Parish for 2006, 2010, and 2020**

| Population | MAF Regional Area | | | Orleans Parish | | |
|---|---|---|---|---|---|---|
| | 2006 | 2010* | 2020* | 2006 | 2010* | 2020* |
| White | 604,025 | 637,798 | 661,575 | 44,497 | 69,342 | 71,927 |
| Black or African American | 262,542 | 330,667 | 364,582 | 106,572 | 168,176 | 185,425 |
| American Indian and Alaska Native | 3,588 | 3,897 | 4,357 | 317 | 499 | 558 |
| Asian | 19,062 | 22,922 | 28,969 | 3,642 | 5,914 | 7,474 |
| Native Hawaiian and Other Pacific Islander | 3 | 3 | 4 | 0 | 1 | 1 |
| Some other race | 11,891 | 13,244 | 14,900 | 1,425 | 2,258 | 2,540 |
| Two or more races | 13,209 | — | — | 2,059 | — | — |
| Hispanic or Latino (of any race) | 42,996 | 50,259 | 64,459 | 4,909 | 7,995 | 10,254 |
| **Total Population** | **914,745** | **1,026,408** | **1,099,267** | **158,353** | **248,323** | **265,950** |
| **Percent Minority** | **33.97** | **37.86** | **39.82** | **71.90** | **72.08** | **72.95** |

Sources: USBC 2000, USBC 2006a, USBC 2006b

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

In 2006, minority race populations represented approximately 34 percent of the total population within the MAF regional area and approximately 72 percent of the total population within Orleans Parish. The Black or African American population was the largest minority group living within the MAF regional area and Orleans Parish in the year 2006. Between 2006 and 2020, minority race populations are expected to increase to 40 percent of the total population within the MAF regional area and approximately 73 percent of the total population within Orleans Parish. The Black or African American population is estimated to remain the largest resident minority group within the MAF regional area and Orleans Parish in 2020 (USBC 2000, USBC 2006a, USBC 2006b).

#### 3.1.3.7.2 Economy

Industrial sectors in the MAF regional area that provided significant employment include education, health, and social services; retail trade; arts, entertainment, recreation, accommodation, and food services; and professional, scientific, management, administrative, and waste management services. An estimated 409,155 people were employed in the MAF regional area in 2006 with an estimated unemployment rate of 5.6 percent (BLS 2007). The national and Louisiana unemployment rates during the same period were estimated at 4.6 and 4.3 percent, respectively (BLS 2007). The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Louisiana – 19.6 percent, MAF regional area – 18 percent, and Orleans Parish – 27 percent (USBC 2006a).

MAF contributes significantly to the local, state, and national economies. MAF contributes more than $142 million in annual direct payroll and provides over $22 million in annual Louisiana subcontracts and more than $74 million annually in total contracts. The total annual estimated economic impact of MAF is $251 million (LDED 2006, MAF 2007). MAF also employs approximately 2,540 persons, making it one of the largest employers in New Orleans. The vast majority of MAF's workforce lives in St. Tammany Parish, followed by Orleans, Jefferson, and Pearl River Parishes. MAF also employs approximately 600 suppliers of goods and services in Louisiana (MAF 2007).

3.1.3.7.3 Transportation

MAF has fully developed infrastructure, including road access and all utilities to support its occupational needs. MAF is served by Interstate 10 with direct access from Old Gentilly Road or Paris Road. MAF is responsible for a major portion of the vehicular traffic on Old Gentilly Road (MAF 2006b).

Several freight and passenger railways serve the New Orleans area and provide access to virtually all of America's major markets. Surface water transportation is located immediately adjacent to MAF. MAF is located close to a domestic and international commercial airport (MAF 2006b).

3.1.3.7.4 Public and Emergency Services

Since Hurricane Katrina, the availability of hospitals has been limited. Six hospitals that are available to MAF personnel include four in Jefferson Parish and two in St. Tammany Parish, all less than 40 km (25 mi) away. MAF is provided police, fire, and health-related emergency and nonemergency services by plant personnel as well as by the city of New Orleans. The city maintains a police station and two fire stations within 8 km (5 mi) of MAF that serve MAF and the New Orleans East area (MAF 2006b).

### *3.1.3.8 Cultural Resources*

There are no National Historic Landmarks and no facilities listed in the NRHP on MAF (DOI 2007a, DOI 2007b). However, there are five structures that would be associated with the Constellation Program which are eligible for the NRHP, including the Vertical Assembly Building (Building 110), High Bay Addition (Building 114), Acceptance and Preparation Building (Building 420), and the Pneumatic Test Facility and Control Building (Building 451 and Building 452) (MAF 2006b).

There are no archeological resources on MAF.

#### *3.1.3.9 Hazardous Materials and Waste*

MAF is classified as a large-quantity generator of hazardous waste, averaging more than 17,237 kg (38,000 lbs) of hazardous waste per month in 2005. MAF generates solid and hazardous waste from its research, development operations, laboratories, instrument repair, and operations and maintenance functions. Approximately 40 percent of the solid and hazardous waste streams come from processing the Space Shuttle External Tank. MAF is a permitted RCRA Part B treatment, storage, or disposal facility (MAF 2006b). All hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations and the MAF plan for managing hazardous materials and waste.

MAF is involved with several RCRA corrective actions related to TCE contamination in groundwater and polychlorinated biphenyls (PCBs), chromium, and polynuclear aromatic hydrocarbons in the soil sediments (NASA 2007a).

All of MAF’s nonhazardous waste is shipped offsite for treatment or disposal (MAF 2006b).

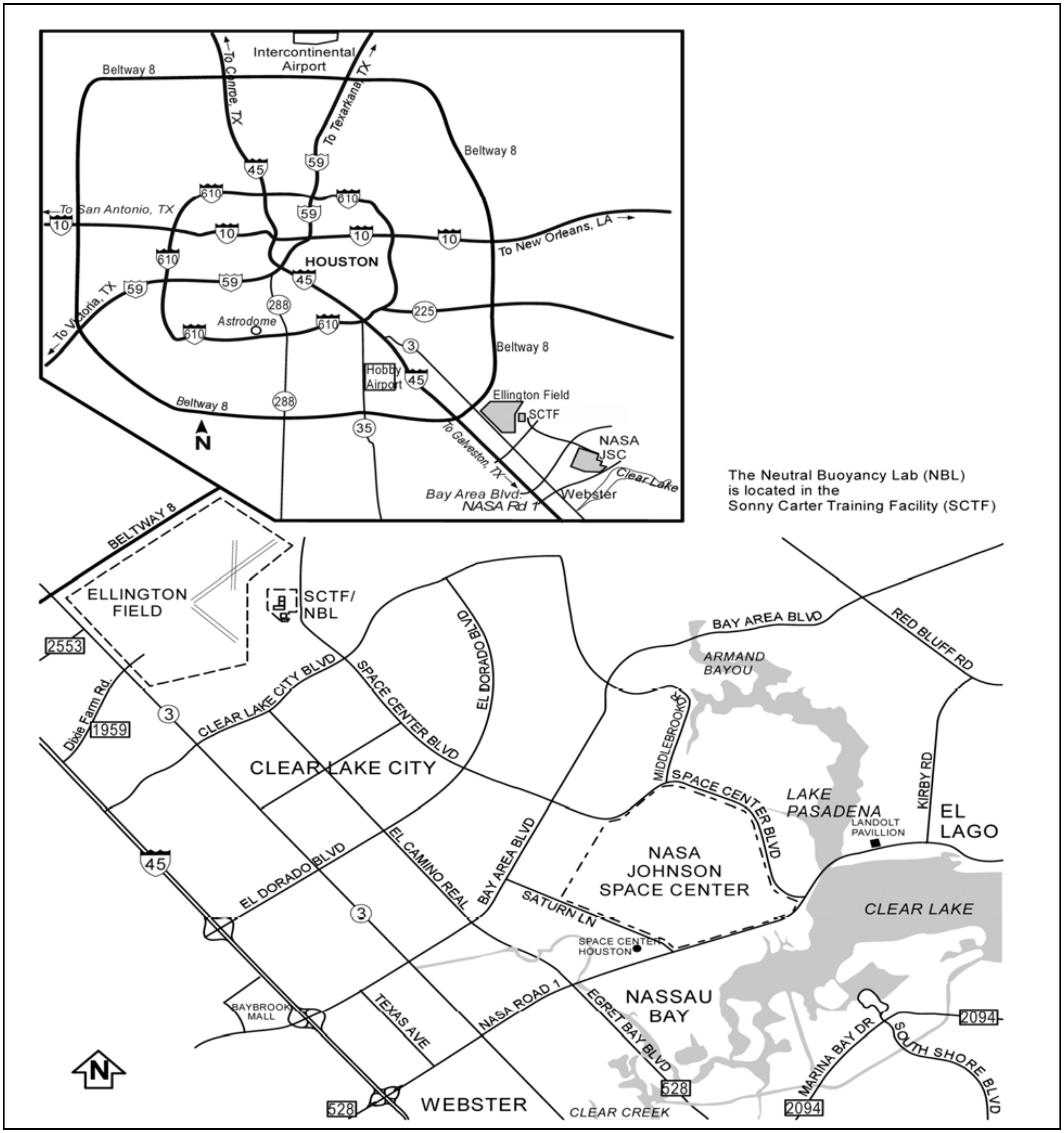
### 3.1.4 Lyndon B. Johnson Space Center

NASA’s JSC is devoted to research, development, and mission planning and execution activities related to NASA’s human space activities. JSC would have lead responsibility for managing the Constellation Program, as well as Project Orion, the Mission Operations Project, Lunar Lander Project, Extravehicular Activities Systems Project, and the Advanced Projects Office. JSC, through the Mission Operations Project, would lead all Constellation launch and atmospheric entry Range Safety activities, including management of all atmospheric entry Range Safety issues not within the boundaries of the landing sites.

#### *3.1.4.1 Land Resources*

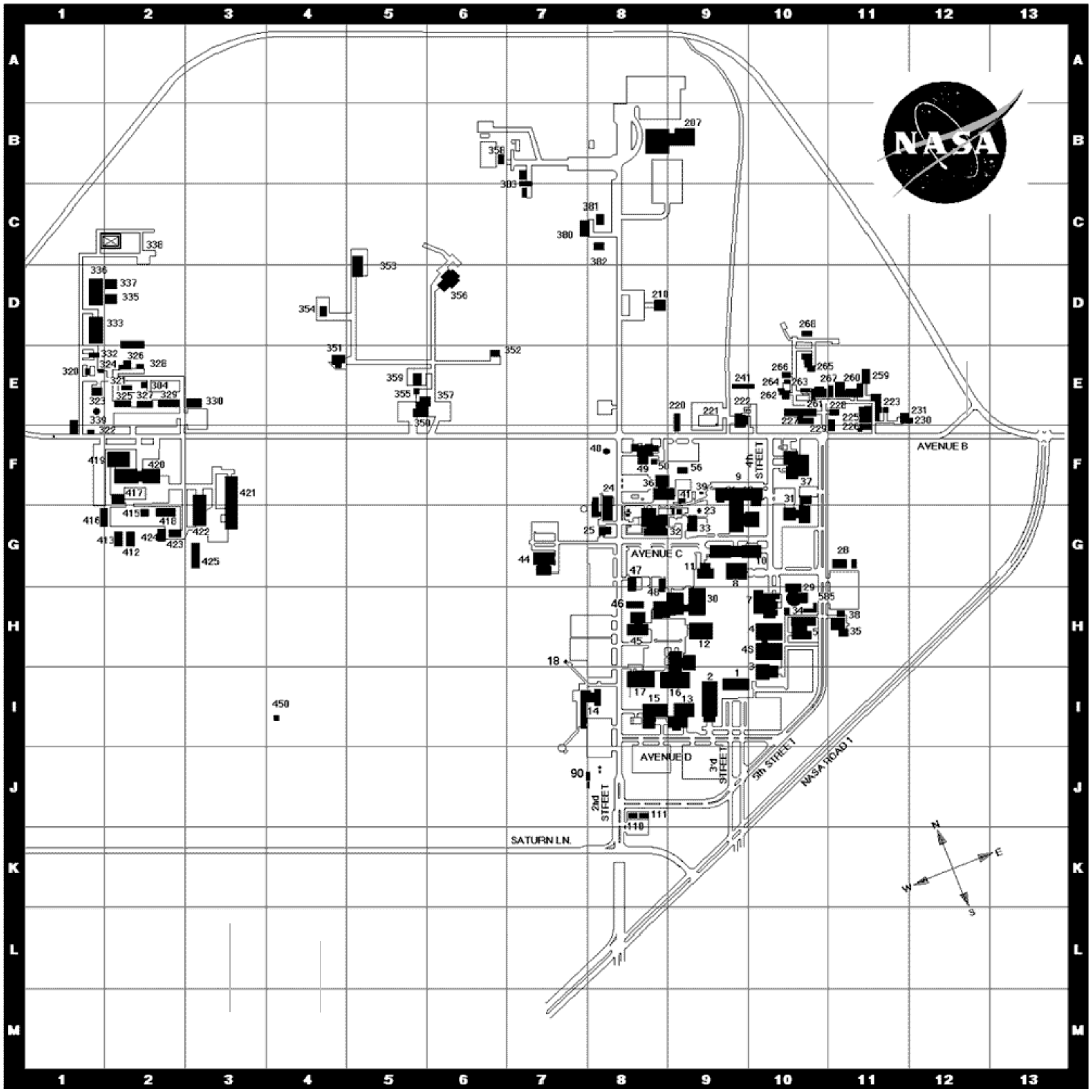
JSC is located in Harris County, Texas, approximately 40 km (25 mi) southeast of central Houston and 3 km (2 mi) northeast of Webster (see Figure 3-8). JSC adjoins public access areas, commercial and industrial sites, and residential areas of Clear Lake City. The Center encompasses approximately 640 ha (1,581 ac) of land and is the program management and operations center for the Space Shuttle and the Space Station programs. Basic and applied space research conducted at JSC includes propellant testing, development of communications devices, materials testing, lunar sample chemistry, physiological adaptation to microgravity, remote sensing, and space simulation. Land use at JSC is primarily commercial/industrial with more than 140 facilities, open space, utilities, and roads (see Figure 3-9). The southwestern portion of JSC is largely undeveloped and acts as a buffer zone. NASA also hosts more than a million visitors annually at the JSC visitors’ center, Space Center Houston, to see displays on human space flight, crewed spacecraft, moon rocks, and space artifacts.

JSC also operates two satellite facilities, Ellington Field and Sonny Carter Training Facility, located 13 km (8 mi) and 8 km (5 mi) northwest of JSC, respectively (see Figure 3-8). Ellington Field is the center of aviation-related training operations for NASA's crewed space program and the Sonny Carter Training Facility is utilized for astronaut training operations (JSC 2006f, JSC 2006g).




Source: JSC 2005b

**Figure 3-8. JSC Location and Vicinity Map**




Source: JSC 2007i

**Figure 3-9. JSC Facility Map**

### *3.1.4.2 Air Resources*

#### 3.1.4.2.1 Climate

The climate at JSC can be classified as warm subtropical with hot summers and mild winters. Annual temperatures range from approximately 45 to 92°F (7 to 33°C). Average annual rainfall is approximately 117 cm (46 in) and the relative humidity is more than 50 percent most of the year. Winds are predominantly from the south and southwest (JSC 2004).

#### 3.1.4.2.2 Air Quality

Air quality at JSC is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. The NAAQS for criteria pollutants have been adopted by the State of Texas.

JSC is classified as a major source of air emissions and operates under a CAA Title V permit (number 100665579) (TCEQ 2007). Sources of air pollutants at JSC, other than mobile sources such as automobiles and construction equipment, include combustion sources (*e.g.*, boilers), surface coating activities, laboratory hood vents, photograph processing, degreasing, woodworking, metal parts cleaning, and fugitive emissions due to chemical product usage at various locations (JSC 2004).

Harris County is currently designated as a moderate nonattainment area for the 8-hour ozone NAAQS (EPA 2007c).

### *3.1.4.3 Water Resources*

#### 3.1.4.3.1 Potable Water

JSC receives its potable water supply from the Clear Lake City Water Authority. Approximately 1.03 million kiloliters (kl) (272 million gal) of water are used annually at JSC (NASA 2007a).

#### 3.1.4.3.2 Surface Water

JSC is set in a landscape with many tidal streams and estuaries of Galveston Bay. Clear Lake is southeast of JSC, Mud Lake (also known as Lake Pasadena) and Armand Bayou are to the northeast, Cow Bayou is to the southwest, and Horsepen Bayou is north of JSC. Galveston Bay is recognized by the EPA as an estuary of national significance and was included in the National Estuary Program in 1989. Armand Bayou is a coastal preserve in the Galveston Bay National Estuary Program. Armand Bayou and Clear Lake are classified by the Texas Natural Resources Conservation Commission as “water quality limited” and designated for contact recreation and high quality aquatic habitat (JSC 2004).

The Clear Lake watershed receives silt and urban runoff from JSC. Stormwater is drained from JSC by underground conduits and ditches. Most stormwater collects in four main ditches; two ditches discharge to Mud Lake and the other two ditches discharge to Cow Bayou and Horsepen Bayou. Clear Lake and ultimately Galveston Bay receive all drainage from JSC. JSC has a general permit for stormwater discharges from industrial activities (JSC 2004).

Wastewater generated at JSC includes domestic sewage, photographic rinse water, plating shop rinse water, laboratory wastewater, blowdown water from cooling towers, wastewater from the Energy Systems Test Area, and oily wastewater from the garage and shops. Most wastewaters from JSC operations flow in an underground sewer pipe to a wastewater treatment plant operated by the Clear Lake City Water Authority. Wastewaters that do not meet the standard for discharge to the sewer system are either pretreated or stored and transported to a permitted disposal facility offsite (JSC 2004).

The majority of JSC lies outside the 100- and 500-year floodplains. However, the eastern corner of JSC near the intersection of NASA Parkway and Space Center Boulevard and a section located along a tributary to Mud Lake in the northeastern portion of the Center lie within the 100- and 500-year floodplains. The USFWS and several independent site-specific surveys have identified at least 21 wetland areas at JSC (JSC 2004).

3.1.4.3.3 Groundwater

The Houston area is underlain by two important fresh water aquifers, the Chicot and the Evangeline. At JSC, the base of the Chicot aquifer is between 180 and 210 m (600 and 700 ft) below the surface, and the base of the Evangeline aquifer is between 790 and 910 m (2,600 and 3,000 ft) below the surface. The shallowest confined aquifer under JSC is a sand layer approximately 18 m (60 ft) below the surface. This aquifer is contained by a clay barrier layer at a depth of 26 m (85 ft). NASA monitors the quality of this aquifer four times per year (JSC 2004). The groundwater table is typically found approximately 2 to 3 m (8 to 11 ft) below the ground surface. The water table fluctuates with weather and may reach the ground surface during wet periods (JSC 2004).

Past activities at JSC have resulted in groundwater contamination. A plume of Freon® 113, caused by a leaky process sewer in 1987, which measures approximately 10 ha (25 ac) in area and is located about 20 m (60 ft) below the Energy Systems Test Area in the northwest part of the Center. Remediation efforts are ongoing; however JSC does not routinely use groundwater. Two water wells are maintained for contingency and emergency use only (JSC 2004).

#### *3.1.4.4 Ambient Noise*

There are six main noise sources at JSC. Three of these sources are utilities, including the Central Heating and Cooling Plant and cooling tower (Building 24), Auxiliary Chiller Facility and cooling tower (Building 28), and Emergency Power Building (Building 48). The other sources are the Vibration and Acoustic Test Facility (Building 49), the Atmospheric Reentry Materials and Structures Evaluation Facility (Building 222), and the Propulsion Test Facility (Building 353) (JSC 2004).

Sensitive receptors to JSC noise include the Child Care Facility (Building 210); the Gilruth Recreation Facility (Building 207); the Visitor Center (Building 90); and homes, stores, and offices outside JSC. Noise sources at JSC do not exceed typical conversation levels of 65 dBA at receptors outside the Center. The Child Care Facility receives up to 73 dBA discontinuously from noise sources. The Center evaluates and controls noise in work areas so that it will not cause loss of hearing or physical impairment (JSC 2004).

### *3.1.4.5 Geology and Soils*

#### 3.1.4.5.1 Geology

JSC is located on a fairly flat coastal plain of deep river silt deposits, with elevations ranging from 3 to 6 m (10 to 20 ft) above sea level. The coastal plain is latticed by nontectonic faults caused by earth movements. One hundred and thirty faults (active and inactive) extend over 300 km (200 mi) in Harris County; none of these faults cross JSC (JSC 2004).

#### 3.1.4.5.2 Soils

JSC is on a nearly level plain of clayey and loamy prairie soils that drain poorly and allow only a small about of rain water to permeate to the groundwater. Without modification, these soils are considered poor building foundations because they shrink when dry and swell when wet (JSC 2004).

Sites of potential soil contamination include the sandblasting area near the Surplus Equipment Staging Warehouse (Building 338), the Fire Prevention Training Facility (Building 384), and the Energy Systems Test Area where contaminated groundwater currently is being treated to remove Freon® 113 (JSC 2004) (see Section 3.1.4.3 for more details).

### *3.1.4.6 Biological Resources*

JSC is located in the Upper Coastal Prairie Grasslands of the Gulf Prairies and Marshes biogeographic area of the State of Texas. The region includes salt grass marshes surrounding bays and estuaries, and tall woodlands in the river bottomlands. Most of JSC is too highly disturbed to support a significant number of indigenous Texas plant species. Many of the native plant species have been replaced with cultivated turf, ornamental shrubs, and trees. The remaining open grasslands in the undeveloped areas and around some buildings are mowed semi-annually (JSC 2004).

The Upper Texas Gulf Coast, including JSC, is home to many species of birds, mammals, reptiles, and amphibians. However, agriculture and urban development have fragmented and degraded wildlife habitat. Homes, shops, and office buildings surround JSC on all but its north and northeast boundaries, which abut Armand Bayou Nature Center, a 750-ha (1,900-ac) nature preserve with undisturbed wildlife habitat. Most of JSC is kept open, with little cover and food for wildlife. In the developed areas, traffic and routine activities also discourage wildlife (JSC 2004).

No threatened or endangered species and no critical habitats for state or federally threatened or endangered species are known to exist at JSC (JSC 2004).

### *3.1.4.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the JSC regional area. The JSC regional area is defined here as the land area within an 80.5-km (50-mi) radius of JSC, which includes Galveston, Chambers, Brazoria, Fort Bend, Harris, Liberty, and portions of Montgomery, Waller, and Jefferson Counties (USBC 2006a).

#### 3.1.4.7.1 Population

The total population within the JSC regional area was approximately 4,411,230 persons in 2000 (see Table 3-5) (USBC 2006a). The total population is expected to increase to approximately 5,133,320 by 2010 and to approximately 5,922,450 by 2020. Similar increases are anticipated in Harris County where the total population was approximately 3,400,580 persons in 2000 and is expected to increase to approximately 3,957,230 by 2010 and to approximately 4,565,560 by 2020 (USBC 2000).

**Table 3-5. Population of the JSC Regional Area and Harris County for 2000, 2010, and 2020**

| Population | JSC Regional Area | | | Harris County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 2,710,433 | 3,029,430 | 3,363,786 | 1,997,123 | 2,232,169 | 2,478,532 |
| Black or African American | 766,582 | 919,294 | 1,081,483 | 628,619 | 753,847 | 886,847 |
| American Indian and Alaska Native | 19,482 | 24,556 | 29,934 | 15,180 | 19,133 | 23,324 |
| Asian | 226,350 | 305,040 | 385,450 | 174,626 | 235,334 | 297,370 |
| Native Hawaiian and Other Pacific Islander | 2,466 | 3,323 | 4,199 | 2,095 | 2,823 | 3,568 |
| Some other race | 562,982 | 703,422 | 862,426 | 482,283 | 602,592 | 738,804 |
| Two or more races | 122,939 | — | — | 100,652 | — | — |
| Hispanic or Latino (of any race) | 1,311,421 | 1,654,537 | 2,056,147 | 1,119,751 | 1,412,719 | 1,755,632 |
| **Total Population** | **4,411,234** | **5,133,319** | **5,922,454** | **3,400,578** | **3,957,226** | **4,565,563** |
| **Percent Minority** | **38.56** | **40.98** | **43.20** | **41.27** | **43.59** | **45.71** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

In 2000, minority race populations represented approximately 39 percent of the total population within the JSC regional area and approximately 41 percent of the total population within Harris County. Hispanic or Latino (of any race) population was the largest minority group living within the JSC regional area and Harris County in the year 2000. Between 2000 and 2020, minority race populations are expected to increase to 43 percent of the total population within the JSC regional area and approximately 46 percent of the total population within Harris County. The Hispanic or Latino (of any race) population is estimated to remain the largest resident minority group within the JSC regional area and Harris County in 2020 (USBC 2000, USBC 2006a).

#### 3.1.4.7.2 Economy

Industrial sectors in the JSC regional area that provide significant employment include education, health, and social services; manufacturing; professional, scientific, management, administrative, and waste management services; and retail trade. An estimated 3,267,177 people were employed in the JSC regional area in 2000 with an estimated unemployment rate of 6.8 percent. The national and Texas unemployment rates during the same period were estimated at 5.8 and 6.1 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Texas – 15.4 percent, JSC regional area – 13.6 percent, and Harris County – 14.8 percent (USBC 2006a).

JSC contributes significantly to the local, state, and national economies. The aerospace industry, centered on JSC, brings billions of dollars in NASA contracts to the area every year. JSC's combined workforce accounts for 16,844 jobs, and is made up of 3,076 civil servants and 13,768 support contractors (BAHEP 2007). The vast majority of JSC's workforce lives in Clear Lake City, followed by the communities of League City, Friendswood, Nassau Bay, and Seabrook/El Lago/Taylor Lake Village. The total economic impact from JSC on the City of Houston and Texas includes more than 26,435 jobs with personal incomes of more than $2.5 billion and total spending that exceeds $3.5 billion (BAHEP 2007).

3.1.4.7.3 Transportation

JSC has fully developed infrastructure, including road access and all utilities to support its occupational needs. Transportation to JSC for most employees is provided via private motor vehicle along State Highway 3, State Highway 146, and Interstate 45. JSC is connected to the local roadway system by NASA Parkway to the south, Space Center Boulevard to the north and east, and Saturn Boulevard to the west. Traffic on NASA Parkway is generally congested during morning and afternoon rush hours.

Bus shuttles to JSC are available from select locations. JSC does not have direct rail service; however, air freight and commercial flight services are within a short drive from JSC. In addition, the Port of Houston and Port of Galveston serve outgoing ships and provide worldwide cargo service.

3.1.4.7.4 Public and Emergency Services

Fire protection at JSC is contracted with the city of Houston fire department, and police protection is provided by a NASA security service. Neighboring city and county police and fire departments would provide additional assistance during an emergency. Health services in the Clear Lake area are adequate to handle JSC's employees and the surrounding communities.

### *3.1.4.8 Cultural Resources*

The Apollo Control Room within the Mission Control Center (within Building 30) and the Space Environment Simulation Laboratory, Chambers A and B (Building 32), are designated National Historic Landmarks (DOI 2007a, DOI 2007b).

Facilities at JSC that would be associated with the Constellation Program and are eligible for individual listing in the NRHP include the Jake Garn Mission Simulator and Training Facility (Building 5), Crew Systems Laboratory (Building 7), Systems Integration Facility (Building 9), Mission Control Center, Space Environment Simulation Laboratory (Building 32), Communications and Tracking Development Laboratory (Building 44), and the Neutral Buoyancy Lab (Building 920N), located at the Sonny Carter Training Facility.

There are no known archeological resources associated with Constellation Program activities.

#### *3.1.4.9 Hazardous Materials and Waste*

JSC uses hazardous materials for various research activities, which in turn generate hazardous wastes. NASA is regulated both for generation, treatment, and storage of hazardous wastes at JSC, for which it holds a RCRA Part B permit. In addition, NASA has registered its hazardous and industrial wastes generated at JSC with the Texas Natural Resource Conservation Commission (JSC 2004). In 2005, JSC generated 88,241 kg (194,535 lb) of hazardous wastes. Such wastes are disposed of offsite at certified hazardous disposal facilities by a licensed contractor. Furthermore, all hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations and JSC's plan for managing hazardous materials and waste (JSC 2004).

Nonhazardous wastes are sent to the city of Houston landfill and some classified wastes (*e.g.*, paper, microfilm, and microfiche) are incinerated onsite. Several closed and graded landfills are located at JSC (JSC 2004).

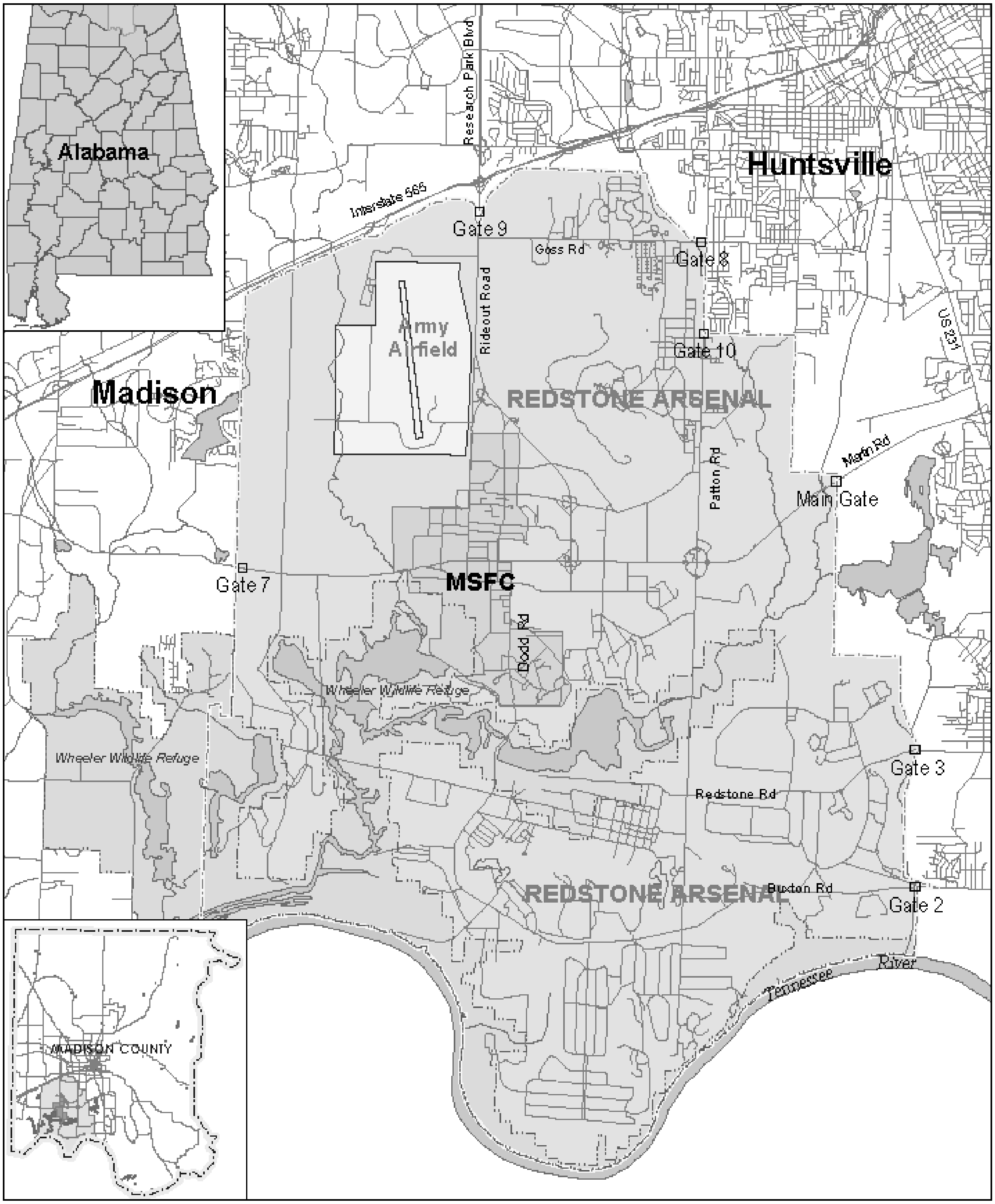
### 3.1.5 George C. Marshall Space Flight Center

MSFC is NASA's principal propulsion research center. The Center supports the design and development of the major space transportation systems, orbital systems, and scientific and applications payloads for space exploration. For the Constellation Program, MSFC would manage Project Ares.

#### *3.1.5.1 Land Resources*

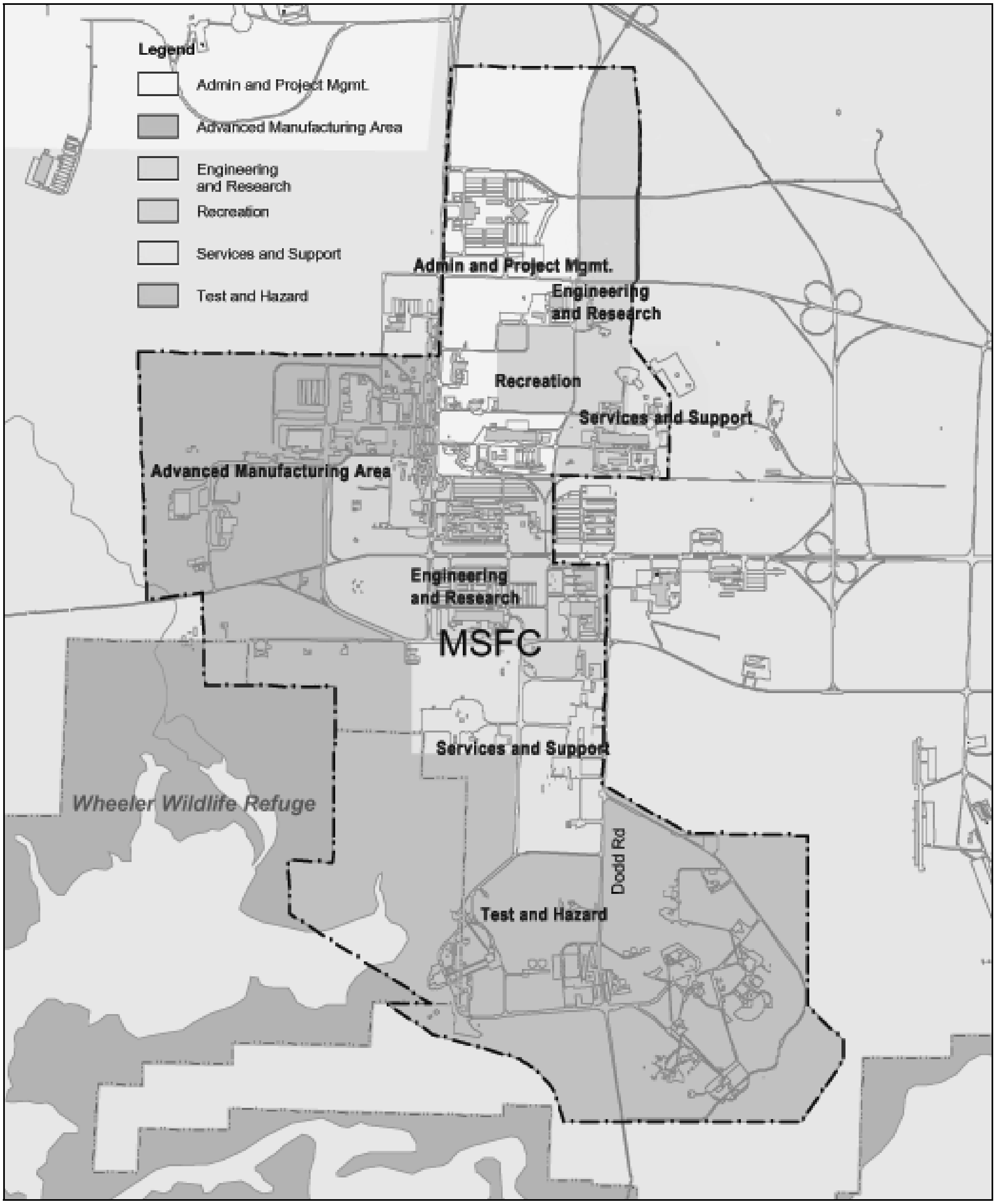
MSFC is located on approximately 745 ha (1,841 ac) within the grounds of the U.S. Army Redstone Arsenal, southwest of the city of Huntsville, Alabama (see Figure 3-10). Redstone Arsenal occupies 15,503 ha (38,309 ac) in the southwestern portion of Madison County, Alabama. MSFC is almost centrally located within Redstone Arsenal, which provides a 4- to 11.3-km (2.5- to 7-mi) buffer zone between the engine test stands and the general public. A substantial portion of Redstone Arsenal, including most of the lands to the south and west of MSFC, is a part of the Wheeler National Wildlife Refuge. Approximately 73 ha (180 ac) of the Wheeler National Wildlife Refuge extends onto property controlled by MSFC. The southern boundary of Redstone Arsenal is formed by the Tennessee River. The city of Huntsville surrounds Redstone Arsenal on the east, north, and much of the west sides (MSFC 2002b).

Land use at MSFC consists primarily of administration and management office space, engineering and research laboratories, services and support facilities, industrial/manufacturing and engine test areas, recreational and open areas, and roadway and parking areas (see Figure 3-11). The wide array of facilities at MSFC are capable of simulating the space environment; testing large propulsion systems; and developing new materials, hardware, and procedures. Test facilities are generally located in the southern portion of MSFC (MSFC 2002a).




Source: MSFC 2002a

**Figure 3-10. MSFC Location and Vicinity Map**




Source: MSFC 2002a

**Figure 3-11. MSFC Land Use Map**

### *3.1.5.2 Air Resources*

3.1.5.2.1 Climate

The climate at MSFC can be classified as temperate with warm and humid summers and cool winters with average annual temperatures ranging from 40 to 79°F (4 to 26°C). The average annual precipitation at MSFC is 137 cm (52 in), and the average relative humidity is more than 70 percent (MSFC 2002a).

3.1.5.2.2 Air Quality

Air quality at MSFC is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. The State of Alabama and the city of Huntsville have adopted the NAAQS.

MSFC is classified as a major source of air emissions and operates under a CAA Title V permit (number 0108900014). Sources of air emissions at MSFC include boilers, internal combustion engines, propulsion engine and launch vehicle system testing, pipe cleaning, air strippers, sand blasting, and grit blasting (MSFC 2006a). The Huntsville/Madison County area is classified as an attainment area for all criteria pollutants regulated under the NAAQS (EPA 2007c).

### *3.1.5.3 Water Resources*

3.1.5.3.1 Potable Water

MSFC obtains its water supply (industrial and potable) from the Redstone Arsenal water supply system which uses the Wheeler Reservoir of the Tennessee River as a source. In 2005, MSFC used approximately 2.19 million kl (575 million gal) of water and treated 14,820 kl (3.9 million gal) of wastewater (MSFC 2006a).

3.1.5.3.2 Surface Water

Surface water is abundant in Madison County. MSFC is located within the boundaries of the Indian Creek and Huntsville Spring Branch Drainage Basin and approximately three miles north of the Tennessee River. Most surface water drainage within MSFC is through constructed ditches to intermittent and perennial streams flowing west and southwest into tributaries of Indian Creek, or south and southeast into tributaries of Huntsville Spring Branch, both of which eventually discharge to the Tennessee River (MSFC 2002a).

Section 303(d) of the Clean Water Act (CWA) requires states to identify waters that are impaired by pollution, even after application of pollution controls. For those waters, states must establish a total maximum daily load (TMDL) of pollutants to ensure that water quality standards can be attained. The Tennessee River was a CWA 303(d) listed water for pH and thermal modifications. This water body was delisted in 2002. Huntsville Spring Branch was a CWA 303(d) listed water for metals and priority organics as parameters of concern. The TMDL for priority organics was finalized in 2003. Huntsville Spring Branch was delisted for metals in 2003. Indian Creek is a CWA 303(a) listed water for organic enrichment, dissolved oxygen, siltation, and priority organics. The TMDL for priority organics was finalized in 2003 and the

TMDLs for organic enrichment/dissolved oxygen and siltation were finished in 2002 (MSFC 2006a).

MSFC operates under an NPDES permit (number AL0000221) that specifies discharge limitations and monitoring requirements for multiple outfalls at MSFC. The majority of these outfalls discharge stormwater and/or process water. Wastewater generated at MSFC generally consists of noncontact cooling water, discharge from floor drains and laboratory sinks, cooling water and boiler blowdowns, photographic and plating wastewaters, and above-ground storage tank dike draining. Wastewater discharged to the sanitary sewer is treated prior to discharge into the river at Redstone Arsenal's water treatment plant. Domestic sewage is primarily treated at Redstone Arsenal and discharged to the Tennessee River. Certain areas, particularly the test areas, use septic tanks and disposal fields for sewage treatment (MSFC 2002a).

A significant portion of MSFC is within the 100-year floodplain and subject to flooding by the Tennessee River. There are no areas near MSFC that are designated within the 500-year floodplain. Twenty-four wetlands have been identified on MSFC as palustrine systems and either scrub-shrub, forested, emergent, or open water systems (MSFC 2002a). Less than 10 percent of MSFC is considered wetlands (MSFC 1997a).

3.1.5.3.3 Groundwater

Two aquifers or layers of groundwater are present near the surface at MSFC. The first layer, the Residuum Aquifer, includes soil and unconsolidated material from the surface to the bedrock. The residuum serves as a large groundwater reservoir. The second layer of groundwater, the Tuscumbia limestone/Fort Payne Aquifer, is characterized by an intricate network of cavities along bedding, joint, and fracture planes through which groundwater can readily flow. The Tuscumbia limestone/Fort Payne is the primary aquifer in the region for water supply (MSFC 2002a).

In 1994, MSFC was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 U.S.C. §§ 9601-9675) National Priorities List. Activities at MSFC and Redstone Arsenal have resulted in large areas of contaminated groundwater (*e.g.*, chlorinated volatile organic compounds, tetrachloroethene [PCE], trichloroethene [TCE], dichloroethene [DCE], vinyl chloride, carbon tetrachloride [CTC], chloroform, and 1,1,2,2-tetrachloroethane [1,1,2,2-PCA]). In addition, a small benzene, toluene, ethyl benzene, and xylene plume is located at the former base refueling area. Contaminated groundwater plumes are believed to discharge to springs located south and west of MSFC. Remediation activities are ongoing (MSFC 2002a).

### *3.1.5.4 Ambient Noise*

MSFC is surrounded by a large federally owned area consisting of the Redstone Arsenal and the Wheeler National Wildlife Refuge. This area is an effective physical barrier between MSFC testing activities and the general public. The U.S. Army has been developing and testing rocket engines at Redstone Arsenal since shortly after the end of World War II. Development and testing of space propulsion systems has been the primary mission of MSFC since its establishment in 1960, and significant engine testing has occurred during the last 40 years (MSFC 1997a).

Several populated areas surround Redstone Arsenal, including Huntsville to the east, north, and west; Madison to the west-northwest; Triana to the southwest; Mooresville to the west; Somerville and Hartselle to the southwest; Decatur to the west-southwest; and Falkville to the south-southwest. The nearest public dwellings to the test facilities at MSFC are approximately 4 km (2.5 mi) along the western boundary of Redstone Arsenal. A child day care center is located within MSFC, 2.5 km (1.5 mi) from the test facilities (MSFC 1997a).

### *3.1.5.5 Geology and Soils*

#### 3.1.5.5.1 Geology

MSFC lies on a gently rolling area, with elevations ranging from 171 to 198 m (560 to 650 ft) above mean sea level. MSFC is underlain by thin to thick beds of coarsely-crystalline, dark to light gray fossiliferous limestone, with some interbedded layers of gray chert. The formation also contains layers of dark gray, fine-grained limestone. The limestone formation has an average thickness of 46 m (150 ft). The area is considered to have low to moderate seismicity with no known active earthquake faults (MSFC 2002a).

#### 3.1.5.5.2 Soils

MSFC is covered by soils consisting of generally well-drained, red, fertile, silty clay loams, and silt loams that are typically associated with level to gently rolling terrain. These soils are composed primarily of insoluble residue produced by chemical weathering of the underlying limestone. In addition, these soils are of variably low to high plasticity, with lenses of silty or sandy clay (MSFC 2002a).

Previous activities at MSFC and Redstone Arsenal have resulted in areas of soil contamination (*e.g.*, polyaromatic hydrocarbons, metals, PCBs, pesticides, and chlorinated solvents), which are managed under CERCLA (MSFC 2002a) (see Section 3.1.5.3 for more detail).

### *3.1.5.6 Biological Resources*

MSFC is located in a region that is rich in biological diversity associated with an abundance of animal and plant communities. The region's dominant vegetation is mixed pine and hardwood forests interspersed with pasture and fallow and abandoned cropland in various stages of regrowth. Within MSFC, nearly half the land area is developed. The remaining undeveloped areas support mostly forests, fields, and marshes in various stages of ecological succession. In upland areas, forest cover includes stands of planted pines such as loblolly, short leaf, Virginia, slash pine, and stands of pines mixed with hardwoods such as various oaks, black walnut, and hickories. Bottomland hardwoods are found in transition and low-lying areas (MSFC 1997a).

MSFC also supports a variety of wildlife species, including whitetail deer, opossum, beaver, mink, and various waterfowl. The most sensitive natural habitats at MSFC are those adjacent to the test areas in the Wheeler National Wildlife Refuge, which is a major waterfowl wintering area and year-round habitat for many species (MSFC 1997a).

Few aquatic habitats exist at MSFC. With the exception of undeveloped wetlands comprising less than 10 percent of MSFC in the southwest portion of the site, and small segments of Indian Creek on the MSFC western boundary, most aquatic habitats are ephemeral (not permanent) and exist only during the wet portions of the year or in response to heavy rain events (MSFC 1997a).

There are four federally threatened and endangered species that could occur on MSFC and Redstone Arsenal, including the Alabama cave shrimp (*Palaemonias alabamae*), gray bat (*Myotis grisescens*), Indian bat (*Myotis sodalis*), and Price's potato bean (*Apios priceana*). The federally protected bald eagle (*Haliaeetus leucocephalus*) could also occur at MSFC. The Southern Cave Fish (Typhlichthys *subterraneus*) and Green Salamander (*Aneides geneus*) are state-protected species that could occur at MSFC. A site survey has been conducted which did not reveal any protected species onsite (MSFC 2002b).

### *3.1.5.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the MSFC regional area. The MSFC regional area is defined here as the land area within an 80.5-km (50-mi) radius of MSFC, which includes Marshall, Morgan, Limestone, Madison, Cullman, Jackson, and portions of Lauderdale, Colbert, Franklin, DeKalb, Etowah, Blount, and Winston Counties in Alabama and Lincoln, Giles, Moore, and portions of Lawrence, Marshall, Bedford, and Franklin Counties in Tennessee (USBC 2006a).

#### 3.1.5.7.1 Population

The total population within the MSFC regional area was approximately 862,360 persons in 2000 (see Table 3-6) (USBC 2006a). The total population is expected to increase to approximately 929,410 by 2010 and to approximately 988,450 by 2020. Similar increases are anticipated in Madison County, where the total population was approximately 276,700 persons in 2000 and is expected to increase to approximately 298,215 by 2010 and to approximately 317,160 by 2020 (USBC 2000).

In 2000, minority race populations represented approximately 16 percent of the total population within the MSFC regional area and approximately 28 percent of the total population within Madison County. The Black or African American population was the largest minority group living within the MSFC regional area and Madison County in the year 2000 (USBC 2000, USBC 2006a). Between 2000 and 2020, minority race populations are expected to increase to 17 percent of the total population within the MSFC regional area and approximately 29 percent of the total population within Madison County. The Black or African American population is estimated to remain the largest resident minority group within the MSFC regional area and Madison County in 2020 (USBC 2000, USBC 2006a).

**Table 3-6. Population of the MSFC Regional Area and Madison County for 2000, 2010, and 2020**

| Population | MSFC Regional Area | | | Madison County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 725,487 | 778,581 | 822,026 | 199,401 | 213,994 | 225,935 |
| Black or African American | 101,445 | 109,491 | 117,569 | 63,025 | 68,023 | 73,042 |
| American Indian and Alaska Native | 7,212 | 7,602 | 8,593 | 2,129 | 2,244 | 2,537 |
| Asian | 6,751 | 8,700 | 10,386 | 5,140 | 6,624 | 7,908 |
| Native Hawaiian and Other Pacific Islander | 375 | 483 | 577 | 158 | 204 | 243 |
| Some other race | 8,655 | 9,433 | 10,223 | 1,629 | 1,775 | 1,924 |
| Two or more races | 12,435 | — | — | 5,218 | — | — |
| Hispanic or Latino (of any race) | 21,615 | 27,037 | 33,114 | 5,226 | 6,537 | 8,006 |
| **Total Population** | **862,360** | **929,414** | **988,451** | **276,700** | **298,215** | **317,158** |
| **Percent Minority** | **15.87** | **16.23** | **16.84** | **27.94** | **28.24** | **28.76** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

#### 3.1.5.7.2 Economy

Industrial sectors in the MSFC regional area that provide significant employment include manufacturing; educational, health, and social services; retail trade; construction; and professional, scientific, management, administrative, and waste management services. An estimated 671,067 people were employed in the MSFC regional area in 2000 with an estimated unemployment rate of 5.4 percent. The unemployment rate for Madison County was 5.7 percent. The national and Alabama unemployment rates during the same period were estimated at 5.8 and 6.2 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Alabama – 16.1 percent, MSFC regional area – 12.2 percent, and Madison County – 10.3 percent (USBC 2006a).

MSFC contributes significantly to the local, state, and national economies. In fiscal year 2006, MSFC had an operating budget of $2.26 billion and contributed $302 million in payroll expenditures. MSFC employed approximately 2,533 civil servants and 4,422 support contractors in 2006 (MSFC 2007c). The vast majority of MSFC's workforce lives in Madison County, followed by Morgan and Limestone Counties (MSFC 2007b).

3.1.5.7.3 Transportation

MSFC has fully developed infrastructure, including road access and all utilities to support its occupational needs. MSFC and Huntsville are served directly by U.S. Highways 72, 72A, 231, and 431. Access to Interstate 65, approximately 24 km (16 mi) west of MSFC, is by way of U.S. 72, U.S. 72A, and Interstate 565 (MSFC 1997a). Local bus service is available for commuters (MSFC 2002a).

MSFC has direct access to low-cost, deep-water transportation via the Tennessee-Tombigbee Waterway and the Tennessee/Ohio/Mississippi River System, including barge-loading docks on the adjacent Redstone Arsenal and a supporting road system to handle very large cargo (MSFC 1997a). Use of rail facilities at Redstone Arsenal was largely discontinued in the early 1970s. Most of the track has been removed, and only a small section of rail remains on Redstone Arsenal. A railhead located near the north boundary has been retained to serve MSFC as the need arises (MSFC 2002a).

MSFC is located approximately 16 km (10 mi) east of the Huntsville International Airport and the International Intermodal Center, a regional air, rail, and highway transportation center (MSFC 2002a).

3.1.5.7.4 Public and Emergency Services

Twenty-four-hour firefighting services, including personnel and equipment, are provided to MSFC by four fire stations owned and operated by the U.S. Army. In addition, MSFC has a mutual aid agreement with the city of Huntsville fire department for firefighting assistance, as well as a working agreement with all northern Alabama fire stations. Security guards under contract with MSFC are in charge of law enforcement duties. Numerous regional medical centers, including a clinic at MSFC and Redstone Arsenal, meet community medical needs (MSFC 2002a).

### *3.1.5.8 Cultural Resources*

Facilities at MSFC that would be associated with the Constellation Program and are designated as National Historic Landmarks include the Propulsion and Structural Test Facility (Building 4572), Structural Dynamic Test Facility (Building 4550), and Multi-purpose High Bay and Neutral Buoyancy Simulator Complex (Building 4705) (DOI 2007b).

Facilities at MSFC that would be associated with the Constellation Program and are eligible for individual listing in the NRHP include the Hardware Simulation Laboratory (Building 4436), Avionics Systems Testbed (Building 4476), Test Facility 116 (Building 4540), Test Stand 116 (Building 4540), Hot Gas Test Facility (Building 4554), Structural Dynamic Test Facility (Building 4550), Test and Data Recording Facility (Building 4583), Materials and Processes Laboratory (Building 4612), Structures and Mechanics Laboratory (Building 4619), Huntsville Operations Support Center (Building 4663), Advanced Engine Test Facility (Building 4670), Multi-purpose High Bay and Neutral Buoyancy Simulator (Building 4705), National Center for Advanced Manufacturing (Building 4707), Engineering and Development Laboratory (Building 4708), and the Wind Tunnel Facility (Building 4732).

There are no known archeological resources associated with Constellation Program activities.

#### *3.1.5.9 Hazardous Materials and Waste*

MSFC is classified as a large-quantity generator of hazardous waste and is managed under RCRA Subtitle C. Generating activities at MSFC include vehicle maintenance, research and development activities, and industrial activities. During 2005, MSFC generated 26,779 kg (59,036 lbs) of hazardous waste and 28,113 kg (61,978 lbs) of controlled waste (MSFC 2006a). These wastes include cadmium, chromium, lead, and other metals; wastes that exhibit the characteristics of ignitability, corrosiveness, or reactivity; lab packs of small amounts of hazardous waste; spent solvents; and wastewater treatment sludge. All hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations and the MSFC plan for managing hazardous materials and waste. Hazardous wastes are disposed of offsite at certified hazardous disposal facilities by a licensed contractor (MSFC 1997a).

MSFC was placed on the CERCLA National Priorities List in 1994 (NASA 2007a) (see Section 3.1.5.3 for more detail). NASA submits annual reports under the EPCRA Toxic Release Inventory Program for the release of pollutants at MSFC. In 2005, a report was submitted for di-isocyanate compounds (NASA 2007a).

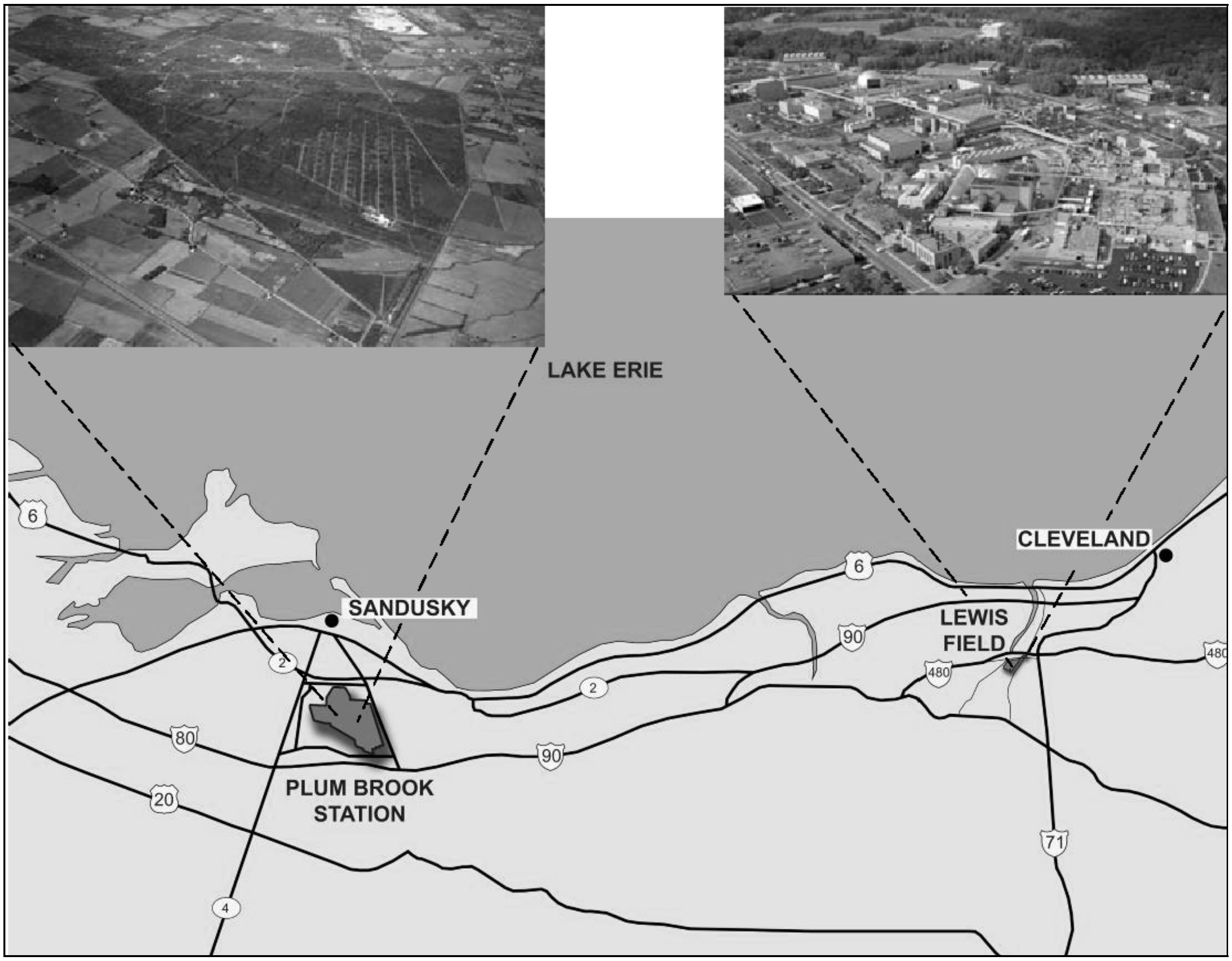
Nonhazardous waste is primarily collected and hauled by a contractor to a local incinerator. Nonhazardous waste excluded from incineration is disposed of in the Redstone Arsenal construction debris landfill (MSFC 2002a). During 2005, 1.45 million kg (3.2 million lbs) of solid waste were generated at MSFC (MSFC 2006a).

### 3.1.6 John H. Glenn Research Center

NASA's GRC specializes in power, propulsion, communications, and micro-gravity science research. GRC consists of two sites in Ohio, Lewis Field in western Cuyahoga County (near Cleveland) and Plum Brook Station (PBS) in west-central Erie County, approximately 80 km (50 mi) west of Lewis Field (see Figure 3-12). For the Constellation Program, Lewis Field would manage Orion Service Module and Spacecraft Adapter development and provide Ares Upper Stage support and development. PBS would provide Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing, Ares Upper Stage engine testing, and integrated stages testing.

#### *3.1.6.1 Land Resources*

The GRC Lewis Field site is predominantly within the limits of the city of Brook Park, approximately 32 km (20 mi) southwest of downtown Cleveland. Lewis Field is bordered by the Cleveland Hopkins International Airport to the east and to the north and west is the Rocky River Reservation, a part of the Cleveland Metropolitan Park District. The southern boundary of Lewis Field is adjacent to highly urbanized and developed residential areas, business districts, and industrial complexes (GRC 2005).




Source: GRC 2006b

**Figure 3-12. GRC Location and Vicinity Map**

Lewis Field encompasses approximately 142 ha (350 ac) of land and contains more than 140 buildings, structures, and other facilities that support NASA's wide array of research, technology, and development programs (see Figure 3-13). Most of Lewis Field is considered fully developed with offices, test facilities, and support facilities, with the exception of approximately 69 ha (171 ac) that are considered undeveloped (GRC 2005).

PBS is operated as a satellite facility (component installation) of GRC and performs various research related to aerospace applications. Use of the site by the Federal Government began in the early 1940s when the U.S. Army established the Plum Brook Ordnance Works for the manufacture of munitions. Munitions production took place throughout the early 1940s, after which buildings and production lines were decontaminated and decommissioned. Ownership of the property subsequently transferred to NASA and the property was renamed PBS (GRC 2005).

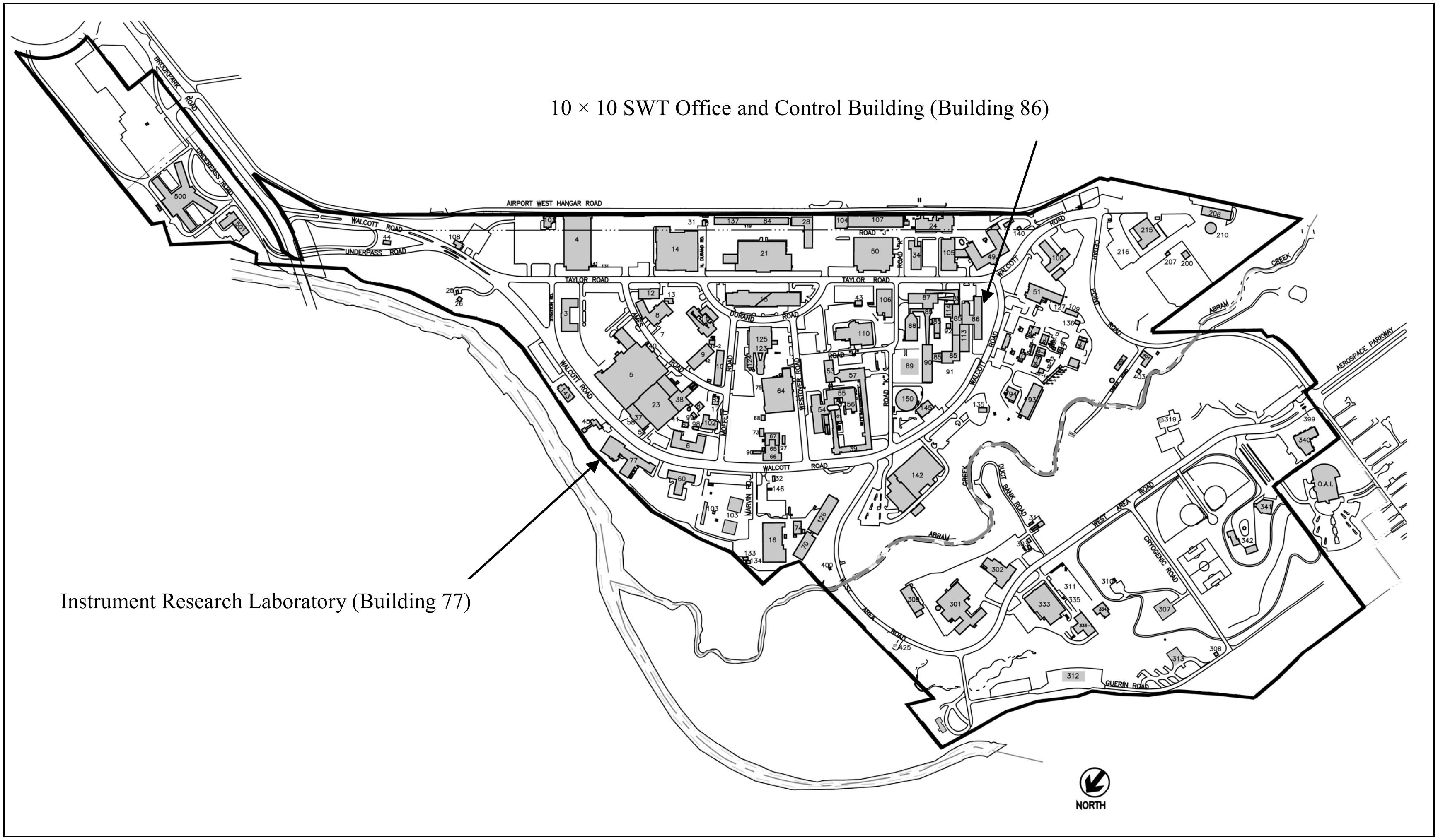
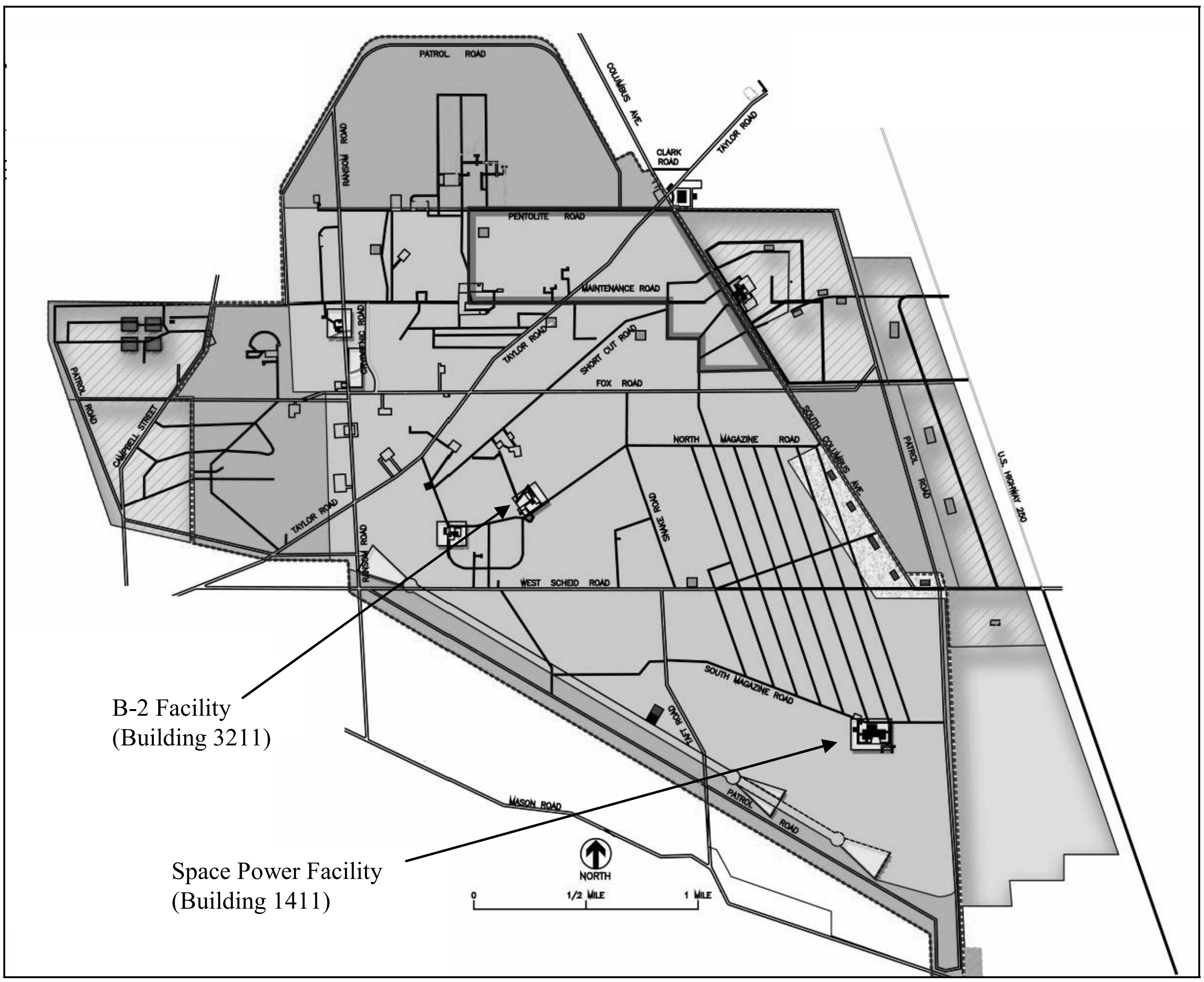



**Figure 3-13. GRC Lewis Field Facilities Map**

PBS encompasses 2,614 ha (6,454 ac) of rural land, located approximately 6 km (4 mi) south of Sandusky, Ohio. Most of PBS consists of forestland and old fields and the surrounding area is largely rural and agricultural. PBS houses more than 174 buildings and structures, including offices, mechanical and process equipment areas, test facilities, substations, warehouses, and wastewater treatment facilities. The vast majority of these facilities are currently inactive. Of the few active facilities at PBS are the Space Power Facility (Building 1411) and the Spacecraft Propulsion Research Facility (B-2 Facility) (Building 3211) (see Figure 3-14). The Space Power Facility was designed to allow for the testing of space power generation systems under simulated space environmental conditions. The facility can fully simulate space vacuum, temperature, and solar environments for various test configurations. The B-2 Facility is used for research, development, and validation testing of spacecraft and space propulsion systems. The facility can simulate vacuum, cryogenic background temperatures, and solar heating conditions found in near-Earth orbit (GRC 2005).




Source: GRC 2005

**Figure 3-14. GRC Plum Brook Facilities Map**

NASA is currently in the process of preparing a facility-wide land use master plan to address future development at GRC Lewis Field and PBS, for which NASA is currently preparing an Environmental Assessment, anticipated to be completed later this year.

#### *3.1.6.2 Air Resources*

##### 3.1.6.2.1 Climate

The climate in this region of Ohio can be classified as continental. Summers are warm and humid, with average temperatures of 70ºF (21ºC). Winters are relatively cold and cloudy, with an average temperature of 28ºF (-2ºC). Precipitation averages approximately 89 cm (35 in) per year. Prevailing winds are typically from the south to southwest (GRC 2005).

##### 3.1.6.2.2 Air Quality

Air quality at Lewis Field and PBS is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants.

Lewis Field is classified as a major source of air emissions and operates under a CAA Title V permit. The majority of emissions from Lewis Field result from the combustion of fuels, including natural gas, #2 fuel oils, and jet fuels. Other sources include air heaters, boilers, and steam generators. Cuyahoga County is designated as a nonattainment area for the $PM_{2.5}$ and 8-hour ozone standards. Cuyahoga County also is designated as a maintenance area for $PM_{10}$, CO, and $SO_2$ (EPA 2007c).

PBS is classified as a minor source of air emissions under Title III and Title V of the CAA and is registered under the Ohio EPA Non-Title V Emission Fee (Blue Card) Program in conjunction with a Presumed Inherent Physical Limitation (the inability to discharge air pollutants in quantities that trigger Title V requirements). Sources of air pollutants at PBS, other than mobile sources such as automobiles and construction equipment, include boilers, heaters, research test cells, a degreaser, and other minor sources (GRC 2005). Erie County is designated as an attainment area for all NAAQS (EPA 2007c).

#### *3.1.6.3 Water Resources*

##### 3.1.6.3.1 Potable Water

Lewis Field and PBS receive potable water from the city of Cleveland municipal water supply system and the Erie County Water Division, respectively. Both municipalities use surface water as the source (GRC 2005).

##### 3.1.6.3.2 Surface Water

The primary surface water features at Lewis Field are the Rocky River and its tributary, Abram Creek. The Rocky River flows along the western edge of Lewis Field, separating it from the Rocky River Reservation of the Cleveland Metropolitan Park District. After passing Lewis Field, the river flows north and discharges into Lake Erie. Abram Creek begins in a low-lying area south of Cleveland Hopkins International Airport and flows through a heavily urbanized area, crossing the Lewis Field property. It travels approximately 6 km (4 mi) to its confluence with the Rocky River (GRC 2005).

Wastewater at Lewis Field is composed of sanitary, stormwater, noncontact and contact cooling, cooling tower blowdown, and miscellaneous process discharges. There are three wastewater collection systems at Lewis Field, including sanitary, stormwater, and industrial. The sanitary sewer system discharges by permit to the Southerly Wastewater Treatment Plant of the Northeast Ohio Regional Sewer District. Stormwater discharges are regulated under two separate Ohio EPA NPDES permits. Stormwater monitoring has indicated occasional exceedances of chlorine. These findings have been reported to the Ohio EPA with no additional action occurring from the Ohio EPA. After onsite settling and oil separation, industrial wastewater is discharged by permit to the sanitary sewer system (GRC 2005).

The Rocky River and Abram Creek are classified as Warmwater Habitats by the Ohio EPA and portions of the Rocky River are designated as “Seasonal Salmonid” due to the occasional migration of salmon. Other use designations for portions of Abram Creek and the Rocky River include Primary Contact Recreation (swimming) and Agricultural and Industrial Water Supply. In addition, because the Rocky River flows through the Cleveland Metroparks, it is designated as a State Resource Water in the vicinity of Lewis Field. This designation affords special protection under the state’s anti-degradation policy (GRC 2005).

The Ohio EPA has reported that sections of the Rocky River and Abram Creek in the vicinity of Lewis Field display signs of environmental degradation and do not meet the warmwater habitat aquatic life use designation. Stream flow patterns indicative of highly urbanized storm flow drainage may be important factors in explaining the degradation of stream biota (GRC 2005).

Floodplains at Lewis Field occur at Abram Creek. Abram Creek fulfills the criteria for an area of special flood hazard (defined as an area of land that would be inundated by a flood having a one percent chance of occurring in any given year). No other mapped floodplains occur at Lewis Field and no facilities are within the 100-year floodplain. The 500-year floodplain for Lewis Field has not been mapped. Wetlands at Lewis Field have not been officially delineated; however, a study performed in 2002 identified four areas as probable wetlands. No activities currently occur in these four areas (GRC 2005).

PBS is located in an area that supports multiple surface water systems that are within the Lake Erie watershed. Eleven streams cross PBS, the largest of which are Pipe Creek, Kuebler Ditch, Ransom Brook, and Plum Brook. Streams generally flow northward and converge into Ransom Creek, Storrs Ditch, Plum Brook, and Sawmill Creek and eventually flow into Lake Erie. More than 17 isolated ponds and reservoirs also are located on PBS (GRC 2005).

All surface waters at PBS are classified as Warmwater Habitats by the Ohio EPA. Other use designations applicable to PBS streams include Primary Contact Recreation and Agricultural and Industrial Water Supply. Although water quality in the streams that originate or flow through PBS is believed to be generally good, there are two surface water areas at PBS that have been affected by trinitrotoluene (TNT) manufacturing operations in the early 1940s. One of the areas, designated as the Pentolite Road Pond, is in the process of remediation by the U.S. Army Corps of Engineers as part of the clean-up of the former Plum Brook Ordnance Works. Further remediation of the second area, designated as the West Area Red Water Ponds, has not been recommended at this time (GRC 2005).

PBS operates under an NPDES permit (number OH 2IO00002) that specifies wastewater discharge limitations and monitoring requirements for multiple outfall points on PBS. Wastewater discharges at PBS include stormwater, noncontact cooling water, cooling tower and boiler blowdown, and sanitary discharges. Domestic sewage is primarily routed to the Erie County Sewage Treatment Works (GRC 2005).

Portions of PBS lie within the 100- and 500-year floodplains. However, no PBS facilities remain in the 100-year floodplain. In addition, there are no activities at PBS that are located in either floodplain. Wetlands at PBS have not been officially delineated. However, based in studies performed to date, there are no known activities currently located in wetlands (GRC 2005).

3.1.6.3.3 Groundwater

Groundwater at Lewis Field occurs in two distinct lithologic zones, in the shale bedrock and in perched lenses in the overlying unconsolidated materials. These zones are approximately 15 to 76 cm (6 to 30 in) thick. The zones are thought to be isolated and not to contain significant amounts of groundwater. Groundwater in the unconsolidated zone is expected to discharge to Abram Creek and the Rocky River. The groundwater zone within the bedrock is under artesian pressure due to the low hydraulic conductivity of the overlying soils. The recharge rate is estimated to be very slow and the shale bedrock has very low permeability (GRC 2005).

There are several permitted drinking water wells within 6 km (4 mi) of Lewis Field and many individuals in the Rocky River Basin use groundwater for drinking. However, groundwater is not used for drinking water at Lewis Field and no aquifer has been designated as a sole or principal drinking water source supply at Lewis Field. In addition, there is no evidence of groundwater contamination or any underground injection wells at Lewis Field (GRC 2005).

PBS is underlain by an overburden aquifer and a limestone and dolomite bedrock aquifer. The bedrock aquifer is overlain by unconsolidated deposits of glacial origin. These unconsolidated deposits comprise the overburden aquifer. The thickness of the overburden aquifer ranges from less than 1.5 m (5 ft) to greater than 8 m (25 ft). Groundwater flow is to the north-northwest toward Lake Erie. The limestone and dolomite aquifer is the primary source of groundwater for Erie County. Although most of the wells surrounding PBS are used for agricultural purposes, a few wells in the vicinity of PBS are used for private and public consumption. No groundwater at PBS is used for private or public consumption.

Groundwater at PBS has been contaminated as a result of munitions manufacturing at the former Plum Brook Ordnance Works. Groundwater investigations are being conducted by the U.S. Army Corps of Engineers in connection with site remediation activities. Ongoing groundwater investigations have identified several contaminants, including nitroaromatics, VOCs, semivolatile organic compounds, and metals (GRC 2005).

#### *3.1.6.4 Ambient Noise*

The Cleveland Hopkins International Airport is the largest noise source in the general vicinity of Lewis Field. Other noise sources include a nearby automotive factory, traffic noise from two major interstate highways, and a large exhibition hall. Noise sources at Lewis Field include research operations (*e.g.*, wind tunnels and engine test cells), NASA aircraft, construction activities, and traffic noise. The general noise level at Lewis Field is well below the average day/night sound level of the Cleveland Hopkins International Airport. Noise levels at the Lewis Field fence line are generally below 70 dBA and are primarily attributed to offsite sources (GRC 2005).

Sources of noise at PBS include an unpaved airstrip, which accommodates light aircraft; transient noise blasts from test facilities; construction activities; and traffic noise. The Army Reserves and the Ohio Air National Guard occasionally discharge pyrotechnic devices at PBS. The nearest public receptor facilities are generally more than 305 m (1,000 ft) from the PBS boundary. None of the noise generating activities at PBS are believed to be a significant source of noise impacts and no noise complaints have been recorded at PBS (GRC 2005).

#### *3.1.6.5 Geology and Soils*

##### 3.1.6.5.1 Geology

The area near Lewis Field consists of gently rolling uplands created by glacial outwash. Lewis Field is generally level due to extensive cut-and-fill operations that reclaimed the area from steep drainage swales. These drainage features were filled in with a variety of undifferentiated soils and gravels, construction debris, and industrial and domestic waste (GRC 2005).

The area surrounding Lewis Field is located on the western flank of the undeformed portion of the Appalachian Basin. The basin contains a southeastward-thickening prism of sandstones, carbonates, shales, and salts that aggregate to a thickness of approximately 1,980 to 7,010 m (6,500 to 23,000 ft). Bedrock in the immediate vicinity of Lewis Field is composed of the Cleveland Shale Member of the Ohio Shale. The probability of an earthquake causing structural damage is minimal. The Ohio Shale is fissile, however, and offers differential resistance to applied stresses depending upon the inclination to the direction of stratification (GRC 2005).

PBS is located on land that was once lake bottom formed from glacial melt waters. The area is relatively flat and slopes gently northward. Elevations range from approximately 191 to 207 m (625 to 680 ft) above sea level. Bedrock in the area consists of carbonates and clastics (sandstones and shales). The depth of the bedrock is highly variable and can range from 0.7 to 7.6 m (2 to 25 ft). The probability of an earthquake causing structural damage at PBS is minimal (GRC 2005).

##### 3.1.6.5.2 Soils

Soils in the vicinity of Lewis Field generally have low to very low permeability and are classified as a silty clay loam, although they often grade to a clay loam glacial till. The natural soils and parent materials in many cases have been removed or covered with fill. There are no prime farmlands within Lewis Field (GRC 2005).

Results from a recent soil sampling effort at Lewis Field indicate the presence of asbestos and organic and metallic chemicals (GRC 2006a). In addition, several areas that were contaminated with PCBs have been remediated (GRC 2005).

The area surrounding PBS is known for its agricultural productivity and farmland. Although much of the native soil was disturbed during construction of Plum Brook Ordnance Works and later by NASA, there are still vast tracts of undisturbed native soils at PBS. The soils at PBS are typically light-textured, often sandy with moderate to slightly acidic pH, and are highly variable in thickness and permeability. As a result of past Army activities at PBS during Plum Brook Ordnance Works operations, the U.S. Army Corps of Engineers is conducting remediation activities in several areas of soil contamination (*e.g.*, PCBs, TNT, diesel oil, lead, and #2 fuel oils) (GRC 2005).

#### *3.1.6.6 Biological Resources*

Lewis Field lies in the Beech-Maple Forest region of the great eastern Deciduous Forest of North America. This region has been classified as a mixture of Beech Forest, Mixed Oak Forest, Elm-Ash Swamp Forest, and Mixed Mesophytic Forest. Most of the site is now too highly disturbed to support significant numbers of indigenous Ohio plant species. The gorge of Abram Creek and the tops of the bluffs above the valley are the only areas that retain natural qualities (GRC 2005).

Animals that inhabit Lewis Field include birds, amphibians, reptiles, butterflies and moths, and various mammals. Most common birds include the European starling, house sparrow, American robin, chimney swift, and house finch. Three amphibian species, one reptile species, many species of butterflies and moths, and three common bat species have been identified at Lewis Field. Other mammals, such as squirrels, chipmunks, rabbits, deer, and groundhogs, also likely inhabit the area (GRC 2005).

PBS contains vast natural resources in the form of a complex mosaic of plant communities in various successional stages and hydrologic regimes. Much of PBS is undeveloped natural areas or recovering natural areas previously used for agriculture. The size and diversity of natural habitats at PBS support a large number of plant and animal species.

Two state-listed potentially threatened plant species, pigeon grape (*Vitis cinerea*) and American chestnut (*Castanea dentata*), are found at Lewis Field. There is no evidence of any federally threatened or endangered animal species at Lewis Field (GRC 2005).

PBS supports large numbers of protected plant and animals species, including one federally protected species (the bald eagle [*Haliaeetus leucocephalus*]), seven state-listed endangered, nine threatened, 11 potentially threatened, and seven species of special concern (GRC 2005).

#### *3.1.6.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the GRC Lewis Field and PBS regional areas. The Lewis Field regional area is defined here as the land area within an 80.5-km (50-mi) radius of Lewis Field, which includes Lorain, Medina, Summit, Cuyahoga, Geauga, and portions of Lake, Erie, Portage, Huron, Ashland, Wayne, Stark, Trumbull, Ashtabula, Richland, and Ottawa Counties. The PBS regional area is defined here as the land area within an 80.5-km (50-mi) radius of PBS, which includes Ottawa, Sandusky, Seneca, Erie, Huron, Lorain, and portions of Medina, Ashland, Richland, Crawford, Lucas, Wood, Hancock, Wyandot, Morrow, Wayne, and Cuyahoga Counties (USBC 2006a).

#### 3.1.6.7.1 Population

The total population within the Lewis Field regional area was approximately 3,410,700 persons in 2000 (see Table 3-7) (USBC 2006a). The total population is expected to increase to approximately 3,480,500 by 2010 and to approximately 3,544,240 by 2020. Similar increases are anticipated in Cuyahoga County, where the total population was approximately 1,393,980 persons in 2000 and is expected to increase to approximately 1,422,505 by 2010 and to approximately 1,448,550 by 2020 (USBC 2000).

**Table 3-7. Population of the Lewis Field Regional Area and Cuyahoga County for 2000, 2010, and 2020**

| Population | Lewis Field Regional Area | | | Cuyahoga County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 2,757,548 | 2,759,790 | 2,753,199 | 938,863 | 939,626 | 937,382 |
| Black or African American | 518,370 | 569,993 | 623,795 | 382,634 | 420,739 | 460,453 |
| American Indian and Alaska Native | 6,513 | 7,395 | 8,268 | 2,529 | 2,872 | 3,211 |
| Asian | 42,351 | 56,211 | 68,982 | 25,245 | 33,507 | 41,120 |
| Native Hawaiian and Other Pacific Islander | 692 | 918 | 1,127 | 338 | 449 | 551 |
| Some other race | 35,093 | 39,885 | 44,910 | 20,962 | 23,842 | 26,826 |
| Two or more races | 50,136 | — | — | 23,407 | — | — |
| Hispanic or Latino (of any race) | 84,920 | 106,772 | 132,868 | 47,078 | 59,193 | 73,660 |
| **Total Population** | **3,410,703** | **3,480,500** | **3,544,236** | **1,393,978** | **1,422,505** | **1,448,554** |
| **Percent Minority** | **19.15** | **20.71** | **22.32** | **32.65** | **33.95** | **35.29** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

In 2000, minority race populations represented approximately 19 percent of the total population within the Lewis Field regional area and approximately 33 percent of the total population within Cuyahoga County. The Black or African American population was the largest minority group living within the Lewis Field regional area and Cuyahoga County in the year 2000. Between 2000 and 2020, minority race populations are expected to increase to 22 percent of the total population within the Lewis Field regional area and approximately 35 percent of the total population within Cuyahoga County. The Black or African American population is estimated to remain the largest resident minority group within the Lewis Field regional area and Cuyahoga County in 2020 (USBC 2000, USBC 2006a).

The total population within the PBS regional area was approximately 1,716,480 persons in 2000 (see Table 3-8) (USBC 2006a). The total population is expected to increase to approximately 1,751,600 by 2010 and to approximately 1,783,680 by 2020. Similar increases are anticipated in Erie County, where the total population was approximately 79,550 persons in 2000 and is expected to increase to approximately 81,180 by 2010 and to approximately 82,670 by 2020 (USBC 2000).

**Table 3-8. Population of the PBS Regional Area and Erie County for 2000, 2010, and 2020**

| Population | PBS Regional Area | | | Erie County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 1,537,283 | 1,538,533 | 1,534,859 | 70,514 | 70,571 | 70,403 |
| Black or African American | 94,718 | 104,151 | 113,982 | 6,876 | 7,571 | 8,274 |
| American Indian and Alaska Native | 3,970 | 4,508 | 5,040 | 164 | 186 | 208 |
| Asian | 16,951 | 22,498 | 27,610 | 298 | 396 | 485 |
| Native Hawaiian and Other Pacific Islander | 413 | 548 | 673 | 4 | 5 | 7 |
| Some other race | 33,727 | 38,332 | 43,161 | 420 | 477 | 537 |
| Two or more races | 29,416 | — | — | 1,275 | — | — |
| Hispanic or Latino (of any race) | 78,873 | 99,169 | 123,407 | 1,664 | 2,092 | 2,604 |
| **Total Population** | **1,716,478** | **1,751,604** | **1,783,680** | **79,551** | **81,179** | **82,666** |
| **Percent Minority** | **10.44** | **12.16** | **13.95** | **11.36** | **13.07** | **14.83** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

In 2000, minority race populations represented approximately 10 percent of the total population within the PBS regional area and approximately 11 percent of the total population within Erie County. The Black or African American population was the largest minority group living within the PBS regional area and Erie County in the year 2000. Between 2000 and 2020, minority race populations are expected to increase to 14 percent of the total population within the PBS regional area and approximately 15 percent of the total population within Erie County. The Black or African American population is estimated to remain the largest resident minority group within the PBS regional area and Erie County in 2020 (USBC 2000, USBC 2006a).

#### 3.1.6.7.2 Economy

Industrial sectors in the Lewis Field and PBS regional areas that provide significant employment include education, health, and social services; manufacturing; retail trade; and professional, scientific, management, administrative, and waste management services. An estimated

2,643,833 people were employed in the Lewis Field regional area in 2000 with an estimated unemployment rate of 5.0 percent. An estimated 1,326,232 people were employed in the PBS regional area in 2000 with an estimated unemployment rate of 4.6 percent. The national and Ohio unemployment rates during the same period were estimated at 5.8 and 5.0 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Ohio – 10.6 percent, Lewis Field regional area – 9.9 percent, PBS regional area – 9.1 percent, Cuyahoga County – 12.9 percent, and Erie County – 8.1 percent (USBC 2006a).

GRC at Lewis Field and PBS contribute significantly to the local, state, and national economies. In fiscal year 2003, GRC, as a whole, generated $1,288 million in spending throughout Ohio. Of this, $439 million resulted from direct spending and more than $849 million resulted from indirect and induced spending throughout the regional economy (GRC 2003). GRC employs approximately 3,110 civil servants and support contractors, of which 14 civil servants and 86 contractors support PBS. The vast majority of GRC's workforce lives in Cuyahoga County (GRC 2005).

#### 3.1.6.7.3 Transportation

Lewis Field has fully developed infrastructure, including road access and all utilities to support its occupational needs. The transportation network in the vicinity of Lewis Field consists of two major highways, Interstate 480 and Interstate 71. These are heavily traveled roads that are often congested during morning and afternoon rush hours. There are many secondary roads also serving the area. Most commuting to Lewis Field is by automobile. The Greater Cleveland Regional Transit Authority provides limited public transportation to Lewis Field. Lewis Field is adjacent to the Cleveland Hopkins International Airport, which provides national and international air service (GRC 2005).

PBS also has fully developed infrastructure, including road access and all utilities to support its occupational needs. PBS has a 101-km (62.5-mi) internal paved road system. There is also a railroad within PBS that is currently unused. Several state roads service the area, including Route 2, north of PBS, which is a major thoroughfare between Cleveland and Toledo, and Interstate 80 and 90 located just to the south. Traffic is moderate in the winter, but increases dramatically during the summer tourist months because of local area tourist attractions (GRC 2005).

#### 3.1.6.7.4 Public and Emergency Services

Emergency services for Lewis Field are provided by the Cleveland Port Authority and the adjacent communities of Brook Park and Fairview Park. Lewis Field also has an onsite medical facility where employees can be treated for acute injuries and illness or occupational injuries during normal working hours (GRC 2005).

Health, emergency, and fire services at PBS are provided by Perkins Township under an informal cooperative agreement. The nearest hospital is approximately 8 km (5 mi) away in Sandusky. Staff at the PBS Plant Protection Office are trained in emergency response procedures.

#### *3.1.6.8 Cultural Resources*

Facilities at Lewis Field that would be associated with the Constellation Program and are eligible for individual listing in the NRHP include the Instrument Research Laboratory (Building 77), and 10- by 10-ft Supersonic Wind Tunnel Office and Control Building (Building 86) (GRC 2006b, GRC 2006c). The Central Area at Lewis Field also is eligible for listing in the NRHP as a Historic District (GRC 2005).

The Spacecraft Propulsion Research Facility (B-2 Facility) (Building 3211) at PBS is a designated National Historic Landmark (DOI 2007a, DOI 2007b). The Space Power Facility (Building 1411) is facility that would be associated with the Constellation Program and is eligible for individual listing in the NRHP.

There are no known archeological resources associated with Constellation Program activities at Lewis Field or PBS.

#### *3.1.6.9 Hazardous Materials and Waste*

Lewis Field is classified as a large-quantity generator of hazardous waste and is managed under RCRA Subtitle C. Lewis Field generates solid and hazardous waste from its research and development operations, facilities maintenance, construction, aerospace testing, cleaning, maintenance, equipment cleaning and degreasing, and photographic processes. In 2002, Lewis Field generated 83,515 kg (184,170 lb) and 275 cubic meters ($m^3$) (9,712 cubic feet [$ft^3$]) of hazardous wastes. Such wastes are disposed of offsite at certified hazardous disposal facilities by a licensed contractor. Furthermore, all hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations (GRC 2005).

PBS is also classified as a large-quantity generator of hazardous waste due to high-volume wastes from past underground storage tank removals. Typical hazardous wastes from PBS consist of used solvents (chlorinated and nonchlorinated), oils, laboratory chemicals, fuels, lab packs, and waste from maintenance operations. Such wastes are disposed of offsite at certified hazardous disposal facilities by a licensed contractor. Furthermore, all hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations (GRC 2005).

Nonhazardous waste at Lewis Field and PBS is collected and hauled by a licensed contractor to offsite landfill/recycling facilities (GRC 2005).

### 3.1.7 Langley Research Center

NASA's LaRC provides leading research in airframe systems and atmospheric sciences. For the Constellation Program, LaRC would manage the Orion Launch Abort System development, the Orion landing system development and testing, and the Ares ascent development flight test vehicle integration.

#### *3.1.7.1 Land Resources*

LaRC is located on a coastal plain in the northeastern portion of the city of Hampton, Virginia, approximately 240 km (150 mi) south of Washington, DC and 80 km (50 mi) southeast of

Richmond, Virginia, and occupies 327 ha (808 ac) (LaRC 2005) (see Figure 3-15). LaRC is divided into two areas, the West Area (see Figure 3-16) and the East Area (see Figure 3-17), separated by the runway facilities of Langley Air Force Base (LAFB). The majority of NASA's facilities are located on the West Area, comprising approximately 319 ha (788 ac). The West Area is bounded by Brick Kiln Creek to the north, State Route 172 to the west, and LAFB to the south and east. The East Area is an additional 8-ha (20-ac) area situated on LAFB property. To the south and north of LaRC are the developed residential communities of Hampton and Poquoson, respectively (LaRC 2005).

Land use at LaRC consists primarily of administration and management office space, engineering and research laboratories, services and support facilities, industrial/fabrication and test areas, recreational and open areas, and roadway and parking areas. The Center houses more than 220 buildings, which are capable of supporting a wide array of activities, including simulating the space environment, developing and testing new materials and hardware, and performing aircraft aerodynamics and stability testing. LAFB dominates land use in the immediate vicinity of LaRC.

LaRC is located within the "coastal zone" as defined under the Virginia Department of Environmental Quality Virginia Coastal Zone Management Program. Under the Virginia Coastal Resources Management Program a network of state agencies and local governments administer enforceable laws, regulations, and policies in the following areas: tidal and nontidal wetlands, fisheries, subaqueous lands, dunes and beaches, point source air pollution, point source water pollution, nonpoint source water pollution, shoreline sanitation, and coastal lands. All Federal actions and programs that directly affect Virginia's coastal zone must be carried out in a manner that is consistent with the enforceable policies comprising Virginia's Coastal Resources Management Program. Virginia Department of Environmental Quality Office of Environmental Impact Review may review Federal projects for consistency with enforceable policies during the NEPA process. Not all of these enforceable programs are applicable to the Proposed Action.

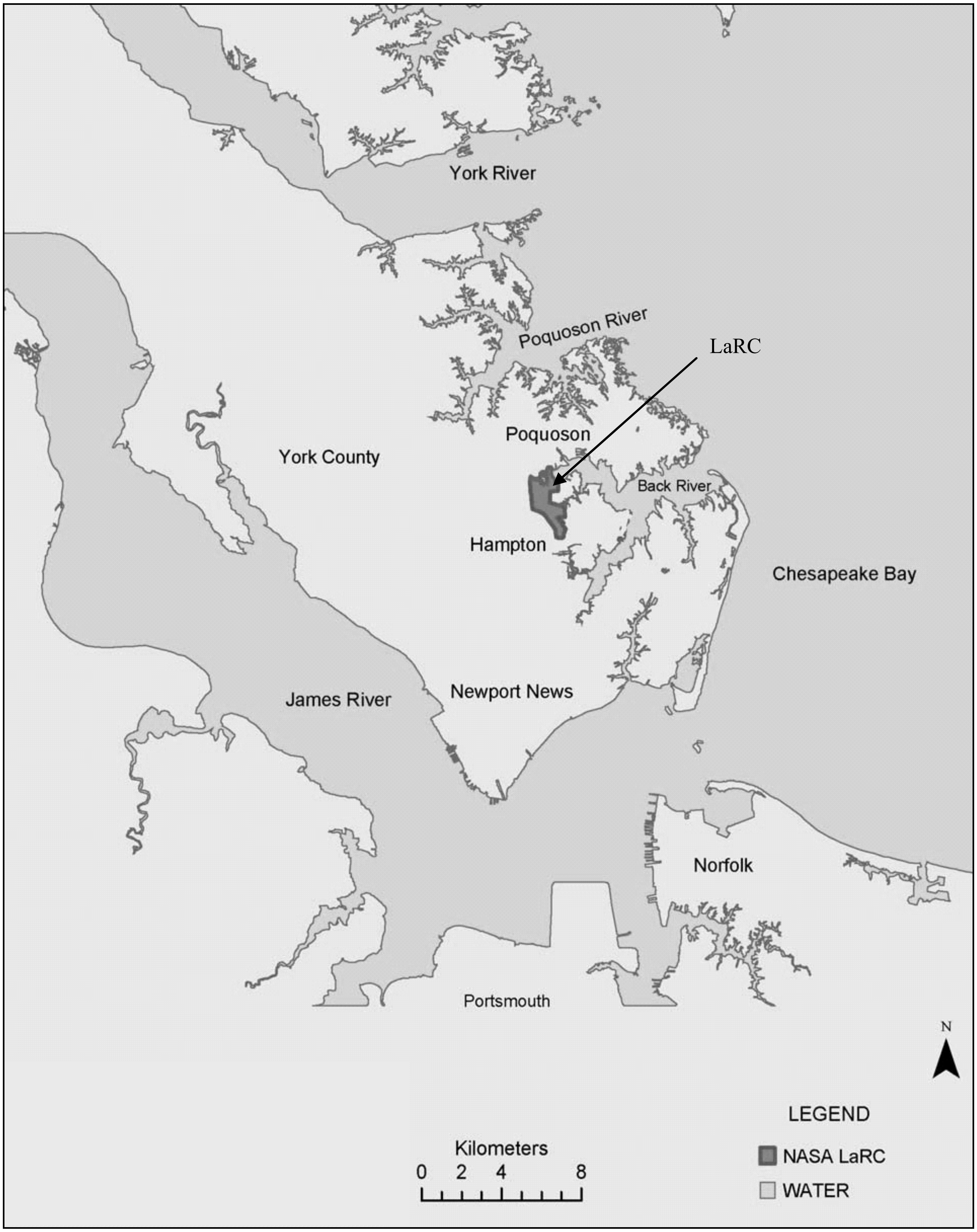
#### *3.1.7.2 Air Resources*

##### 3.1.7.2.1 Climate

The climate at LaRC can be classified as modified continental with generally mild winters and warm, humid summers. Annual temperatures range from 32 to 85°F (0 to 29°C) and average monthly precipitation ranges from less than 0.64 cm (0.25 in) to more than 36 cm (15 in). Winds are predominantly from the south to southwest (LaRC 2005).

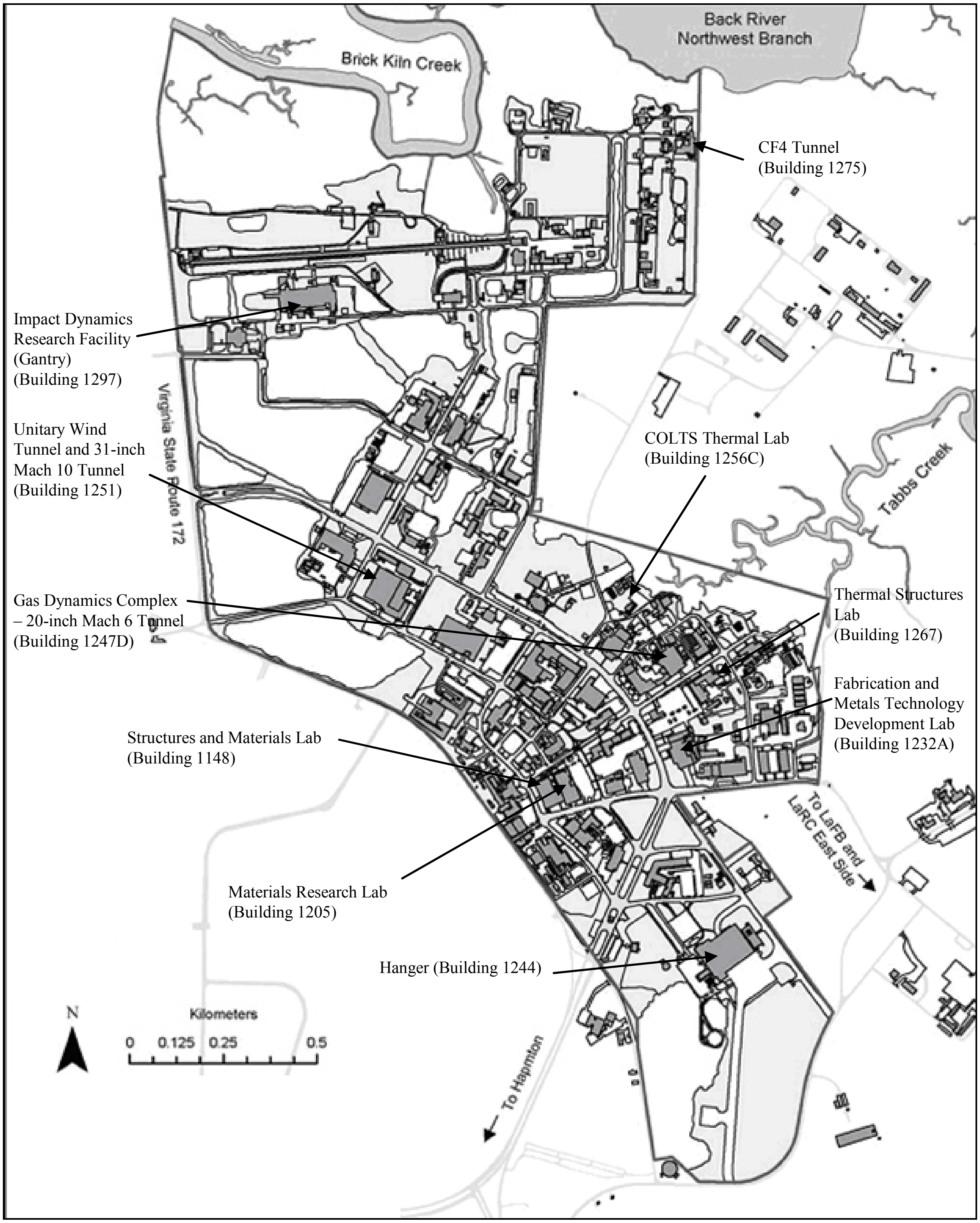
##### 3.1.7.2.2 Air Quality

Air quality at LaRC is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. The NAAQS for criteria pollutants have been adopted by the Commonwealth of Virginia (VDEQ 2004). LaRC is located within the Hampton Roads Intrastate Air Quality Control Region.




Source: LaRC 2005

**Figure 3-15. LaRC Location and Vicinity Map**




Source: LaRC 2005

**Figure 3-16. LaRC West Area Map**


Source: LaRC 2005

**Figure 3-17. LaRC East Area Map**

LaRC is not required to operate under a CAA Title V permit. LaRC qualifies as a synthetic minor source because its air emissions are limited below the prescribed thresholds by its state operating permit (ASF number 5165000006) (EPA 2007d). Air emission sources at LaRC include steam plant, various heating systems, burners, two underground gasoline storage tanks, spray booths, dust collectors, parts washers/degreasers, and miscellaneous testing facilities (*e.g.*, the 8-Foot High Temperature Tunnel and the Direct Connect Supersonic Test Facility) (LaRC 2005). Facility-wide emissions are significantly below the state permit threshold for criteria air pollutants, VOCs, and HAPs (LaRC 2005).

In the recent past, the Hampton Roads area had been designated as a marginal nonattainment area for the 8-hour ozone NAAQS (EPA 2007c). Based on an analysis of air quality monitoring data, source emission reduction information, and the existing Federal and state regulatory programs, on June 1, 2007, the EPA approved the redesignation request and the maintenance plan for the Hampton Roads area of Virginia (EPA 2007c).

### *3.1.7.3 Water Resources*

#### 3.1.7.3.1 Potable Water

LaRC receives its potable water supply from the Newport News Water Works. LaRC has water distribution facilities, but no water production or treatment facilities. In 2004, approximately 496 million l (131 million gal) of water was provided to LaRC's West Area. The primary use included cooling towers and steam production facilities (LaRC 2005).

#### 3.1.7.3.2 Surface Water

LaRC is located on the small coastal basin of the Back River, a tidal estuary of the Chesapeake Bay. The Brick Kiln Creek runs along the northern boundary of LaRC, joining the northwest branch of the Back River, and drains approximately 40 percent of the West Area at the Center. Tabbs Creek, which drains most of the rest of the West Area and part of LAFB, flows in a northerly direction to join the Back River near the confluence of its northwest and southwest branches. A small southern portion of the West Area drains to Tides Mill Creek. The East Area drains to the Back River. The local waterways are influenced by tides in the Chesapeake Bay (LaRC 2005).

The waters in the local streams are designated by the state as Class IIa, estuarine waters where shellfish can be found. None of the waterways within LaRC qualify for the provisions of the Wild and Scenic Rivers Act (LaRC 2005).

LaRC operates under three water discharge permits, two from the State of Virginia and one from the Hampton Roads Sanitation District. The Hampton Roads Sanitation District permit (number 0085) allows LaRC to discharge nonhazardous industrial wastewater and sanitary sewage to the Hampton Roads Sanitation District sanitary sewer system. A Virginia Pollutant Discharge Elimination System permit (number 0024741), issued by the Virginia Department of Environmental Quality, authorizes LaRC to discharge to surface waters in accordance with the effluent limitations and monitoring requirements set forth in the permit. LaRC is allowed to discharge effluent from its operations to the surface waters of Virginia at nine outfall locations.

Three other locations contain only stormwater runoff rather than process water, and no monitoring is required. The other permit (number VAR040092), issued by the Virginia Department of Conservation and Recreation, is a general permit for Small Municipal Separate Storm Sewer Systems. This permit requires that LaRC develop, implement, and enforce a stormwater management program to reduce the discharge of pollutants from the Center to the maximum extent practicable (LaRC 2005).

The southwest branch of the Back River, near LAFB, is identified on the state's list of impaired waters due to high levels of fecal coliform. The watershed potentially receives inputs from residential sewage treatment systems, wetlands areas, and stormwater runoff associated with the surrounding residential and urban area. The specific source of the bacteria causing the fecal coliform bacteria standard violations is currently unknown. Overall, water pollution sources at LaRC are limited due to the relatively low level of industrial operations at LaRC. However, sampling studies conducted in the 1980s showed PCB and polychlorinated terphenyl (PCT) contamination in the sediments of Tabbs Creek and in the storm sewer lines connected to a LaRC outfall (LaRC 2005). LaRC subsequently was jointly listed with LAFB on the CERCLA National Priorities List in 1994. Clean-up of the PCB and PCT contamination was completed at LaRC by 2000 (EPA 2006c).

Nearly one-third of the West Area of LaRC is within the 100- and 500-year floodplains and approximately 8.1 ha (20 ac) of jurisdictional wetlands have been identified in the West Area of LaRC (LaRC 2005).

3.1.7.3.3 Groundwater

Groundwater near LaRC is present primarily in thick sequences of porous and permeable strata. These strata form regional aquifers, and less permeable strata form confining units between aquifers. The groundwater is recharged principally by infiltration of precipitation and percolation to the water table. Most of the unconfined groundwater flows relatively short distances and discharges to nearby streams, but a small amount flows downward to recharge the deeper, confined aquifers. Groundwater movement at LaRC is tidally influenced at locations near Brick Kiln Creek and Tabbs Creek (LaRC 2005).

Groundwater near LaRC is often brackish because of the Chesapeake Bay's close proximity and marine deposits found in the soil. Since 1995, samples collected from monitoring wells at LaRC have not shown contamination of the groundwater (LaRC 2005).

### *3.1.7.4 Ambient Noise*

Primary noise sources at LaRC include the wind tunnels, compressor stations, and substations. Most of the wind tunnels are closed-loop tunnels and the noise generated is contained largely within the building. In addition, many of the laboratories and shops have equipment that produces high interior noise levels within the buildings (LaRC 2005).

Although the military aircraft operating from LAFB are by far the dominant and most widespread noise source in the area, several LaRC facilities located close to the property line produce noise levels higher than ambient levels outside the property line. At times, some of the large, closed-circuit wind tunnels that have large electrical power requirements operate during extended, off-peak hours at night. The major noise sources at LaRC include the Jet Exit Test Facility (Building 1234), National Transonic Facility (Building 1236), 8-Foot High Temperature Tunnel (Building 1265A-E), Landing Loads Compressor and Control Building (Building 1258), 14 × 22-Foot Subsonic Tunnel (Building 1241), and the Transonic Dynamics Tunnel (Building 648). The 8-Foot High Temperature Tunnel is considered to be the loudest of these sources, reaching 112 dB at the end of East Reid Street (near the tunnel exhaust end) during a tunnel run. Runs typically last 2 or 3 minutes and occur once a day, several days a week. In addition, several wind tunnel operations at LaRC, such as the 8-Foot High Temperature Tunnel, produce noticeable vibrations outside the LaRC property. However, due largely to the lack of major residential development in the immediate vicinity of LaRC, there have not been significant complaints regarding noise or vibrations from LaRC operations (LaRC 2005).

The Transonic Dynamics Tunnel, which would be used to support the Constellation Program, has a maximum operating noise level of 47 dBA in the community adjacent to LaRC (LaRC 2005).

### *3.1.7.5 Geology and Soils*

#### 3.1.7.5.1 Geology

LaRC is located on the Virginia Coastal Plain, characterized by flat land cut by rivers, creeks, and streams. The Coastal Plain is underlain by layers of Cretaceous and younger clay, sand, and gravel that dip gently eastward. Fossilized marine layers are mixed with the Cretaceous clays and miscellaneous beach, estuarine, and fluvial deposits. The youngest deposits of the Coastal Plain are sand, silt, and mud (VDMR 2001). LaRC is located in an area designated as Seismic Risk Zone 1, which is an area with minor damage expected (LaRC 2005).

#### 3.1.7.5.2 Soils

The soils at LaRC range in texture from clay and silt to fine gravel, with most of the soils being fine to medium sandy loam. These soils are considered to be poorly drained to moderately well-drained. The surface is a deposited loam from 0.6 to 1.8 m (2 to 6 ft) in depth (LaRC 2005).

Previous activities at LaRC have resulted in areas of soil contamination along Tabbs Creek (*e.g.*, PCBs and PCTs), which are managed under CERCLA (EPA 2006c) (see Section 3.1.7.3 for more details). In addition, an old construction debris landfill, located at the north edge of LaRC near Brick Kiln Creek, has been placed on the CERCLA National Priorities List.

### *3.1.7.6 Biological Resources*

The predominant ecological feature of the LaRC region is the Chesapeake Bay. With its extensive open-water areas and associated tidal flats, creeks, and marshes, the Chesapeake Bay is a major migratory flyway and provides important waterfowl nesting and wintering habitat. Two designated preservation areas are located in the vicinity of LaRC, including the Plum Tree Island National Wildlife Refuge in the city of Poquoson and the North End Point Natural Preserve in the city of Hampton. There are no designated conservation areas on LaRC property (LaRC 2005).

LaRC supports a wide-array of terrestrial and aquatic resources. These resources provide a broad range of natural habitat for hundreds of species of flora and fauna. The predominant types of plant communities within LaRC include mixed deciduous/pine forest, disturbed forest, pine plantation, open field, disturbed deciduous forest with brackish influence, brackish tidal marshes, brackish ponds with occasional tidal influence, palustrine freshwater ponds, and brackish and freshwater ditch systems. Aquatic fauna include fish, crustaceans, and mollusks, as well as some amphibian and reptile species. Terrestrial fauna include a large variety of mammals and birds, and several species of amphibians and reptiles (LaRC 2005).

No state or federally threatened or endangered plant, mammal, or fish species have been identified at LaRC. Three reptile and amphibian species listed as endangered or threatened have been observed in the area, but not identified at LaRC. The canebrake rattlesnake (*Crotalus horridus atricaudatus*) is listed by the state as an endangered species, the Eastern glass lizard (*Ophisaurus ventralis*) is state-listed as a threatened species, and the Kemp's Ridley sea turtle (*Lepidochelys kempii*) is on the Federal and state endangered lists. Four state and federally protected, endangered, or threatened bird species also have been identified, including the brown pelican (*Pelicanus occidentalis*), least tern (*Sterna antillarum*), bald eagle (*Haliaeetus leucocephalus*), and piping plover (*Charadrius melodus*). Five additional bird species are listed as endangered or threatened by the Commonwealth of Virginia, including the Henslow's sparrow (*Ammodramus henslowii*), Wilson's plover (*Charadrius wilsonia*), gull-billed tern (*Sterna nilotica*), loggerhead shrike (*Lanius ludovicianus*), and peregrine falcon (*Falco peregrinus*). The Henslow's sparrow is a Federal species of concern (LaRC 2005).

#### *3.1.7.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the LaRC regional area. The LaRC regional area is defined here as the land area within an 80.5-km (50-mi) radius of LaRC, which includes portions of the Norfolk-Virginia Beach-Newport News, Virginia-North Carolina Metropolitan Statistical Area (MSA) known as Hampton Roads. The regional area includes the cities of Hampton, Poquoson, Newport News, and Williamsburg; and James City County and York County in Virginia (USBC 2006a).

##### 3.1.7.7.1 Population

The total population within the LaRC regional area was approximately 1,680,980 persons in 2000 (see Table 3-9) (USBC 2006a). The total population is expected to increase to approximately 1,847,160 by 2010 and to approximately 2,005,170 by 2020. Similar increases are anticipated in the city of Hampton, where the total population was approximately 146,440 persons in 2000 and is expected to increase to approximately 160,910 by 2010 and to approximately 174,680 by 2020 (USBC 2000).

In 2000, minority race populations represented approximately 38 percent of the total population within the LaRC regional area and approximately 50 percent of the total population within the city of Hampton. The Black or African American population was the largest minority group living within the regional area and the city of Hampton in the year 2000. Between 2000 and 2020, minority race populations are expected to increase to 43 percent of the total population within the LaRC regional area and approximately 54 percent of the total population within the city of Hampton. The Black or African American population is estimated to remain the largest resident minority group within the LaRC regional area and the city of Hampton in 2020 (USBC 2000, USBC 2006a).

**Table 3-9. Population of the LaRC Regional Area and the City of Hampton for 2000, 2010, and 2020**

| Population | LaRC Regional Area | | | City of Hampton | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 1,045,141 | 1,103,827 | 1,152,707 | 72,556 | 76,630 | 80,024 |
| Black or African American | 528,894 | 610,382 | 694,046 | 65,428 | 75,509 | 85,858 |
| American Indian and Alaska Native | 7,178 | 7,546 | 8,481 | 616 | 648 | 728 |
| Asian | 43,403 | 59,524 | 75,805 | 2,694 | 3,695 | 4,705 |
| Native Hawaiian and Other Pacific Islander | 1,349 | 1,850 | 2,356 | 136 | 187 | 238 |
| Some other race | 19,257 | 23,370 | 27,624 | 1,505 | 1,826 | 2,159 |
| Two or more races | 35,759 | — | — | 3,502 | — | — |
| Hispanic or Latino (of any race) | 50,648 | 69,979 | 90,454 | 4,153 | 5,738 | 7,417 |
| **Total Population** | **1,680,981** | **1,847,159** | **2,005,174** | **146,437** | **160,913** | **174,679** |
| **Percent Minority** | **37.83** | **40.24** | **42.51** | **50.45** | **52.38** | **54.19** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

### 3.1.7.7.2 Economy

Industrial sectors in the LaRC regional area that provide significant employment include education, health, and social services; retail trade; manufacturing; and professional, scientific, management, administrative, and waste management services. An estimated 1,290,227 people were employed in the LaRC regional area in 2000 with an estimated unemployment rate of 5.6 percent. The national and Virginia unemployment rates during the same period were estimated at 5.8 and 4.2 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Virginia – 9.6 percent, LaRC regional area – 10.4 percent, and the city of Hampton – 10.3 percent (USBC 2006a).

LaRC contributes significantly to the local, state, and national economies. In 2004, LaRC contributed $194 million to the Hampton Roads economy, $252 million to the economy of the Commonwealth of Virginia, and $505 million to the national economy. The total direct and indirect impact in fiscal year 2004 was more than $2.61 billion (LaRC 2006). In 2006, LaRC's budget was $702 million and LaRC employed 1,960 civil servants and 1,500 support contractors. The vast majority of LaRC's workforce lives in the Yorktown area, Hampton, Newport News, Poquoson, and the Williamsburg area (LaRC 2006).

3.1.7.7.3 Transportation

LaRC has fully developed infrastructure, including road access and all utilities to support its occupational needs. The region is supported by a network of Federal, state, and county roads; cargo and passenger rail service; two major airports; and a seaport with cargo and cruise terminals (LaRC 2005).

3.1.7.7.4 Public and Emergency Services

NASA has contracted a private company to provide 24-hour police protection. Additional law enforcement is provided by the city of Hampton. Fire protection service is provided by the LaRC fire department and the city of Hampton fire department. The surrounding communities support four general hospitals, two specialty hospitals, and three military hospitals. In addition, a health clinic for LaRC staff and other personnel is available at LaRC.

#### *3.1.7.8 Cultural Resources*

The Lunar Landing Research Facility/Impact Dynamics Research Facility (Gantry) (Building 1297) is designated as a National Historic Landmark (DOI 2007a, DOI 2007b). The historic status of additional facilities that would be used by the Constellation Program will be determined after the on-going eligibility surveys have been completed.

There are no known archeological resources associated with Constellation Program activities.

#### *3.1.7.9 Hazardous Materials and Waste*

LaRC uses hazardous materials for various research activities, which in turn generate hazardous wastes. LaRC is classified as a large-quantity generator of hazardous waste and is managed under RCRA Subtitle C. In 2004, LaRC generated 9,226 kg (20,339 lb) of hazardous wastes and 6,792 kg (14,974 lb) of regulated waste. Such wastes are disposed of offsite at certified hazardous disposal facilities by a licensed contractor. All hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations and the LaRC Waste Management Program (LaRC 2005).

LaRC was jointly listed with LAFB on the CERCLA National Priorities List in 1994 (EPA 2006c). Brick Creek Kiln has been listed as a CERCLA site and is being studied for remediation (see Section 3.1.7.3 for more details on remediation activities).

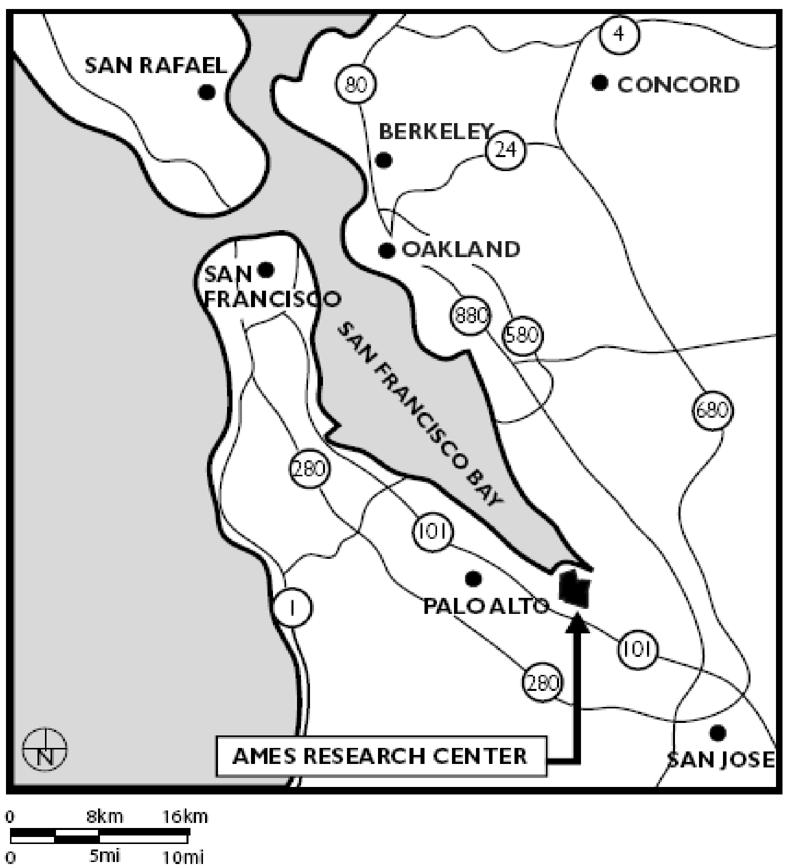
Nonhazardous/municipal solid wastes are collected and hauled by a contractor to EPA-approved offsite disposal facilities. LaRC has no active landfills (LaRC 2005).

### 3.1.8 Ames Research Center

NASA's ARC primarily engages in the areas of information technology, nanotechnology, fundamental space biology, biotechnology, aerospace and thermal protection systems, and human factors research. For the Constellation Program, ARC would lead Orion Thermal Protection System development.

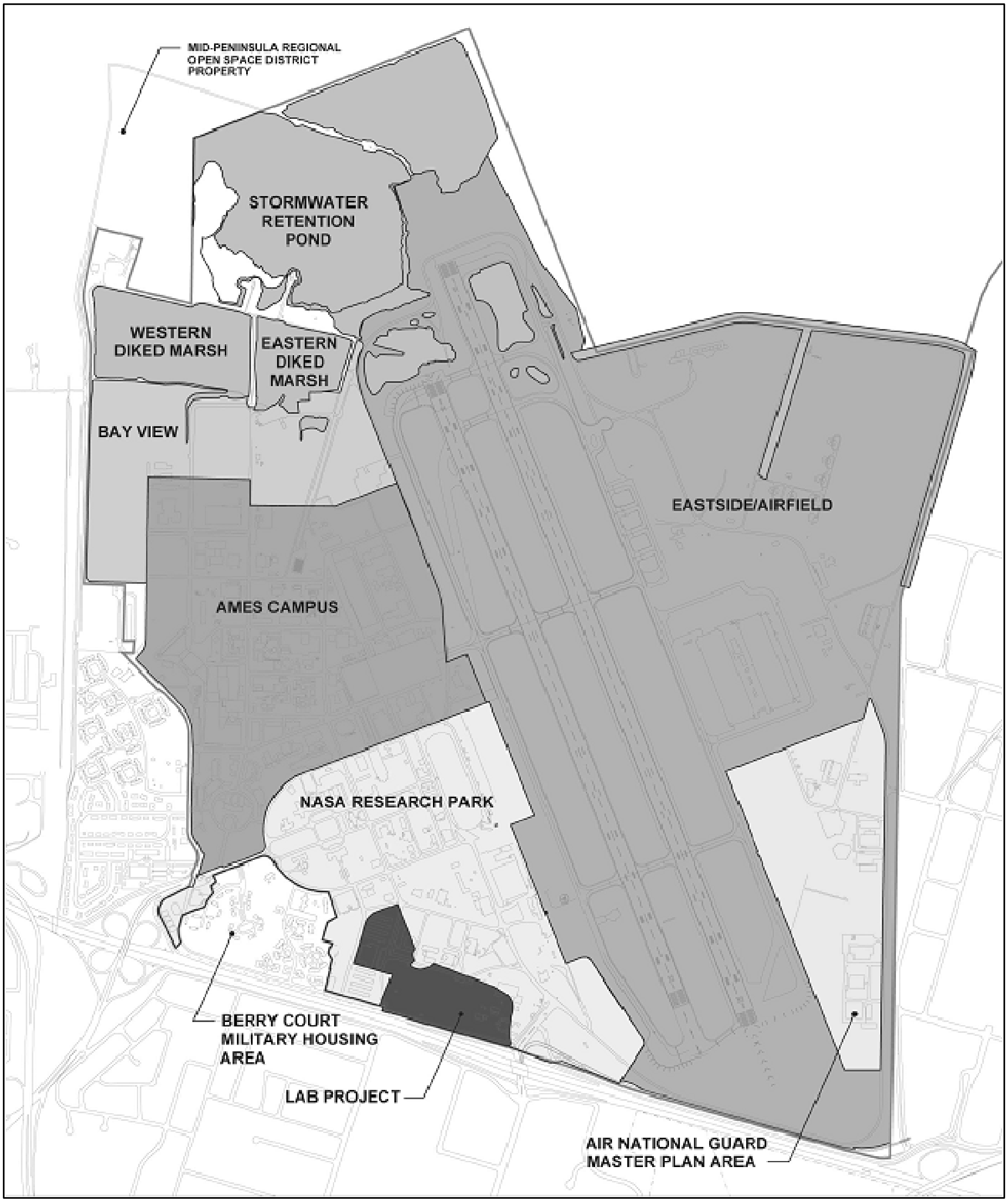
#### *3.1.8.1 Land Resources*

ARC encompasses approximately 800 ha (2,000 ac) in the northern portion of Santa Clara County, California, approximately 56 km (35 mi) south of San Francisco and 16 km (10 mi) north of San Jose (see Figure 3-18). ARC adjoins public access and wildlife protected areas, commercial and industrial sites, and residential areas of the cities of Mountain View and Sunnyvale. Land use at ARC is classified as industrial and is composed of the Ames Research Campus, the NASA Research Park, an airfield and support facilities, barracks, support facilities (active and inactive) for military personnel, and open space (see Figure 3-19) (ARC 2005).




Source: ARC 2002a

**Figure 3-18. ARC Location and Vicinity Map**




Source: ARC 2002a

**Figure 3-19. ARC Land Use Map**

NASA supports a wide-array of facilities at ARC, including wind tunnels, motion-based flight simulators, atmosphere-entry heat simulators, advanced digital computation systems, and free flight ballistic test facilities. In addition, there are a range of well-equipped ground-based and airborne laboratories that are dedicated to the study of solar and geophysical phenomena, life synthesis, life detection, and life environmental factors. ARC also has a number of support buildings, including aircraft hangers, machine shops, warehouses, a cafeteria, a post office, and numerous office buildings (ARC 2005).

In August 2002, NASA published the *Final Programmatic Environmental Impact Statement for the NASA Ames Development Plan* (67 *FR* 161). The NASA Ames Development Plan (NADP) provides for a collaborative effort among NASA, universities, and businesses to develop educational, office, research and development, museum, conference center, housing, and retail space in the Research Park area, as well as new development (primarily housing) in the Bay View area. The NADP also includes new high-density office and research and development space on the Ames Campus. It is estimated that implementation of planned development and activities under the NADP will add 7,088 new private-sector employees, approximately 3,000 students, and house 4,909 residents in 1,930 housing units within the ARC (ARC 2002b).

### *3.1.8.2 Air Resources*

#### 3.1.8.2.1 Climate

The climate at ARC is characterized by warm, dry summers and cool, wet winters with average annual temperatures ranging from 42 to 75°F (6 to 25°C). The average annual rainfall is approximately 35 cm (13.5 in). Wind prevails generally from the north-northwest during daytime hours and from the south in the evening and during colder months (ARC 2005).

#### 3.1.8.2.2 Air Quality

Air quality at ARC is regulated through the NAAQS promulgated under the CAA, as well as the California Ambient Air Quality Standards. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. Air quality in California is controlled on a regional basis with factors such as climate, meteorology, topography, vegetation, land use, population, and growth projections considered when setting air quality control regions. An air quality control region may include whole or parts of counties. ARC is in the Bay Area Air Quality Management District, which includes nine whole and partial counties of the San Francisco Bay Area, including Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, southwestern Solano, and southern Sonoma Counties.

ARC is not required to operate under a CAA Title V permit. ARC qualifies as a synthetic minor source because its air emissions are limited below the prescribed thresholds by its state operating permit. Sources of air emissions, other than mobile sources such as automobiles and construction equipment, include boilers, internal combustion engines, solvent cleaning, aircraft engine testing, laser seeding operations, coating activities, oil/water separation, and tub grinding. The largest sources of emissions at ARC are vehicular traffic and aircraft operations. ARC has an operating permit from the Bay Area Air Quality Management District (BAAQMD 2005).

The Bay area is classified as a nonattainment area for the state ozone, $PM_{10}$ and $PM_{2.5}$ air quality standards (CARB 2007). Furthermore, the Bay area has been designated as a marginal nonattainment area for the 8-hour ozone NAAQS. The Bay area also is classified as a maintenance area for carbon monoxide (CO) (EPA 2007c).

### *3.1.8.3 Water Resources*

#### 3.1.8.3.1 Potable Water

ARC receives its potable water and fire protection water supply from the San Francisco Water Department. The annual water demand in 2005 was approximately 901 megaliters (238 million gal) (ARC 2005).

#### 3.1.8.3.2 Surface Water

There are three major surface water bodies in the vicinity of ARC. The San Francisco Bay is located approximately 1.6 km (1 mi) north of ARC, Stevens Creek forms the western boundary of ARC, and the Guadalupe Slough is located approximately 3.2 km (2 mi) northeast of ARC. The northeastern portion of ARC is classified as a wetland area, composed primarily of a stormwater retention pond and dike marshes (ARC 2005).

ARC is in the Stevens Creek watershed, a tributary to South San Francisco Bay, but historical surface water drainage patterns at the site have been modified substantially to manage runoff from impervious surfaces. Stormwater from the west side of the site is impounded at the north end of ARC, with excess peak runoff occasionally pumped into Stevens Creek. Stormwater from the east side of the campus discharges to the Moffett Channel, then to Guadalupe Slough, and ultimately into the Bay. Surface water flowing adjacent to ARC reflects water quality typical of urban or developed streams, where various types of point- and nonpoint-source pollutants affect water quality (ARC 2005).

Domestic wastewater at ARC is discharged to a sanitary sewer system and transported to an offsite treatment facility. An onsite industrial wastewater treatment facility is used to remove metals and dissolved solids from industrial wastewater and treated groundwater (ARC 2005).

The northern portion of ARC is within the 100- and 500-year tidal floodplains. The limit of 500-year tidal flooding at ARC is not significantly different from the 100-year limit because the elevation difference between the 100-year high tide and 500-year high tide is only approximately 0.08 m (0.25 ft). At present, however, the levees around the retention ponds and Stevens Creek protect ARC from tidal flooding (ARC 2005).

#### 3.1.8.3.3 Groundwater

ARC is within the Santa Clara Valley groundwater basin, the largest groundwater basin adjoining the San Francisco Bay. Historically, groundwater was a major source of municipal, industrial, and agricultural water for Santa Clara County. Today, groundwater provides only approximately 50 percent of the county's total water supply. Although there are several aquifers present in the subsurface at ARC, they are no longer used for domestic, municipal, or industrial water supply (ARC 2005).

Groundwater beneath ARC has been substantially affected by the Middlefield-Ellis-Whisman Superfund site in neighboring Mountain View, and by chemical spills and releases associated with U.S. Navy and NASA operations. The Moffett Naval Air Station, which transferred to NASA in 1994, was placed on the CERCLA National Priorities List in 1987. The main groundwater contaminants include TCE, perchloroethylene, 1,1,1-trichloroethane, cis- and trans-1,2-dichloroethene, 1,1-dichloroethane, 1,1-dichloroethene, dichlorobenzene, chloroform, Freon® 113, phenol, and vinyl chloride. Remediation efforts are ongoing (ARC 2005).

#### *3.1.8.4 Ambient Noise*

Noise generated by wind tunnels and aircraft operations at ARC and Moffett Field has historically been a source of complaints from the surrounding residents. Among NASA's wind tunnels, the primary noise generators include the 40- by 80-ft Wind Tunnel, the 80- by 120-ft Wind Tunnel, the Unitary Plan Wind Tunnels, and the 12-ft Pressure Wind Tunnel. In addition to the wind tunnels, the Outdoor Aerodynamic Research Facility, the Arc Jet Complex, and the airfield operations have been known to generate noise that affects the surrounding communities. None of these noise sources are considered to be constant noise generators. The most notable source of ambient noise in the area is traffic on local highways (ARC 2005).

#### *3.1.8.5 Geology and Soils*

##### 3.1.8.5.1 Geology

The ARC site is located on nearly flat topography at the north end of the Santa Clara Valley with elevations ranging from approximately 0.6 m (2 ft) below mean sea level near its northern boundary to approximately 10 m (33 ft) above mean sea level in the south end. The principal topographic features on the site are low levees constructed to protect roads and structures from Bay waters during high storm tides. Bedrock at the site is overlain by 460 m (1,495 ft) or more of alluvium and bay muds. ARC is located in one of the most seismically active regions of the U.S. Although the hazard of surface fault rupture at the site is probably low, the site could be subject to strong groundshaking as a result of an earthquake on any of the region's major faults, and could also experience liquefaction (ARC 2005).

##### 3.1.8.5.2 Soils

The soils at ARC have been altered substantially by land uses during the past 100 years. The majority of the site's upland areas and portions of its wetlands now support artificial fill and/or impervious cover overlying native soils. Native soil typically is exposed only in the diked brackish marshes and open grasslands on the northwest portion of the site, and even in these areas some alterations related to land use constraints have occurred. Most of the soil at ARC is considered silty clay, which is characterized by its dark gray color, fine texture, poor drainage, moderate alkalinity, and high fertility (ARC 2005).

Previous activities at ARC have resulted in areas of soil contamination (*e.g.*, polyaromatic hydrocarbons, metals, PCBs, pesticides, and chlorinated solvents) which are managed under CERCLA (ARC 2005) (see Section 3.1.8.3 for more details).

#### *3.1.8.6 Biological Resources*

Nearly all of the existing habitat areas at ARC have been extensively disturbed by development, resulting in limited natural habitat. The primary habitat types at ARC include weed-dominated areas, disturbed areas, and urban landscaped areas. The northwestern portion of ARC contains the most diverse and least disturbed habitats, including coastal and seasonal salt marshes, freshwater and brackish marshes, coyote brush scrub, and unvegetated areas (including open water). Much of this area has been excluded from future development because of the presence of jurisdictional wetlands (ARC 2005).

Wildlife at ARC largely consists of birds from the nearby bay front and open water habitats, migratory birds, and several resident species of birds and small mammals (ARC 2005).

No special-status plants are known to occur in the ARC area. In addition, no designated critical habitat areas are within or near ARC. Approximately 14 state and federally endangered or threatened animal species are known to frequent ARC. However, only one special-status animal, the western burrowing owl (*Athene cunicularia hypugea*) (listed as a California Species of Concern), is known or expected to occur within the developed areas that make up the NASA Research Park and Ames Research Campus (ARC 2005).

#### *3.1.8.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the ARC regional area. The ARC regional area is defined here as the land area within an 80.5-km (50-mi) radius of ARC, which includes Alameda, Contra Costa, San Francisco, San Mateo, Santa Clara, Santa Cruz, and portions of Marin, Monterey, Sacramento, San Benito, San Joaquin, Solano, and Stanislaus Counties (USBC 2006a).

##### 3.1.8.7.1 Population

The total population within the ARC regional area was approximately 6,222,130 persons in 2000 (see Table 3-10) (USBC 2006a). The total population is expected to increase to approximately 7,483,430 by 2010 and to approximately 8,500,590 by 2020. Similar increases are anticipated in Santa Clara County where the total population was approximately 1,682,585 persons in 2000 and is expected to increase to approximately 2,023,670 by 2010 and to approximately 2,298,725 by 2020 (USBC 2000).

In 2000, minority race populations represented approximately 44 percent of the total population within the ARC regional area and approximately 46 percent of the total population within Santa Clara County. The Hispanic or Latino (of any race) and Asian populations were the largest minority groups living within the ARC regional area and Santa Clara in 2000. Between 2000 and 2020, minority race populations are expected to increase to approximately 46 percent of the total population within the ARC regional area and approximately 48 percent of the total population within Santa Clara County. The Asian population is estimated to be the largest resident minority group within the ARC regional area and Santa Clara County in 2020 (USBC 2000, USBC 2006a).

**Table 3-10. Population of the ARC Regional Area and Santa Clara County for 2000, 2010, and 2020**

| Population | ARC Regional Area | | | Santa Clara County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 3,509,759 | 3,957,201 | 4,629,831 | 905,660 | 1,021,118 | 1,194,684 |
| Black or African American | 469,769 | 525,717 | 614,076 | 47,182 | 52,801 | 61,676 |
| American Indian and Alaska Native | 38,171 | 41,592 | 47,925 | 11,350 | 12,367 | 14,250 |
| Asian | 1,253,682 | 1,733,353 | 2,323,772 | 430,095 | 594,654 | 797,206 |
| Native Hawaiian and Other Pacific Islander | 33,643 | 46,515 | 62,359 | 5,773 | 7,982 | 10,701 |
| Some other race | 609,198 | 798,935 | 1,040,567 | 204,088 | 267,652 | 348,601 |
| Two or more races | 307,904 | — | — | 78,437 | — | — |
| Hispanic or Latino (of any race) | 1,257,333 | 1,675,627 | 2,204,378 | 403,401 | 537,606 | 707,250 |
| **Total Population** | **6,222,126** | **7,483,431** | **8,500,586** | **1,682,585** | **2,023,667** | **2,298,725** |
| **Percent Minority** | **43.6** | **47.1** | **45.5** | **46.2** | **49.5** | **48.0** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

#### 3.1.8.7.2 Economy

Industrial sectors in the ARC regional area that provide significant employment include education, health, and social services; professional, scientific, management, administrative, and waste management services; manufacturing; and retail trade. An estimated 4,915,902 people were employed in the ARC regional area in 2000 with an estimated unemployment rate of 4.6 percent. The national and California unemployment rates during the same period were estimated at 5.8 and 7.0 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, California – 14.2 percent, ARC regional area – 8.7 percent, and Santa Clara County – 7.4 percent (USBC 2006a).

The ARC regional area is a major center for high-technology development with one of the strongest economies in the U.S. ARC contributes significantly to this economy with an annual budget of approximately $775 million and a combined workforce of approximately 6,037 civil servants and support contractors (ARC 2005, ARC 2006). NASA supports roughly 66 percent of ARC's workforce, with a payroll of approximately $315 million (ARC 2005).

3.1.8.7.3 Transportation

ARC has fully developed infrastructure, including road access and all utilities to support its occupational needs. Transportation to and from ARC is predominantly by private automobile. There are currently no capacity issues on internal roads. However, U.S. Highway 101, located adjacent to the southern boundary of the facility, provides primary transportation access to the facility and is subject to high levels of congestion during morning and afternoon rush hours (ARC 2005) (see Figure 3-18). Public transportation to ARC is available via bus and light rail service from the surrounding areas. Commuter bicycle lanes are also available (ARC 2005).

3.1.8.7.4 Public and Emergency Services

NASA contracts a private company to provide 24-hour police protection. Fire protection service at ARC is provided through an agreement with the California Air National Guard. The Moffett Field fire department is also available to provide fire protection services in an emergency. In addition, ARC has a cooperative response agreement with all the city fire departments in Santa Clara County. A health unit for ARC staff and other personnel is available at ARC. Medical emergencies also can be handled by the Moffett Field fire department. In addition, the Santa Clara County paramedics can be called, if necessary (ARC 2005).

### *3.1.8.8 Cultural Resources*

The Unitary Plan Wind Tunnel Complex (Building N227), which includes the 11-ft Transonic Tunnel (Building N227A), is a designated National Historic Landmark (DOI 2007a, DOI 2007b). The Arc Jet Laboratory (Building N238) is a facility that would be associated with the Constellation Program and is eligible for individual listing in the NRHP (ARC 2005).

There are no known archeological resources associated with Constellation Program activities.

### *3.1.8.9 Hazardous Materials and Waste*

NASA, along with other resident agencies at ARC, uses a wide variety of hazardous materials for research and operations, resulting in generation of hazardous and nonhazardous wastes. ARC is classified as a large-quantity generator of hazardous waste and is managed under RCRA Subtitle C (ARC 2005). In 2006, ARC generated 764 mt (842 tons) of hazardous wastes. Such waste is managed in accordance with applicable Federal, state, and local rules and regulations and the ARC plan for managing hazardous materials and waste.

NASA has received informal action notices of RCRA permit violations over the past 2 years. An informal notice is an action by EPA or an authorized state that notifies the facility of a violation. This differs from formal action where significant noncompliance is detected, or the facility does not respond to an informal enforcement action (EPA 2006b). In addition, NASA has reported releases of dichlorodifluoromethane, Freon® 113, and xylene at ARC under the EPCRA Toxic Release Inventory Program.

Nonhazardous wastes are collected and transported by a contractor to EPA-approved offsite disposal facilities. ARC has no active landfills (ARC 2005).

### 3.1.9 White Sands Missile Range/Johnson Space Center White Sands Test Facility

WSMR is a multi-service facility managed by the U.S. Department of the Army to support research, development, testing, and evaluation of weapons and space systems. WSMR provides a variety of services to the Army, Navy, Air Force, NASA, and the Defense Nuclear Agency, and to other governmental agencies, approved commercial firms, and foreign governments. NASA's WSTF operates under JSC as a field test installation within the boundaries of WSMR with the primary purpose of providing test services to NASA for the U.S. Space Program. For the Constellation Program, WSMR would perform Orion abort flight test ground operations, launch pad abort testing, and flight ascent abort testing. During vehicle development and testing, WSTF would perform ground servicing and operational checkout of the Orion Launch Abort System flight tests. These tests would be coordinated with WSMR Range Safety. WSTF also would perform Ares Upper Stage hot fire engine verification testing of the Reaction Control System and Thrust Vector Control subsystems.

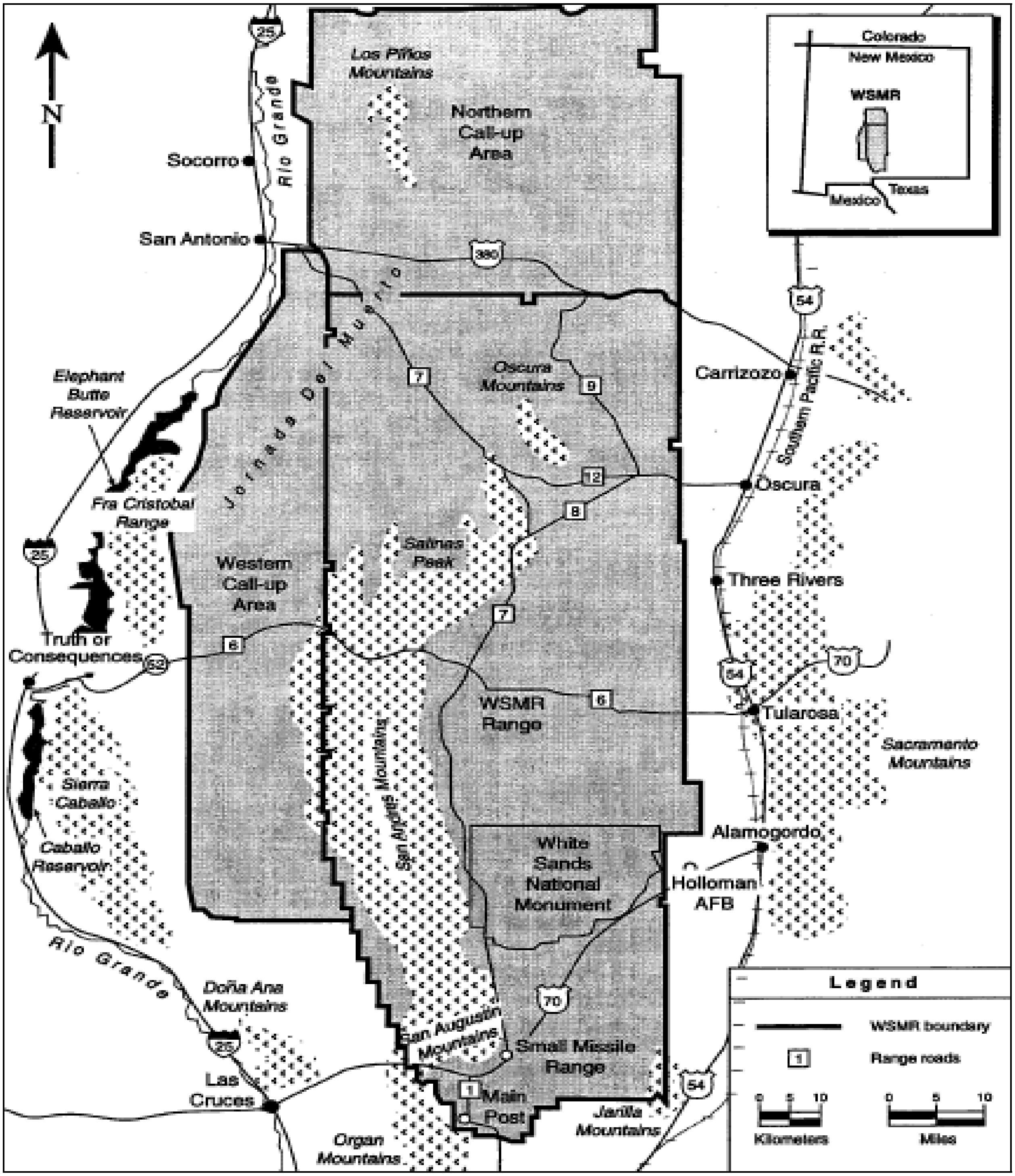
#### *3.1.9.1 Land Resources*

WSMR encompasses approximately 1.5 million ha (3.8 million ac) within the Tularosa Basin of south-central New Mexico (see Figure 3-20). The Main Post area, which serves as the center of operations for most organizations and tenants at WSMR, is located in the southern portion of WSMR approximately 32 km (20 mi) east of Las Cruces, New Mexico, and 72 km (45 mi) north of El Paso, Texas. WSMR extends into parts of five New Mexico counties and spreads almost 161 km (100 mi) north to south by 64 km (40 mi) east to west. WSMR is the Nation's largest military installation and one of the largest expanses of relatively undeveloped land remaining in the southwestern U.S. (WSMR 2001).

WSMR supports a central administrative and technical complex and more than 2,000 on-range test sites and facilities. Ongoing activities at WSMR include testing and evaluating missile systems, high-energy laser and directed energy systems, air defense fire-distribution systems, and space systems (WSMR 2001).

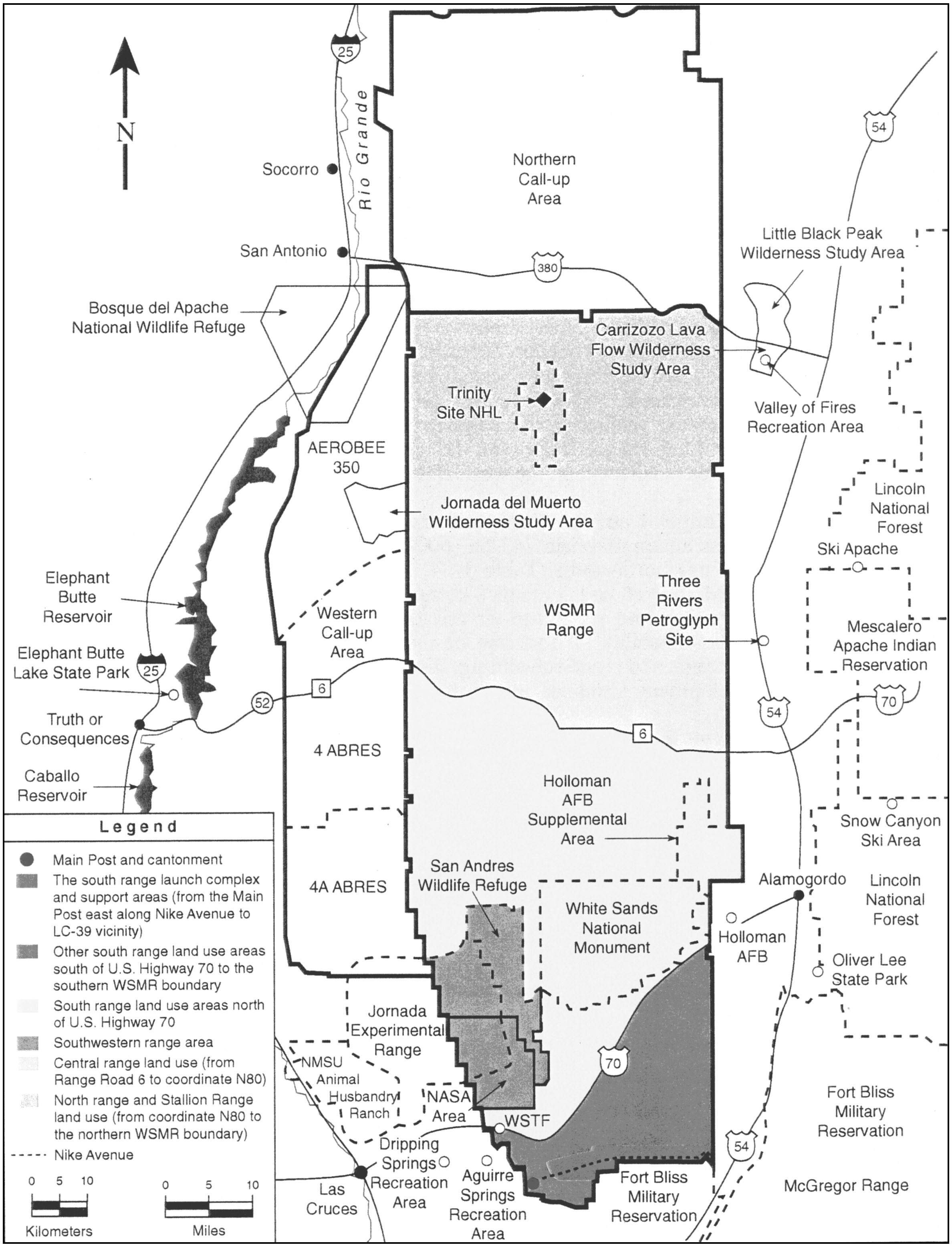
NASA's WSTF occupies approximately 24,483 ha (60,500 ac) of land near the southern boundary of WSMR, located entirely within Doña Ana County, New Mexico. To the west, WSTF is bounded by private lands, Bureau of Land Management land, and the Jornada Experimental Range. The vast majority of WSTF land area is utilized as a buffer zone (WSTF 2001). Other areas within WSMR, but managed independently of WSMR, include White Sands National Monument, San Andres Wildlife Refuge, and the Trinity Site National Historic Landmark. WSMR is bounded by several recreation, wilderness study, and wildlife refuge areas, Fort Bliss, Holloman AFB, and several private ranches and farms (see Figure 3-21) (WSMR 1998). The region surrounding WSMR is sparsely populated with most habitation concentrated in small rural villages and the Rio Grande River valley. Primary land uses are cattle grazing, recreation (predominantly hunting and sightseeing), and agriculture (ARL 1993).

The South Range Launch Complex and Support Areas would be the primary location used to support the Constellation Program (see Figure 3-21). This area encompasses approximately 243 ha (600 ac) and supports eight launch complexes (LC-32 to LC-38 and LC-50), located east of the Main Post. These complexes support a variety of missile test launches (WSMR 1998).




Source: WSMR 1998

**Figure 3-20. WSMR Location and Vicinity Map**




Source: WSMR 1998

**Figure 3-21. WSMR Land Use Map**

### *3.1.9.2 Air Resources*

#### 3.1.9.2.1 Climate

The climate at WSMR is typical of the northern Chihuahuan Desert, with hot summers and mild falls, winters, and springs. Average annual temperatures range from approximately 21 to 93°F (-6 to 34°C). Average annual precipitation on WSMR is 30 cm (12 in) and the relative humidity in the region is typically low, ranging from 29 to 55 percent over the course of a year. Prevailing wind direction varies throughout the year (WSMR 2001).

#### 3.1.9.2.2 Air Quality

Air quality at WSMR is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. In addition to the Federal standards, the State of New Mexico has set forth, in Air Quality Control Regulation 20.2.3, ambient air quality standards (see Table 3-11) (NMED 2006a).

**Table 3-11. New Mexico Air Quality Control Standards**

| Pollutant | Averaging Time | NAAQS (Primary Standards) | New Mexico Standards |
|---|---|---|---|
| Carbon Monoxide | 8-hour [(a)] | 9 ppm (10 mg/m$^3$) | 8.7 ppm (9.97 mg/m$^3$) |
| | 1-hour [(a)] | 35 ppm (40 mg/m$^3$) | 13.1 ppm (15.01 mg/m$^3$) |
| Lead | Quarterly Average | 1.5 μg/m$^3$ | none |
| Nitrogen Dioxide | Annual (Arithmetic Mean) | 0.053 ppm (100 μg/m$^3$) | 0.05 ppm (0.09 mg/m$^3$) |
| | 24-hour | none | 0.10 ppm (0.19 mg/m$^3$) |
| Particulate Matter ($PM_{10}$) | 24-hour [(b)] | 150 μg/m$^3$ | none |
| Particulate Matter ($PM_{2.5}$) | Annual [(c)] (Arith. Mean) | 15.0 μg/m$^3$ | none |
| | 24-hour [(d)] | 35 μg/m$^3$ | none |
| Ozone | 8-hour [(e)] | 0.08 ppm | none |
| Sulfur Dioxide | Annual [(a)] (Arith. Mean) | 0.03 ppm | 0.02 ppm |
| | 24-hour [(a)] | 0.14 ppm | 0.10 ppm |
| Total Suspended Particulate (TSP) Matter | 24-hour | none | 150 μg/m$^3$ |
| | 7-day average | none | 110 μg/m$^3$ |
| | 30-day average | none | 90 μg/m$^3$ |
| | Annual geometric mean | none | 60 μg/m$^3$ |

Source: NMED 2006a

[(a)] Not to be exceeded more than once per year.

[(b)] Not to be exceeded more than once per year on average over 3 years.

[(c)] To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 μg/m$^3$.

[(d)] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 μg/m$^3$.

[(e)] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

WSMR is classified as a major source of air emissions and operates under a CAA Title V permit (NMED 2006b). Within the WSMR area, industry, military operations, and transportation contribute to the atmospheric pollutant loading. Although all of WSMR is classified as an attainment area for all criteria pollutants regulated under the NAAQS and the New Mexico ambient air quality standards, exceedances of $PM_{10}$ due to wind-blown dust have been recorded in Doña Ana County (NMED 2006a; EPA 2007c). In response to these exceedances, a Natural Events Action Plan has been developed for wind blown dust in Doña Ana County. As part of the Natural Events Action Plan, WSMR signed a Memorandum of Agreement with the New Mexico Environment Department in support of the Natural Events Action Plan (WSMR 2000).

### *3.1.9.3 Water Resources*

#### 3.1.9.3.1 Potable Water

WSMR receives all of its potable water from groundwater resources (WSMR 2001).

#### 3.1.9.3.2 Surface Water

Surface water resources within WSMR are limited due to low rainfall, high evaporation rates, and high soil infiltration properties. Most streams, lakes, and rainwater catchments are ephemeral (not permanent) and are dependent on runoff from relatively infrequent precipitation events. Surface water generally occurs as overland flow from occasional intense thunderstorms during summer, accumulating in natural or constructed depressions (WSMR 2006). The only major perennial stream on WSMR is Salt Creek, located in the northwestern part of the Tularosa Basin. Most of the streams in the South Range Launch Complex and Support Areas originate in the mountains and flow to the east. Other surface drainage in this area occurs on alluvial fans of the Jarilla Mountains (WSMR 2001).

Surface water quality depends on the amount of snow accumulation in the mountainous areas, as well as the amount, intensity, and number of precipitation events. In general, much of the water found on WSMR contains high levels of minerals and salt. The surface water quality in intermittent water bodies ranges from fresh to brine, and can become more highly concentrated with total dissolved solids over time due to evaporation (WSMR 2001).

Sanitary wastewater and minor industrial discharges generated at the Main Post are treated onsite. Dewatered sludge is disposed of at an offsite commercial landfill. Discharge from the onsite treatment facility is monitored under a New Mexico Environmental Department Discharge Permit (WSMR 2001).

Approximately 3,816 ha (9,430 ac) on WSMR have been mapped as jurisdictional wetlands. The majority of these wetlands, approximately 3,590 ha (8,870 ac), were mapped as lacustrine wetlands, which are generally associated with ponds and lakes (WSMR 1998). LC-32, located within the South Range Launch Complex and Support Areas, is adjacent to the southern end of a large tract of designated wetland (WSTF 2007a).

#### 3.1.9.3.3 Groundwater

Groundwater tables across WSMR vary from very near to the surface in the Tularosa Basin to more than 91 m (300 ft) deep in the Jornada Basin (WSMR 2001). The principal aquifer underlying the South Range Launch Complex and Support Areas occurs in the unconsolidated alluvium and basin fill of Tertiary and Quaternary Age (ARL 1993).

The major source of recharge for all aquifers in this region is snowmelt and precipitation runoff. The major sources of discharge are from evaporation, evapotranspiration, wells, springs, seeps, and Salt Creek (WSMR 2001). Water table contours in the Main Post area indicate that groundwater moves eastward out of the reentrant to the lower part of the basin east of the area. From there, it moves southeast toward the Hueco Bolson in Texas (WSMR 1998). The quality of groundwater in the area varies significantly. Overall, the water is categorized as fresh to slightly saline (WSMR 2001).

Voluntary site investigations at WSMR have identified multiple areas of surface water, soil, and groundwater contamination as a result of legacy actions. Many areas have been cleaned up or are under remediation. No known groundwater or surface water contamination exists near or at LC-32. The nearest active restoration site is at the Temperature Test Facility methylene chloride spill area, located approximately 4 km (2.5 mi) west of LC-32. This release never reached the groundwater and was contained in the vadose zone. In addition, a release of diesel fuel occurred at LC-38, located approximately 13 km (8 mi) east of LC-32. Soil contamination occurred at this site, but no groundwater contamination has been recorded. Additional contaminated sites can be found within the Main Post area (WSMR 2007).

### *3.1.9.4 Ambient Noise*

Major sources of noise at WSMR include test firings of missiles, rockets, and space vehicles; sonic booms; ordnance explosions; low-altitude military jet traffic; aircraft drone overflights; gunfire; military helicopters; and general vehicle traffic (WSMR 2006).

Noise levels at the WSMR Main Post area boundaries (the only populated center within WSMR), at the WSMR southern property boundary, and at the San Andres National Wildlife Refuge (located approximately 19 km [12 mi] north of the Main Post area) have been estimated to be 55 to 65, 45 to 55, and 45 dBA, respectively. The Main Post area noise levels are estimated to fall in roughly the same noise level ranges as the urban areas of Holloman AFB and Alamogordo, New Mexico. Noise experienced by personnel on post would be typical of other rural or suburban communities. Personnel on the WSMR Main Post working in areas where occupational noise levels exceed 85 dBA are required to wear ear protection (WSMR 1998).

### *3.1.9.5 Geology and Soils*

#### 3.1.9.5.1 Geology

WSMR lies within an area defined by alternating uplifting fault blocks forming mountains and mesas, and downthrown blocks forming drainage basins. Two large basins occur on WSMR:

the Jornada del Muerto, west and northwest of the San Andres Mountains, and the Tularosa, east of the San Andres Mountains. The Tularosa Basin ranges in elevation from 1,182 to 3,645 m (3,878 to 11,958 ft) and the Jornada del Muerto Basin ranges from 1,406 to 2,607 m (4,613 to 8,553 ft). The San Andres Mountains, the most prominent mountain range on WSMR, traverse the west side of the Tularosa Basin (which is 129 km [80 mi] long) and rise more than 1,548 m (5,079 ft) above the basin's lowest point (WSMR 2001). Erosion of the uplifted fault blocks and subsequent depositional processes have resulted in thick sequences of alluvial material within the basins (WSMR 1998).

The South Range Launch Complex and Support Areas are located in the Main Post/Lower Tularosa Basin. There are two principal geomorphic structures in this area: the piedmont slopes located near the western and southeastern boundaries of the Lower Tularosa Basin and the expansive and hummocky basin floor that merges upward to the margins of the slopes. The piedmont surfaces vary in composition because of the influence of the distinct stratigraphy of the three mountain ranges, the Organ, San Augustin, and Jarilla Mountains (WSMR 2001). In general, the surficial geology of this area consists of wind-deposited (sand and silt) dunes that range from 1.2 to 6.1 m (4 to 20 ft) in height (ARL 1993).

3.1.9.5.2 Soils

The diversity of soil types represented at WSMR is a function of the varying topography and soil formation processes in the region. Soils identified at WSMR include the gypsum dunes and lake deposits of White Sands National Monument and the Lake Lucero area, the rocky soils associated with the rough foothills and slopes of the neighboring mountains, and the sandy loams of the Tularosa Basin and the Jornada del Muerto (WSMR 1998).

Soils in the South Range Launch Complex and Support Areas are described as sands to loams and are characterized by slow runoff and permeabilities ranging from slow to very rapid. The soils are highly susceptible to wind erosion in the area (WSMR 1998).

Voluntary site investigations at WSMR have identified widespread areas of surface water, soil, and groundwater contamination as a result of legacy actions (see Section 3.1.9.3 for more details).

### *3.1.9.6 Biological Resources*

WSMR lies entirely within the Basin and Range Section of the Chihuahuan Semi-desert Ecoregion, except for the extreme northeast corner, which barely extends into the Arizona-New Mexico Mountains Ecoregion. Variations in elevation and topography control much of the broad distribution of vegetation types at WSMR. The lowland areas of the Tularosa and Jornada del Muerto basins consist primarily of shrublands and grasslands and the higher elevations of the San Andres and Oscura Mountains support woodlands and coniferous forest. The South Range Launch Complex and Support Areas are dominated by basin shrublands and are part of a broad, extensive dune field of mesquite coppice dunes that extend south into Texas and Chihuahua, Mexico (WSMR 2001).

The diversity of habitats and quality of vegetation communities at WSMR support more than 70 mammal species, nearly 300 avian species, and a wide assortment of reptile and amphibian species. The only fish species native to WSMR is the White Sands pupfish. Many of the structures at the South Launch Complex are known to be used by birds, especially raptors and bats (WSMR 2001).

A total of 61 plant species and 25 animal species having Federal or state protected status occur or potentially occur on WSMR (WSMR 2006). Four federally and state listed species of concern, the Organ Mountain evening primrose (*Oenothera organensis*), mosquito plant (*Agastache cana*), Vasey's bitterweed (*Hymenoxys vaseyi*), and American Peregrine Falcon (*Falco peregrinus anatum*), have documented occurrences within the Main Post/Lower Tularosa Basin area. Two state-listed endangered species, the Desert night-blooming cereus (*Peniocereus greggii var. greggii*) and the American Peregrine Falcon (*Falco peregrinus anatum*), have documented occurrences within the Main Post/Lower Tularosa Basin area (WSMR 2001). In addition, the desert bighorn sheep (*Ovis canadensis mexicana*), a state-listed endangered species, has documented occurrences within WSTF (WSTF 2001). There are no documented occurrences of federally threatened or endangered species within the Main Post/Lower Tularosa Basin area (WSMR 2001).

#### *3.1.9.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the WSMR regional area. The WSMR regional area is defined here as the land area within an 80.5-km (50-mi) radius of WSMR, which includes Doña Ana County and portions of Luna, Sierra, and Otero Counties in New Mexico, as well as portions of El Paso County, in Texas (USBC 2006a).

##### 3.1.9.7.1 Population

The total population within the WSMR regional area was approximately 462,370 persons in 2000 (see Table 3-12) (USBC 2006a). The total population is expected to increase to approximately 545,320 by 2010 and to approximately 635,840 by 2020. Similar increases are anticipated in Doña Ana County, where the total population was approximately 174,680 persons in 2000 and is expected to increase to approximately 206,020 by 2010 and to approximately 240,220 by 2020 (USBC 2000).

In 2000, minority race populations represented approximately 28 percent of the total population within the WSMR regional area and approximately 32 percent of the total population within Doña Ana County. The Hispanic or Latino (of any race) population was the largest minority group living within the WSMR regional area and Doña Ana County in 2000. Between 2000 and 2020, minority race populations are expected to increase to 33 percent of the total population within the WSMR regional area and approximately 37 percent of the total population within Doña Ana County. The Hispanic or Latino (of any race) population is expected to remain the largest resident minority group within the WSMR regional area and Doña Ana County in 2020 (USBC 2000, USBC 2006a).

**Table 3-12. Population of the WSMR Regional Area and Doña Ana County for 2000, 2010, and 2020**

| Population | WSMR Regional Area | | | Doña Ana County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 332,748 | 379,582 | 426,408 | 118,478 | 135,154 | 151,827 |
| Black or African American | 18,343 | 24,096 | 30,378 | 2,723 | 3,577 | 4,510 |
| American Indian and Alaska Native | 4,630 | 5,666 | 6,890 | 2,580 | 3,158 | 3,839 |
| Asian | 6,310 | 8,635 | 11,020 | 1,330 | 1,820 | 2,323 |
| Native Hawaiian and Other Pacific Islander | 565 | 773 | 987 | 117 | 160 | 204 |
| Some other race | 83,293 | 103,534 | 127,378 | 43,209 | 53,709 | 66,078 |
| Two or more races | 16,479 | — | — | 6,245 | — | — |
| Hispanic or Latino (of any race) | 277,249 | 343,194 | 421,943 | 110,665 | 136,987 | 168,420 |
| **Total Population** | **462,368** | **545,324** | **635,836** | **174,682** | **206,023** | **240,218** |
| **Percent Minority** | **28.03** | **30.39** | **32.94** | **32.18** | **34.40** | **36.80** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

### 3.1.9.7.2 Economy

Industrial sectors in the WSMR regional area that provide significant employment include education, health, and social services; retail trade; manufacturing; and arts, entertainment, recreation, accommodation, and food services. An estimated 336,509 people were employed in the WSMR regional area in 2000 with an estimated unemployment rate of 8.2 percent. The national and New Mexico unemployment rates during the same period were estimated at 5.8 and 7.3 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 is as follows: U.S. – 12.4 percent, New Mexico – 18.2 percent, WSMR regional area – 21.3 percent, Doña Ana County – and 24.7 percent (USBC 2006a).

WSMR contributes significantly to the local, state, and national economies. WSMR directly commits approximately $350 million per year into the economy of the region, including monies from salary and local contract dollars. In 2002, WSMR employed 2,553 civil servants, 508 military personnel, and 3,150 support contractors. The vast majority of WSMR's workforce lives in the Las Cruces area, followed by the El Paso area, WSMR proper, and the Alamogordo area (WSMR 2006). In 2006, WSTF had approximately 600 persons working for NASA and various contractors (MSFC 2007d, WSTF 2001).

3.1.9.7.3 Transportation

WSMR has fully developed infrastructure, including road access and all utilities to support its occupational needs. An extensive network of roads and highways in southern New Mexico provides interstate and local access to all parts of WSMR. WSMR is bounded by U.S. Highway 380 to the north and U.S. Highway 54 to the east. U.S. Highway 70 crosses the southern portion of WSMR. There are seven primary entry points onto WSMR and an extensive system of limited-access roads have been developed and maintained by WSMR (WSMR 2001).

There are several government-owned aircraft landing facilities within and adjacent to WSMR and commercial aircraft services are available within a short drive. No rail system exists within WSMR; however, a major rail line runs along the entire length of WSMR's eastern boundary (WSMR 2001).

3.1.9.7.4 Public and Emergency Services

WSMR provides personnel with a variety of community services, including security, fire protection, and emergency response capabilities. Most of the personnel providing these services are based at the Main Post. Health facilities are available through the onsite health clinic. For off-range areas of the region, public safety and health services are provided by local jurisdictions (city and county) (WSMR 2001).

### *3.1.9.8 Cultural Resources*

The Trinity Site, located in the north-central portion of WSMR, is recognized as a World Heritage Site and as a National Historic Landmark (DOI 2007a, DOI 2007b). The V-2 Launching Site, located in the South Range Complex, is a designated National Historic Landmark (DOI 2007b). LC-33 is listed in the NRHP and the White Sands National Monument is listed as a historic district in the NRHP (DOI 2007a).

The White Sands National Monument and the Parabolic Dune Hearth Mounds within the monument are both listed on the New Mexico State Register of Cultural Properties. In addition, the Mockingbird Gap site adjacent to WSMR is listed in New Mexico State Register of Cultural Properties (WSMR 1998).

Several Native American Traditional Cultural Properties, as designated by the NRHP, exist in the vicinity of WSMR. These properties are of primary interest to the Mescalero Apache, whose lands are on the northeastern periphery of WSMR. Available records indicated that mountainous regions in the northern portion of WSMR have been used as traditional religious sites by Native Americans (WSMR 1998).

### *3.1.9.9 Hazardous Materials and Waste*

WSMR uses hazardous materials for various research and testing activities, which in turn generate hazardous wastes. WSMR is regulated both for generation and storage of hazardous wastes, for which it holds a RCRA Part B permit. In 2005, WSMR generated 35,380 kg (78,000 lb) of hazardous wastes (EPA 2005). Such wastes are disposed of offsite at certified hazardous disposal facilities by a licensed contractor. Furthermore, all hazardous materials and waste are managed in accordance with applicable Federal, state, and local rules and regulations (ARL 1993).

Legacy actions involving hazardous materials and waste at WSMR have resulted in widespread areas of surface water, soil, and groundwater contamination (see Section 3.1.9.3 for more details).

There are two state-permitted landfills in operation at WSMR. However, domestic solid waste from the Main Post has been collected and transported off-range for disposal since 1997 (WSMR 2001).

### 3.1.10 Other U.S. Government Facilities

Other U.S. Government facilities that would support the Constellation Program include NASA's DFRC, GSFC, and JPL. Most of the activities that would be implemented at these facilities would be limited to engineering design and data analysis, component testing, project management, procurement, operational checkout, and administrative support. The Constellation Program also may use other U.S. Government facilities, such as U.S. Air Force's wind tunnels and other test facilities. The activities that would be expected to occur at these U.S. Government facilities would fall within the normal realm of operations at each facility. These activities would not be expected to result in environmental impacts. Therefore, the existing environments at these facilities are not addressed in detail in this Final PEIS. Any activities determined to be outside the scope of activities normally undertaken at these facilities would be subject to separate NEPA review and documentation, as appropriate.

DFRC is one of NASA's premier centers for aeronautical flight research and atmospheric flight operations. DFRC is located within the boundaries of Edwards Air Force Base (EAFB) in Kern County, California, approximately 105 km (65 mi) northwest of Los Angeles. DFRC leases three locations within EAFB, with an area of approximately 339 ha (838 ac). EAFB encompasses more than 121,406 ha (300,000 ac), which affords DFRC a considerable degree of isolation. There are no major urban areas within the immediate area (DFRC 2003). In 2006, DFRC had a total budget of approximately $174 million and employed 500 civil servants and 466 support contractors. For the Constellation Program, DFRC would lead the Orion abort flight test integration and operations, procure abort test boosters, and manage the flight test article development and integration.

NASA's GSFC conducts scientific investigation, development, and operation of space systems, and development of related technologies. GSFC's main facility is located approximately 11 km (7 mi) northeast of Washington, DC in Prince George's County, Maryland. The Center encompasses approximately 514 ha (1,271 ac) of land and is surrounded by the town of Greenbelt to the west and southwest and the community of Glenn Dale to the southeast. The areas to the west, south, and east of GSFC are residential. Property that bounds GSFC to the north is government-owned. The GSFC main facility contains more than 50 buildings that support administration, research, design and construction of spacecraft, spacecraft operations, information storage and archival, data analysis, maintenance, utilities, and tracking and communication operations (GSFC 2005). In 2006, GSFC had a total budget of approximately $2.9 billion and employed 3,277 civil servants and 2,750 support contractors. For the

Constellation Program, GSFC would provide communications and tracking for the Orion spacecraft and Ares I and Ares V launch vehicles. GSFC also would provide systems engineering, integration, safety, reliability, quality assurance, test and verification support at the Program and Project level.

JPL is managed by the California Institute of Technology for NASA. JPL's primary mission is the planning and execution of robotic science missions throughout the Solar System. JPL's main facility encompasses approximately 71 ha (176 ac) of land in northwestern Pasadena in Los Angeles County, California. To the north are the San Gabriel Mountains and Angeles National Forest, to the east is the Arroyo Seco Canyon, to the south is the Los Angeles Metropolis, and to the west is the city of La Cañada-Flintridge. JPL resembles a university campus by appearance with offices and laboratory facilities for research and development work (JPL 2002). For fiscal year 2007, JPL has a total operating budget of $1.6 billion and employs 5,463 persons. JPL created a total economic impact of $2.66 billion in output, $904 million in income, and 16,254 jobs in 2006 (JPL 2006). For the Constellation Program, JPL would provide support for mission operations, the Orion Thermal Protection System, and systems engineering, integration, testing, and verification.

## 3.2 COMMERCIAL FACILITIES

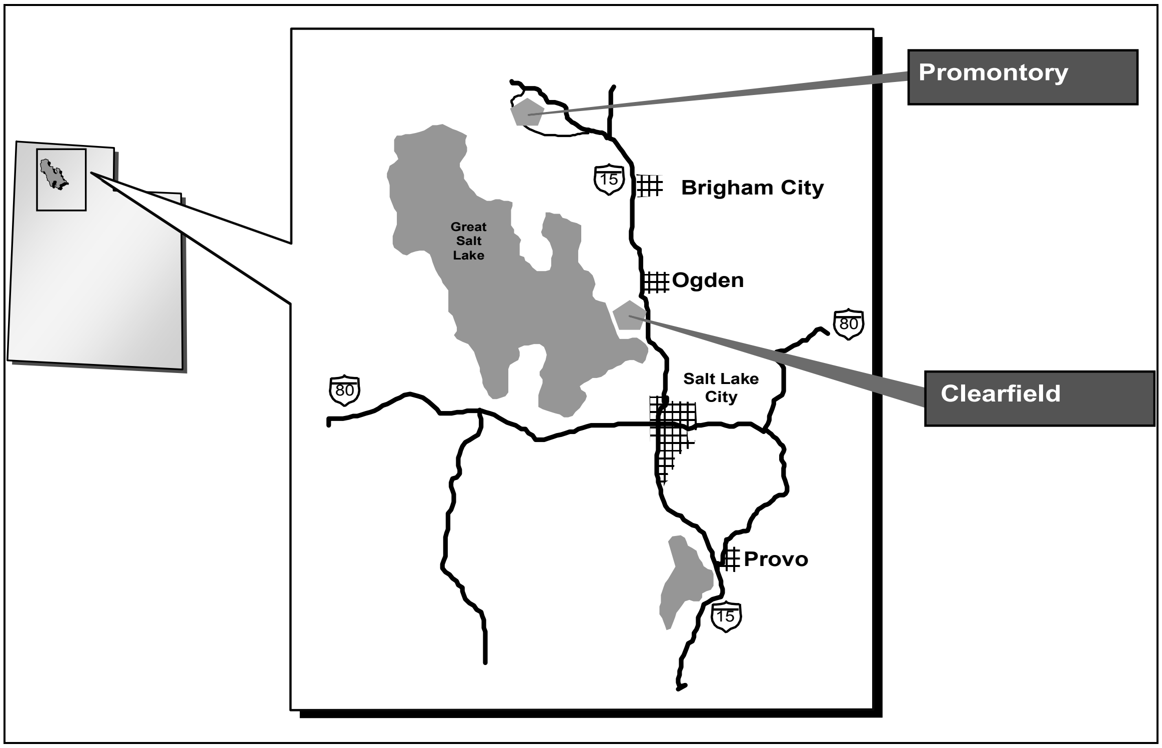
### 3.2.1 Alliant Techsystems-Launch Systems

ATK provides manufacturing and testing services for rocket systems for space launch vehicles. For the Constellation Program, ATK would provide solid rocket motor development, testing, and production for the Ares launch vehicles. ATK may perform additional work for the Constellation Program awarded through competitive procurements.

#### *3.2.1.1 Land Resources*

Activities associated with the five segment reusable solid rocket motor for the Constellation Program would occur at two ATK locations in Utah, including ATK-owned facilities at Promontory, which is northwest of Brigham City, Utah, and at leased facilities at the Clearfield Refurbishment Center (CRC), which is southwest of Ogden, Utah (see Figure 3-22). The Promontory facility is located in Box Elder County northwest of Great Salt Lake and encompasses 8,054 ha (19,900 ac) of Great Basin range land. The Promontory facility consists of 535 buildings, approximately 250 of which are used for Space Shuttle and other NASA programs. The buildings encompass approximately 232,250 square meters ($m^2$) (2.5 million square feet [$ft^2$]) of manufacturing facilities and 27,870 $m^2$ (300,000 $ft^2$) of research and development laboratories. The test area that would support the Constellation Program is located near the southern end of the Promontory facility.

The Promontory facility has been ground test firing solid rocket motors since the late 1950s and continues to be used for mixing and casting solid propellant and for solid rocket motor assembly and testing. Solid rocket motors for Delta II and Delta IV launch vehicles, for Minutemen missiles, and the Space Shuttle are currently fabricated at this facility. Primary land use outside the central facility area, including much of the test area, propellant development area, and part of the south plant, is designated for livestock grazing (see Figure 3-23) (ATK 2006).



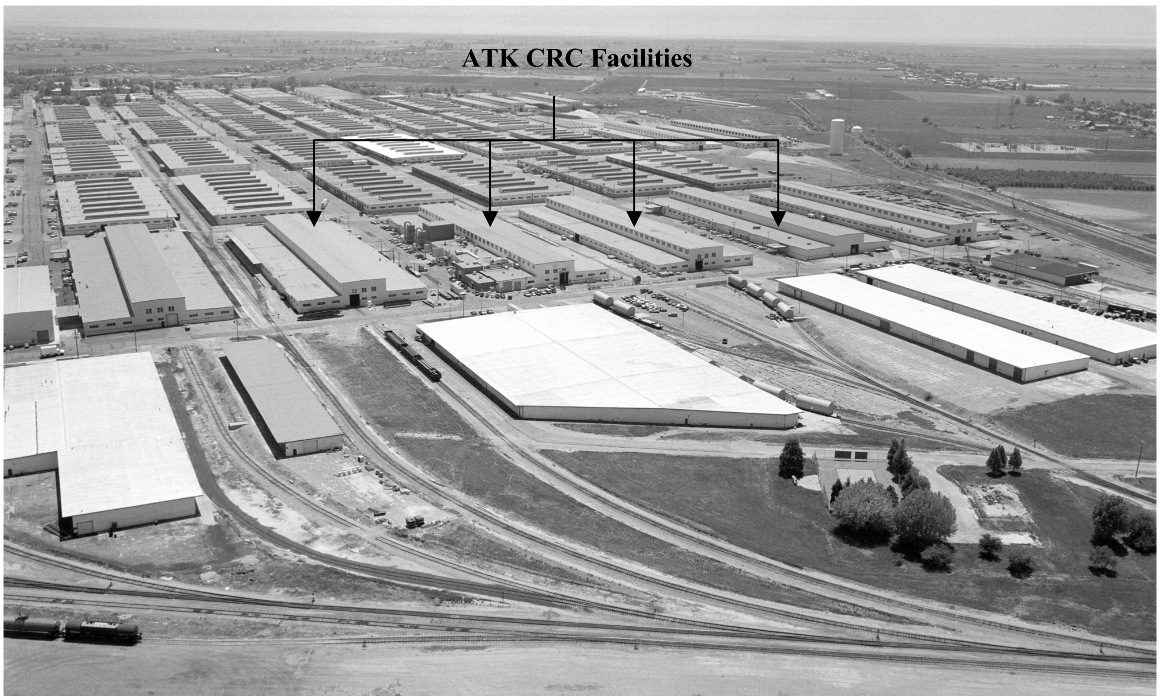

Source: ATK 2006

**Figure 3-22. Location and Vicinity of ATK Facilities in Utah**

Source: ATK 2006

**Figure 3-23. Central Portion of the Promontory Facility**

The CRC is located in Davis County, north of Salt Lake City in an industrial complex known as the Freeport Center (see Figure 3-24). The privately owned Freeport Center is a former U.S. Navy facility and presently hosts the CRC, other ATK operations outside of the Launch Systems Group, and numerous other industrial firms. ATK's CRC occupies seven buildings with approximately 65,030 $m^2$ (700,000 $ft^2$) of manufacturing and office space. The primary function of the CRC is refurbishment of the Space Shuttle's solid rocket motors and other spent hardware returning from flight. Activities include removal of residual insulation and paint, and testing of expended solid rocket motor flight hardware for reuse (ATK 2006).




Source: ATK 2006

**Figure 3-24. ATK Facilities at Freeport Center**

### *3.2.1.2 Air Resources*

#### 3.2.1.2.1 Climate

The climate in northern Utah is typical of middle latitude, semi-arid lands where evaporation potential exceeds precipitation throughout the year. The summers are considered hot and dry and winters are cold and often bring snow (Ogden 2007).

#### 3.2.1.2.2 Air Quality

Air quality is regulated through the NAAQS promulgated under the CAA. See Section 3.1.1.2 for a discussion of primary and secondary air quality standards and criteria pollutants. The NAAQS for criteria pollutants have been adopted by the State of Utah.

Davis and Box Elder Counties are currently classified as attainment areas for all criteria pollutants regulated under the NAAQS (EPA 2007c). Davis County is classified as a maintenance area for the 1-hour ozone standard. The Brigham City Metropolitan Statistical Area and the Ogden-Clearfield Metropolitan Area are likely to be designated as nonattainment areas under the 35 $\mu g/m^3$ 24-hour $PM_{2.5}$ NAAQS (UDAQ 2006a). Attainment under the 35 $\mu g/m^3$ 24-hour $PM_{2.5}$ standard is anticipated by April 2015 (EPA 2006e).

The Promontory facility is classified as a major source of air emissions and operates under a CAA Title V Permit. Primary activities associated with air emissions at the Promontory facility include the manufacturing and testing of solid rocket motor propellant, flare illuminants, and composite materials. The CRC is not classified as a major source of air emissions and is not required to operate under a CAA Title V Permit. Primary sources of air emissions at the CRC are solvents used during cleaning, and testing of expended solid rocket motor components (ATK 2006).

An ozone depleting substance, TCA, is used at Promontory as a component in solid rocket motor insulation and other critical bonding operations. NASA has an EPA exemption to use TCA, which is stockpiled under an essential use exemption (EPA 2007b). The TCA is stored in climate-controlled units with provisions for secondary containment in the event of a spill. Methylene chloride is used at the CRC as a cleaning agent in the solid rocket motor refurbishment activities. It is stored in a unit with a vapor recovery system. Both TCA and methylene chloride are distributed to workers in small quantities on an as-needed basis with management controls for distribution of the substances (ATK 2006).

#### *3.2.1.3 Water Resources*

##### 3.2.1.3.1 Potable Water

The Promontory facility operates its own non-transient, non-community water system while CRC receive potable water from the local municipal water supply system.

##### 3.2.1.3.2 Surface Water

The Promontory facility is located in a generally dry area with few springs and seasonal streams within the facility's boundaries. At least two of these springs, Pipe Springs and Shotgun Springs, are contaminated with TCE and perchlorate from historical waste management activities. This contamination is being addressed through a RCRA post-closure permit administered by the Utah Department of Environmental Quality. Multiple intermittent streams, which ultimately drain to the Great Salt Lake, and large tracts of marsh and wetland areas, can be found to the east and south of the Promontory facility (ATK 2006).

The Promontory facility operates two outfalls into Blue Creek under a Utah Pollutant Discharge Elimination System Permit for Wastewater Treatment and Discharge (number UT0024805) and a Utah Pollutant Discharge Elimination System Multi-Sector General Permit for Storm Water Discharge Associated with Industrial Activity (number UTR000529). The Promontory facility also operates under a Storm Water Pollution Prevention Plan and Stormwater Discharge Permit (number UTR000546) (ATK 2006).

The CRC is located within a concrete paved industrial complex that supports virtually no natural surface water. Wastewater at the CRC is treated and discharged to the local wastewater treatment facility under an NPDES permit, or under a North Davis County Discharge Permit (number 150). Most water from washing operations is recovered and reused (ATK 2006).

The Promontory facility and CRC are not known to be within 100- or 500- year floodplains.

3.2.1.3.3 Groundwater

Groundwater in northern Utah flows primarily through fractured bedrock and faults. In terms of water quality, the water is naturally too salty for human or agricultural use. Groundwater underlying the Promontory facility is contaminated with perchlorate and TCE (and breakdown products) from historical waste management practices (ATK 2006).

A major source of groundwater pollution at the Promontory facility was eliminated in 1988, with the cessation of using the unlined M-136 liquid waste surface impoundments. The M-136 Liquid Thermal Treatment Area had been used for the management of wastewaters contaminated with explosives and solvents since 1962. The area was closed in 1991 under a State of Utah approved closure plan, by constructing low-permeable caps over the impoundment areas to minimize infiltration and control any further releases (ATK 2006).

Contaminated sites at the Promontory facility are being investigated and/or remediated under the direction of the State of Utah RCRA Program (ATK 2006).

### *3.2.1.4 Ambient Noise*

The Promontory facility is located in the remote western desert, which provides a large separation from populated areas. Onsite buildings, operations, and areas that pose noise hazards require hearing protection. The nearest house to the Promontory facility is approximately 5 km (3 mi) away. Historically, noise complaints by the public have not been an issue at the Promontory facility.

The CRC is located in a high-density industrial complex. Areas where the noise levels can exceed 85 dBA have been identified and mapped. Hearing protection for onsite personnel is required in these areas. Typical noise levels in noise hazard areas range from 90 to 95 dBA with some activities that are between 100 and 105 dBA, such as grit blast operations. Most activities occur within enclosed structures and noise levels are significantly diminished before reaching populated areas. There are no sensitive noise receptors in the immediate vicinity of the CRC (ATK 2006).

### *3.2.1.5 Geology and Soils*

The Promontory facility is located in a vast area of hilly and flat land dominated by rocks and boulders. The most extensive soil types in the proposed Constellation Program administration and manufacturing areas are Stingal and Hupp series. Sanpete and Sandall-Rock series are the two most extensive types in the motor test area. These major soil types generally have moderate to severe use limitations. The Soil Conservation Service has noted that slow permeability, land slopes, and shallow bedrock are reasons for the use limitations. Soils of these types are suitable primarily for range and wildlife habitat (ATK 2006).

Legacy actions at the Promontory facility have contributed to TCE and perchlorate contamination of soil. Remediation efforts are ongoing (see Section 3.2.1.3 for details).

The CRC is located on highly disturbed soils that once were used to support tomato fields. Much of the Freeport Center, which houses the CRC, is paved with concrete and has been significantly altered from its natural soil conditions (ATK 2006).

#### *3.2.1.6 Biological Resources*

The Promontory facility is located in a sparsely vegetated area dominated by bluebunch wheat grass and sagebrush. Various species of wildlife have been observed within the facility and the surrounding area, including more than 75 bird and 47 mammal species. There are no sensitive or critical habitats within or adjacent to the facility. In addition, there are no state or federally threatened or endangered species known to inhabit the Promontory facility. The federally protected bald eagle (*Haliaeetus leucocephalus*) and federally threatened snowy plover (*Charadrius alexandrinus)* have been reported in the vicinity (ATK 2006).

The CRC is located in a high-density industrial complex that supports little, if any, natural habitat for animal or plant life. Small landscaped areas may support a few bird and small mammal species. There are no sensitive or critical habitats within or adjacent to the CRC. In addition, there are no state or federally threatened or endangered species known to inhabit the CRC (ATK 2006).

#### *3.2.1.7 Socioeconomics*

This section addresses the existing socioeconomic conditions and characteristics in the Promontory and CRC regional areas. The Promontory regional area is defined here as the land area within an 80.5-km (50-mi) radius of the Promontory facility, which includes Box Elder, Cache, Weber, Davis, Morgan, and portions of Rich Counties in Utah, and Oneida and portions of Franklin, Bannock, and Cassia Counties in Idaho. The CRC regional area is defined here as the land area within an 80.5-km (50-mi) radius of the CRC, which includes Weber, Davis, Salt Lake, Morgan, and portions of Utah, Tooele, Box Elder, Cache, Rich, Summit, and Wasatch Counties in Utah (USBC 2006a).

##### 3.2.1.7.1 Population

The total population within the Promontory regional area was approximately 496,255 persons in 2000 (see Table 3-13) (USBC 2006a). The total population is expected to increase to approximately 576,120 by 2010 and to approximately 636,850 by 2020 (USBC 2006a). Similar increases are anticipated in Box Elder County, where the total population was approximately 42,745 persons in 2000 and is expected to increase to approximately 49,620 by 2010 and to approximately 54,855 by 2020 (USBC 2000). In 2000, the U.S. Bureau of Census reported no residents within a 12.9-km (8-mi) radius of the Promontory's test areas (USBC 2006a).

In 2000, minority race populations represented approximately 10 percent of the total population within the Promontory regional area and approximately 7 percent of the total population within Box Elder County. The Hispanic or Latino (of any race) population was the largest minority group living within the Promontory regional area and Box Elder County in 2000. Between 2000 and 2020, minority race populations are expected to increase to 13 percent of the total population within the Promontory Facility regional area and approximately 11 percent of the total population within Box Elder County. The Hispanic or Latino (of any race) population is expected to remain the largest resident minority group within the regional area and Box Elder County in 2020 (USBC 2000, USBC 2006a).

**Table 3-13. Population of the Promontory Regional Area and Box Elder County for 2000, 2010, and 2020**

| Population | Promontory Regional Area | | | Box Elder County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 446,836 | 508,993 | 552,592 | 39,699 | 45,221 | 49,095 |
| Black or African American | 5,560 | 7,544 | 9,067 | 71 | 96 | 116 |
| American Indian and Alaska Native | 3,497 | 4,426 | 5,184 | 375 | 475 | 556 |
| Asian | 7,542 | 10,214 | 12,537 | 409 | 554 | 680 |
| Native Hawaiian and Other Pacific Islander | 887 | 1,201 | 1,474 | 34 | 46 | 57 |
| Some other race | 22,221 | 29,704 | 36,866 | 1,473 | 1,969 | 2,444 |
| Two or more races | 9,712 | — | — | 684 | — | — |
| Hispanic or Latino (of any race) | 44,091 | 59,293 | 75,371 | 2,791 | 3,753 | 4,771 |
| **Total Population** | **496,255** | **576,116** | **636,848** | **42,745** | **49,624** | **54,855** |
| **Percent Minority** | **9.96** | **11.65** | **13.23** | **7.13** | **8.87** | **10.50** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

The total population within the CRC regional area was approximately 1,562,100 persons in 2000 (see Table 3-14) (USBC 2006a). The total population is expected to increase to approximately 1,813,480 by 2010 and to approximately 2,004,655 by 2020. Similar increases are anticipated in Davis County where the total population was approximately 238,990 persons in 2000 and is expected to increase to approximately 277,455 by 2010 and to approximately 306,700 by 2020 (USBC 2000). In 2000, the population of Clearfield was approximately 25,970 persons and the population of Ogden was approximately 77,230 persons (USBC 2006a).

In 2000, minority race populations represented approximately 12 percent of the total population within the CRC regional area and approximately 8 percent of the total population within Davis County. The Hispanic or Latino (of any race) population was the largest minority group living within the CRC regional area and Davis County in 2000. Between 2000 and 2020, minority race populations are expected to increase to approximately 15 percent of the total population within the CRC regional area and approximately 11 percent of the total population within Davis County. The Hispanic or Latino (of any race) population is expected to remain the largest resident minority group within the CRC regional area and Davis County in 2020 (USBC 2000, USBC 2006a).

**Table 3-14. Population of the CRC Regional Area and Davis County for 2000, 2010, and 2020**

| Population | CRC Regional Area | | | Davis County | | |
|---|---|---|---|---|---|---|
| | 2000 | 2010* | 2020* | 2000 | 2010* | 2020* |
| White | 1,380,700 | 1,572,763 | 1,707,481 | 220,486 | 251,157 | 272,670 |
| Black or African American | 15,606 | 21,174 | 25,448 | 2,615 | 3,548 | 4,264 |
| American Indian and Alaska Native | 12,307 | 15,577 | 18,246 | 1,379 | 1,745 | 2,044 |
| Asian | 31,991 | 43,324 | 53,179 | 3,665 | 4,963 | 6,092 |
| Native Hawaiian and Other Pacific Islander | 12,419 | 20,644 | 20,644 | 639 | 865 | 1,062 |
| Some other race | 73,719 | 98,545 | 122,304 | 5,501 | 7,354 | 9,126 |
| Two or more races | 35,357 | — | — | 4,709 | — | — |
| Hispanic or Latino (of any race) | 158,763 | 213,502 | 271,396 | 12,955 | 17,422 | 22,146 |
| **Total Population** | **1,562,099** | **1,813,484** | **2,004,655** | **238,994** | **277,455** | **306,703** |
| **Percent Minority** | **11.61** | **13.27** | **14.82** | **7.74** | **9.48** | **11.10** |

Sources: USBC 2000, USBC 2006a

* Projected population values for 2010 and 2020 do not represent absolute limits to growth; for any group, the future population may be above or below the projected value.

Note: Because an individual may report more than one race, the aggregate of the population groups may not match the total population.

#### 3.2.1.7.2 Economy

Industrial sectors in the Promontory and CRC regional areas that provide significant employment include education, health, and social services; manufacturing; retail trade; and public administration. An estimated 350,789 people were employed in the Promontory regional area in 2000 with an estimated unemployment rate of 5.4 percent. Box Elder County's unemployment rate was 5.2 percent in 2000. An estimated 1,124,116 people were employed in the CRC regional area in 2000 with an estimated unemployment rate of 4.7 percent. Davis County's unemployment rate was 4.4 percent in 2000. The national and Utah unemployment rates during the same period were estimated at 5.8 and 5.0 percent, respectively. The estimated percent of persons living below the poverty level (low-income persons) in 2000 was as follows: U.S. – 12.4 percent, Utah – 9.4 percent, Promontory regional area – 8.7 percent, CRC regional area – 7.7 percent, Box Elder County – 7.0 percent, and Davis County – 5.0 percent (USBC 2006a).

The Promontory facility contributes significantly to the local, state, and national economies. In fiscal year 2006, the Promontory facility's budget was $604 million. The Promontory facility employed approximately 110 civil servants and 3,485 support contractors and the vast majority of these employees lived in Box Elder County, followed by Weber and Cache Counties (ATK 2006).

The Freeport Center, including ATK's CRC, is also a significant contributor to the Utah economy. The Freeport Center is home to more than 70 national and local companies that support a workforce of more than 7,000 employees (Freeport 2007). In fiscal year 2006, the CRC's budget was $33 million. The CRC employed approximately seven civil servants and 174 support contractors and the vast majority of these employees lived in Weber County, followed by Davis and Box Elder Counties (ATK 2006). ATK's Promontory and CRC facilities had a combined budget of $637 million and a workforce of 3,776 employees with a payroll of $228 million in fiscal year 2006 (ATK 2006).

#### 3.2.1.7.3 Transportation

ATK's Promontory and CRC facilities have fully developed infrastructure, which includes road access and utilities to support their occupational needs. The Promontory facility is served by State Road 83 and the CRC is serviced by Interstate 15 and 84, and rail access. Salt Lake City International Airport is located approximately 64 km (40 mi) south of the city of Ogden.

The Constellation Program's solid rocket motors would face the same transportation requirements as the Space Shuttle Program's solid rocket motors. Incoming ammonium perchlorate is delivered to Corinne, Utah via rail and transloaded onto flatbed trailers by a hazardous materials-certified commercial trucking company and delivered to Promontory following U.S. Department of Transportation (DOT) regulations (ATK 2006).

At Promontory, the raw constituents of solid fuel are trucked to a mixing facility and mixed remotely in large mix bowls. The mixed propellant is transported to a nearby facility for casting into a solid rocket motor segment. Once loaded and prepared, the segments are transported to KSC in special rail cars. Any remaining solid fuel and partially processed solid fuel constituents are transported to an open burn facility. ATK has an approval order from the Utah Division of Air Quality to open burn energetic waste materials. Buildings housing explosives or solid fuel are placed sufficiently far apart to satisfy standoff requirements based on explosives quantities (ATK 2006).

DOT regulations also apply to transporting solid rocket motors to and from ATK. Transporting loaded solid rocket segments from Promontory to Corinne is conducted during daytime hours on specialized transports which must not travel faster than 32 km per hour (20 mi per hour). Approval to move solid rocket motors after dark must be obtained from the State of Utah Highway Patrol. When this is done, the roads are shut down and additional security guards are required to make the move. At Corinne, loaded segments are transferred onto railcars. The railroad carriers are restricted to 80.5 km per hour (50 mi per hour). These shipments are also escorted by ATK personnel from Utah to KSC (ATK 2006).

#### 3.2.1.7.4 Public and Emergency Services

Access to the Promontory facility and CRC is controlled by security personnel. The closest community hospital to Promontory is approximately 39 km (24 mi) away in Tremonton. The CRC is serviced by several community hospitals within approximately 8 km (5 mi) (USBC 2006a). The Promontory facility maintains two onsite fire stations. In addition, it operates under an Emergency and Disaster Response Plan (ATK 2006).

#### *3.2.1.8 Cultural Resources*

The Promontory facility and CRC have no designated National Historic Landmarks or listings in the NRHP (DOI 2007a, DOI 2007b). Although no cultural surveys have been performed, there are no known culturally significant areas in close proximity to the facilities that would support the Constellation Program (ATK 2006). The Golden Spike National Historic Site, which is listed in the NRHP, is located approximately 4.8 km (3 mi) northwest of the Promontory test area (DOI 2007a).

#### *3.2.1.9 Hazardous Materials and Waste*

ATK uses hazardous materials for various research and testing activities, which in turn generate hazardous wastes. ATK is regulated both for generation and for treatment, storage, and disposal of hazardous wastes at its Promontory and CRC facilities, for which it holds a RCRA Treatment, Storage and Disposal Permit (number UTD009081357). ATK has management systems in place for hazardous materials and waste along with spill prevention control and countermeasure plans and pollution prevention/waste minimization plans (ATK 2006).

Wastes from current operations include propellant, paints, coatings, solvents, cleaning rags, catalysts, curing agents, polymers, and similar compounds. For the Space Shuttle Program, in 2004, the Promontory and CRC facilities generated and disposed of or otherwise treated 1.1 million kg (2.4 million lb) of hazardous waste. Hazardous waste is managed in several ways, including offsite treatment and/or disposal at permitted facilities, onsite thermal treatment by open burning, and onsite landfills (ATK 2006). All hazardous materials and hazardous wastes are managed in accordance with applicable Federal, state, and local rules and regulations (ATK 2006).

### 3.2.2 Other Commercial Facilities

The Constellation Program would be supported by various other commercial facilities throughout the U.S. It is expected that the activities engaged in at each commercial facility involved in the Constellation Program would fall within the normal realm of operations at that facility. It is also expected that all such facilities would be in compliance with applicable Federal, state, and local environmental laws, regulations, and permits. NASA would ensure that this is the case as a matter of contract with all commercial entities selected to support the Constellation Program.

## 3.3 GLOBAL ENVIRONMENT

In accordance with Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, this section provides a general overview of the global environment. It includes basic descriptions of the troposphere, stratosphere, and potential landing sites for the Orion Crew Module and jettisoned Orion and Ares hardware.

### 3.3.1 Troposphere

The troposphere is the atmospheric layer closest to the Earth's surface (see Figure 3-25). This layer accounts for more than 80 percent of the mass and essentially all of the water vapor, clouds, and precipitation contained in the Earth's atmosphere. The height of the troposphere ranges from an altitude of 10 km (6 mi) at the poles to 15 km (9 mi) at the equator. In general, the troposphere is well-mixed and aerosols in the troposphere are removed in a short period of time as a result of this mixing and scavenging by precipitation. A narrow region called the tropopause separates the troposphere from stratosphere (USAF 1998).

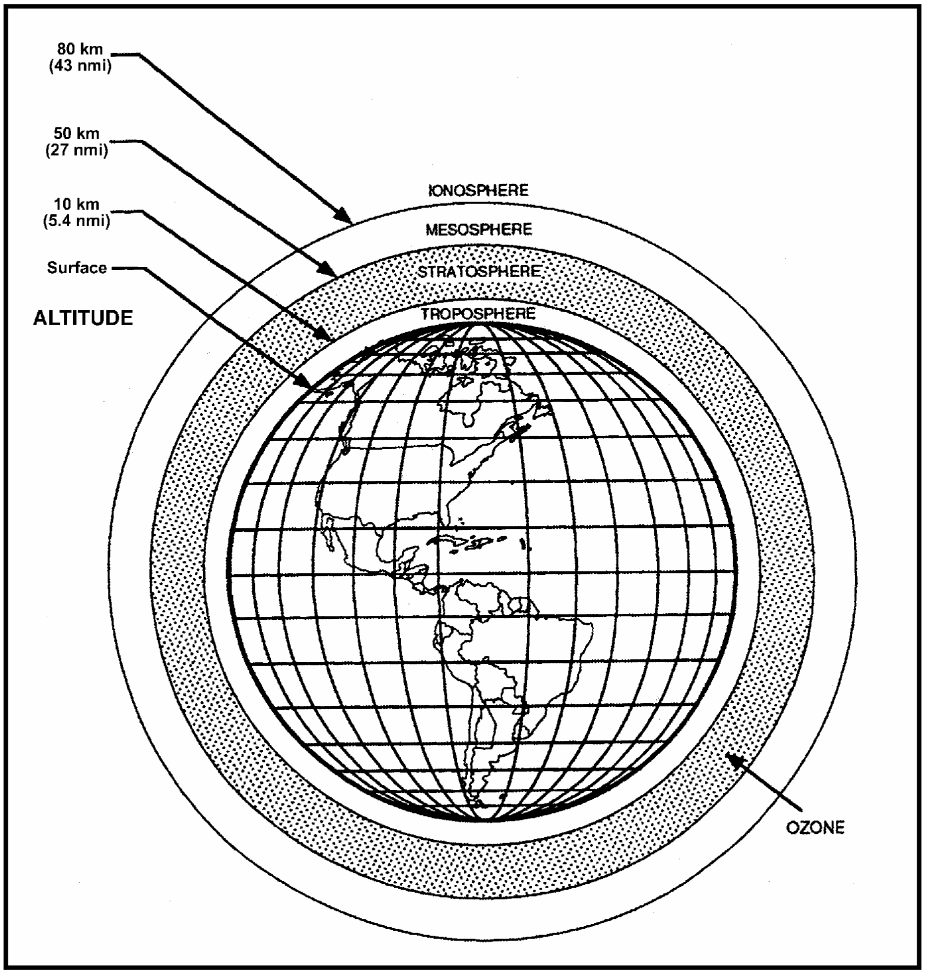



**Figure 3-25. Atmospheric Layers and Their Estimated Altitude**

### 3.3.2 Stratosphere

The stratosphere extends from the tropopause up to an altitude of approximately 50 km (31 mi) (see Figure 3-25). In general, vertical mixing is limited within the stratosphere, providing little transport between the layers above and below. Thus, the relatively dry, ozone-rich stratospheric air does not easily mix with the lower, moist, ozone-poor tropospheric air. The lack of vertical mixing and exchange between atmospheric 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 Montreal Protocol, an international treaty ratified by the U.S., is designed to protect the stratospheric ozone layer by phasing out production and consumption of substances that deplete the ozone layer. It was first adopted in 1987 with additional requirements adopted through 1999. Recent measurements indicate that stratospheric chlorine levels are decreasing, consistent with expected declines resulting from the Montreal Protocol (EPA 2003).

### 3.3.3 Potential Landing Sites for the Orion Crew Module and Jettisoned Orion and Ares Hardware

Although both ocean and terrestrial landing sites for the return of the Orion Crew Module are currently under study, terrestrial landing sites are not addressed in this Final PEIS. In general, it is expected the terrestrial landing site(s) would be in the western continental U.S. and would consist of the following characteristics: a sparsely populated large, flat area of land without marshes, forests, boulders or ravines. At such time as the evaluations of terrestrial landing sites mature sufficiently, NASA will prepare separate NEPA documentation, as appropriate.

An ocean landing of the Orion Crew Module could occur in the Atlantic Ocean, Indian Ocean, or Pacific Ocean following an ascent abort, or in the Pacific Ocean off the western coast of the U.S. following a normal Earth atmospheric entry from the International Space Station or the Moon. A recovery team would retrieve the Orion Crew Module upon Earth return. Although specific landing locations are unknown at this time, the future selection process would avoid sensitive marine environments to the best extent practicable. Figure 3-26 illustrates the Federal marine protected areas off the U.S. West Coast.

The primary hardware that would be jettisoned during an Orion/Ares I launch would include the Ares I First Stage and Upper Stage, the Orion Launch Abort System, and the Spacecraft Adapter fairings. For an Ares V launch, the primary hardware that would be jettisoned would include the Core Stage, payload fairings, and SRBs. Similar components would be jettisoned during Ares test launches from KSC. These components would fall into either the Indian Ocean or the Atlantic Ocean, depending upon when each is jettisoned during launch vehicle ascent. In addition, the Orion Service Module and docking mechanism (for International Space Station missions) would be jettisoned into the Pacific Ocean during atmospheric entry. Components could be jettisoned into the Indian, Atlantic, or Pacific Oceans in the event of a launch ascent abort; however, the possibility exists that hardware components could fall on land. Under a normal launch, a recovery team would retrieve the Ares I First Stage and the Ares V SRBs. While all remaining hardware would not be recovered and would be expected to breakup in the atmosphere or upon ocean impact and sink to the ocean floor, some hardware components may remain temporarily afloat.

The Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. This could gain additional performance margin for certain missions by eliminating the launch weight of the booster recovery systems.

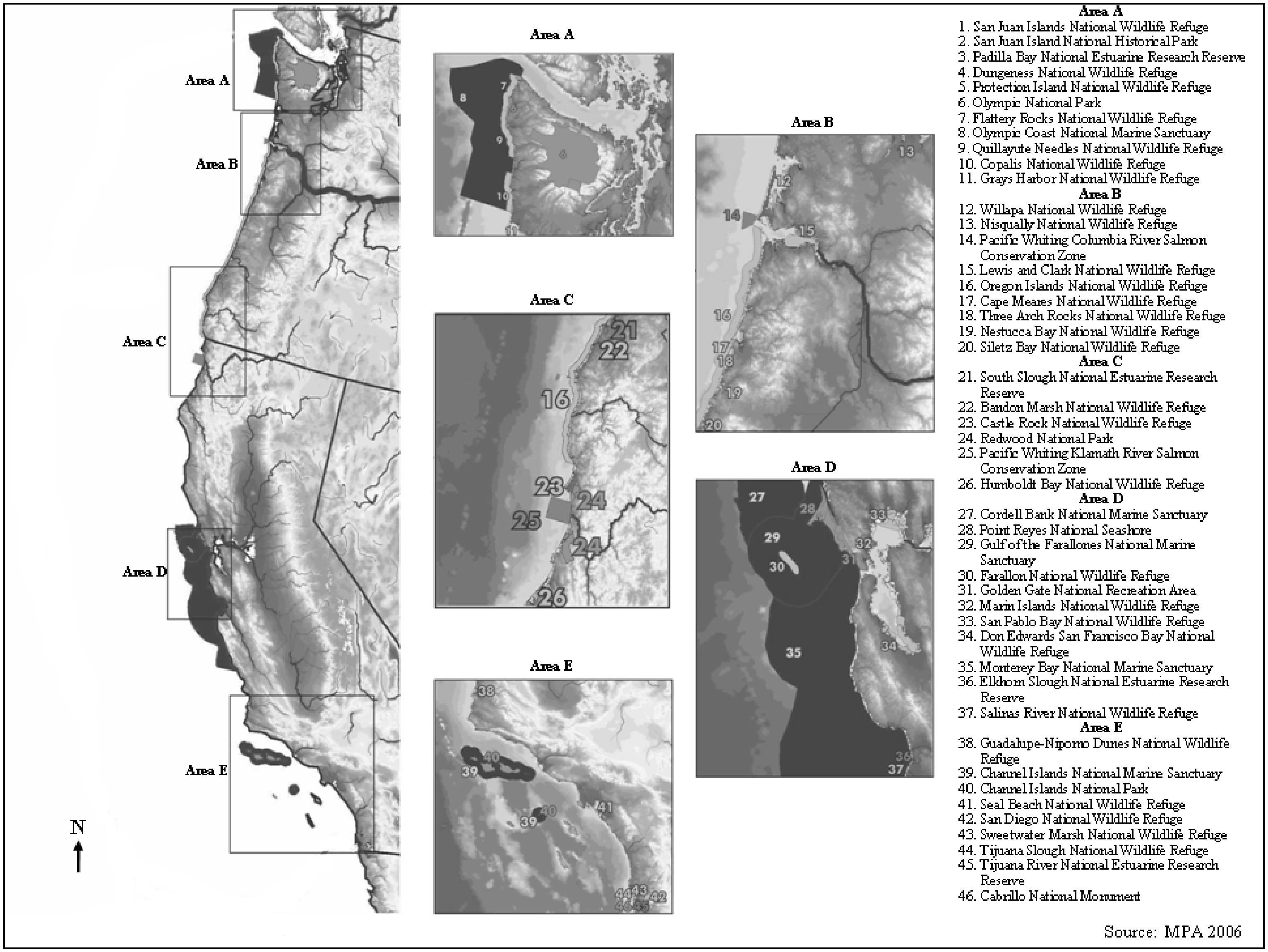



**Figure 3-26. Federal Marine Protected Areas of the U.S. West Coast**

# 4. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

The potential environmental consequences of both the National Aeronautics and Space Administration's (NASA) Proposed Action (Preferred Alternative) to continue preparations for and to implement the Constellation Program, and the No Action Alternative, not continue preparations for nor implement the Constellation Program, are summarized in Chapter 2 and are presented in detail in this Chapter. In addition, this Chapter presents in Cumulative Impacts (see Section 4.3) the potential environmental consequences of two overlapping but individual NASA actions: implementing the Constellation Program and close-out of the Space Shuttle Program.

## 4.1 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION (PREFERRED ALTERNATIVE)

Under the Proposed Action, NASA would continue preparations for and implement the Constellation Program. This Program would involve activities at many U.S. Government and commercial facilities. Although detailed aspects of the Constellation Program and the full scope of the activities that might occur at each facility are not fully known, the activities described in Section 2.1 present enough information to broadly estimate the nature of the potential environmental impacts that might occur if NASA implements the Proposed Action.

Figure 2-2 presents a high-level summary of the major Constellation Program activities that would be expected to occur at each of the primary U.S. Government facilities, as well as commercial facilities with the potential for significant environmental impacts. Given the long-term nature of the Constellation Program, and NASA's desire to utilize as much of the Space Shuttle Program infrastructure as practicable, it is expected that over time, many of the existing facilities currently used by the Space Shuttle Program and planned to be used for the Constellation Program would require maintenance, upgrading, renovation, and/or replacement.

For evaluation purposes, this Final Programmatic Environmental Impact Statement (PEIS) discusses the potential environmental impacts of the proposed Constellation Program activities at each NASA Center, and other U.S. Government or commercial facilities, and at more broadly defined locations (*e.g.*, the Atlantic, Indian, and Pacific Oceans) for which impact locations are undefined at this time. For each site, the potential environmental impacts are presented in a number of broad areas. For each area, only potential impacts deemed more than minimal in nature are described.

It is anticipated that the nature and locations of many activities associated with the Constellation Program would be similar to the ongoing activities conducted in support of the Space Shuttle Program. Thus, the known environmental impacts of the Space Shuttle Program have been used as the baseline for predicting potential impacts of implementing the Constellation Program. The impacts of the Space Shuttle Program have been well-characterized in NEPA documents prepared for the Space Shuttle Program, including site- or program-specific NEPA documents, in analyses documented by the Space Shuttle Program, and in Environmental Resources Documents for various NASA Centers.

### 4.1.1 Potential Environmental Impacts at U.S. Government Facilities

#### *4.1.1.1 John F. Kennedy Space Center*

Table 4-1 summarizes the major activities currently anticipated at the John F. Kennedy Space Center (KSC) in support of the individual projects within the Constellation Program. At KSC, most of the reasonably foreseeable activities would be similar to ongoing activities conducted in support of the Space Shuttle Program. As such, the environmental impacts of implementing the Constellation Program at this site would be expected to be similar to the environmental impacts of the ongoing Space Shuttle Program, which have been documented in various environmental documents, including the KSC Environmental Resources Document (KSC 2003).

**Table 4-1. Description of Constellation Program Activities at KSC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Manage:<br>• Ground processing, launch operations, and recovery support during design, development, test, and evaluation phases of Orion development<br>• Final integration of Orion spacecraft<br>• Ground support equipment development and support |
| Project Ares | Ground processing, launch operations, and recovery support for Ares I and Ares V |
| Ground Operations Project | Manage:<br>• Design, development, testing and evaluation, and logistics activities for all ground processing, launch, and recovery systems<br>• Ground processing, launch, and landing recovery operations planning and execution |

Several of the facilities at KSC identified for potential use in the Constellation Program may require modification. In some cases, new facilities may be needed. Many of the modifications would be relatively simple such as internal upgrades to electrical wiring and moving interior walls. However, some of the modifications would be more extensive. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an environmental assessment (EA) or an EIS. See Section 4.1.1.1.8 for discussion of historic/cultural impacts associated with the construction activities.

In order to meet the proposed timeline of the Constellation Program, some actions needed to be accomplished before the NEPA process for this PEIS is completed. Included are the near-term modifications to the Launch Complex (LC)-39 Pad B launch tower, installation of a lightning protection system, and the construction of a new mobile launcher to accommodate the initial test launches of the Ares I. Therefore, NASA prepared and published the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f) to address these modifications and the associated environmental impacts of construction and operation. NASA signed a Finding of No Significant Impact (FONSI) on May 2, 2007 allowing for the proposed action to proceed. The potential environmental impacts of construction and operation addressed in that EA are summarized as appropriate in the following subsections.

Similar modifications to those underway for LC-39 Pad B (KSC 2007f) would be needed at LC-39 Pad A to accommodate Ares V launches. Therefore, the potential environmental impacts of modifying and operating LC-39 Pad A would be similar to those for LC-39 Pad B. In addition, the mitigation measures adopted for LC-39 Pad B would be adopted for LC-39 Pad A. It is NASA's intention that both Ares launch vehicles would be able to be launched from these two launch pads.

As the planning for the Constellation Program proceeds and matures, construction of new facilities or modifications to existing facilities that are currently unanticipated may be deemed necessary. These activities would be subject to separate NEPA review and documentation, as appropriate.

The following sub-sections discuss the potential environmental impacts of Constellation Program activities at KSC.

##### 4.1.1.1.1 Land Resources

Activities described under the Proposed Action would not impact or conflict with land use plans at KSC. There are several tracts of largely undisturbed natural areas within KSC, including the Merritt Island National Wildlife Refuge (MINWR) and the Cape Canaveral National Seashore. There are also various wildlife management areas and wetlands located within both KSC and Merritt Island. None of these areas would experience impacts exceeding those currently experienced under the Space Shuttle Program.

KSC is within the Coastal Zone as defined by Florida Statute (15 CFR 930.30-44). As such, a Coastal Zone Consistency Determination for the Proposed Action is required. NASA has performed such a Determination and has determined that the Proposed Action can be implemented within existing environmental regulations and is consistent with the Florida Coastal Zone Management Plan.

##### 4.1.1.1.2 Air Resources

This discussion has been divided into sections that address normal launches and launch accidents. See Section 4.1.1.1.12 for a discussion of air quality impacts associated with launch accidents.

The principal sources of air emissions at KSC during the Constellation Program would be vehicular traffic from workers and visitors, especially on launch days, and the exhaust clouds from test launches and mission launches. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time. The number of launches per year would be comparable to the historic Space Shuttle launch schedule. In addition, vehicular emissions created by visitors on launch days would be similar to those created during Space Shuttle launches. Increases in fugitive dust during construction are not expected to be a major source of air emissions and have been previously addressed (KSC 2007f).

Launches involving solid rocket boosters (SRBs) produce several pollutants of concern from igniting the solid propellants: hydrogen chloride (HCl), aluminum oxide ($Al_2O_3$) particulate matter, and nitrogen oxides ($NO_x$). HCl and $Al_2O_3$ are products of the combustion of the solid propellants. $NO_x$ is produced by the combustion of atmospheric nitrogen under high-temperature conditions and is a contributing pollutant in the formation of ground-level ozone ($O_3$).

Space Shuttle launches at KSC and launches from Cape Canaveral Air Force Station (CCAFS) serve as a basis for understanding the expected emissions from normal launches of the Ares launch vehicles and their effects on the surrounding environment. Factors determining the ground-level impacts from launches would be receptor location and meteorology, more so than quantities of emissions from the launch vehicle. Therefore, the differences in air emissions between Ares and Space Shuttle launches (due to differences in solid propellant quantities or aspects of the launch pad sound suppression systems) would have less influence on the relative impacts from each launch vehicle than would variations in meteorological conditions (KSC 2007a).

The impacts associated with Space Shuttle launches have been well-characterized (KSC 1985). These impacts are principally associated with HCl and $Al_2O_3$ emissions from the Space Shuttle SRBs at liftoff. The interaction of these emissions with water from the Space Shuttle's sound suppression system creates a wet acidic deposition that produces the majority of the local environmental impacts near the launch complex (AIAA 1993). Lengthy environmental monitoring and assessment programs associated with Space Shuttle launches have led to a better understanding of the scope and magnitude of launch environmental effects. The Ares I First Stage and the Ares V SRBs would produce the same pollutants as the Space Shuttle at launch.

Launch impacts may be described in terms of the following categories: 1) exhaust emissions directly at the launch pad that remain and are deposited in that area, 2) near-field impacts from the exhaust cloud (generally within 500 meters [m] [1,640 feet [ft]) but sometimes up to 1,000 m [3,280 ft] from the pad), 3) impacts from far-field deposition of the buoyant portion of the exhaust cloud (more than a few kilometers from the launch pad), and 4) impacts on the stratosphere as the launch vehicle passes through it. The fourth category is described in detail in Section 4.1.6.1.

Much of the Space Shuttle emissions that are confined to the launch pad become entrained in the 3 million liters (l) (800,000 gallon [gal]) of sound suppression system water sprayed into a flame trench beneath the Space Shuttle at liftoff. After a launch, HCl may revolatilize as water evaporates on the launch pad.

The near-field impacts from an exhaust cloud depend primarily on the amount of sound suppression system water (its evaporation lowers the temperature and the altitude of the exhaust cloud) and on the time that the launch vehicle remains near the launch pad during ascent. The observations of near-field impacts from launches have been well-documented based on many years of Space Shuttle launches. They include destruction of sensitive plant species followed by regrowth, a rapid, two to three day drop in pH (a measure of acidity/alkalinity) in nearby waters down to 1 m (3.3 ft), which results in fish kills in the shallow surface waters of the lagoons north of LC-39 Pad A or the impoundments north of LC-39 Pad B, both of which are in line with the pad flame trenches. This is followed by a return to normal pH levels, and possibly deaths of burrowing animals in the path of the exhaust cloud. The near-field impacts from exhaust clouds have been observed at distances up to a few hundred meters from the launch pad, well within KSC/CCAFS, and do not reach human populations offsite (KSC 1985, AIAA 1993).

HCl deposition on leaves has been detected up to 22 kilometers (km) (13.6 miles [mi]) away following a Space Shuttle launch. Although the HCl deposition persists on leaf surfaces for considerable periods, no mortality of these plants and no changes in plant community composition or structure have been observed in the far-field related to launch effects (KSC 1985, AIAA 1993).

The Ares I would use the same type of SRB propulsion as does the Space Shuttle, as would the Ares V in its current planning configuration. The Ares I First Stage would use less solid propellant than the Space Shuttle at launch and the Ares V would use more solid propellant than the Space Shuttle. The difference in the total mass of solid propellant would primarily affect the exhaust cloud generated as the vehicle ascends to orbit and would not be a significant concern at the launch site. The potential exhaust cloud effects for an Ares launch would remain similar to those documented for Space Shuttle launches (KSC 2007a). Specifically, the same type effects from acidic deposition associated with Space Shuttle launches would be expected from the Ares vehicles. While the real extent and magnitude of impacts would depend in large part on the final launch pad configuration and volume of sound suppression system water entrained in the exhaust cloud, the impacts from an Ares I launch would be less than for an Ares V or the Space Shuttle.

Differences in local environmental effects between Space Shuttle and Ares launches could result if the amount of sound suppression system water for liftoff differed significantly. It is possible that final designs of the Ares vehicles and launch pads may employ significantly less sound suppression water (KSC 2007a). Reductions in the amount of water utilized would lessen the spatial extent and severity of impacts from wet acidic deposition. The exact amount of sound suppression system water utilized for Ares launches is still to be determined, but the amount currently used for the Space Shuttle could be used as a representative case to assess the scope and magnitude of local environmental impacts from Ares launches (KSC 2007a).

The current Ares V concept would use five liquid-fueled (liquid hydrogen/oxygen [LH/LOX]) RS-68B main engines, in addition to the two SRBs, at launch; thus, the Ares V would produce more heat in the exhaust than the Space Shuttle's main engines. This hotter exhaust would be more buoyant and would result in more emissions being carried aloft in the Ares V exhaust cloud, thus decreasing the near-field effects. An Ares V launch, by using approximately 25 percent more solid propellant in each SRB than the Space Shuttle, would release more emissions overall than the Space Shuttle.

The far-field impacts (more than a few kilometers from the launch pad) would be expected to be similar to the Space Shuttle (*i.e.*, negligible). When launches are planned, the KSC/CCAFS Range Safety Office, in general referred to as Launch Range Safety, uses computer modeling and launch safety criteria to ensure that significant far-field effects would not be expected. When the Ares I and Ares V launch specifications are determined, Launch Range Safety would provide these inputs to the air diffusion models used to determine if it is safe to launch under the current and projected meteorological conditions.

#### 4.1.1.1.3 Water Resources

Constellation Program activities at KSC would not be expected to have substantial adverse impacts on surface water or groundwater resources at KSC. The principal source of potential impacts on water resources would be Ares launches.

Direct impacts to surface waters from heat, vibration, and exhaust products are expected within a few hundred meters of the launch area. Figure 4-1 illustrates the major surface water bodies in and surrounding KSC. LC-39 Pads A and B are near the Mosquito Lagoon, Banana Creek, Banana River, and Indian River, and an Ares exhaust cloud could impact any of these water bodies, depending on the wind direction (KSC 2003). Water quality near the launch area could be affected as a result of contamination of surface waters by the exhaust cloud; however, long-term adverse effects are not anticipated. Thus, if launch activities do not adversely affect the water quality in the vicinity of the launch site, the Atlantic Ocean and coastal region would not be impacted.

Space Shuttle launches from LC-39 typically result in temporary impacts to the waters of adjacent impoundments. These impacts consist of a sharp but temporary depression of pH due to removal of HCl from the exhaust cloud formed by the combustion products of the solid fuel in the SRBs. Launch of the Ares vehicles would have similar effects.

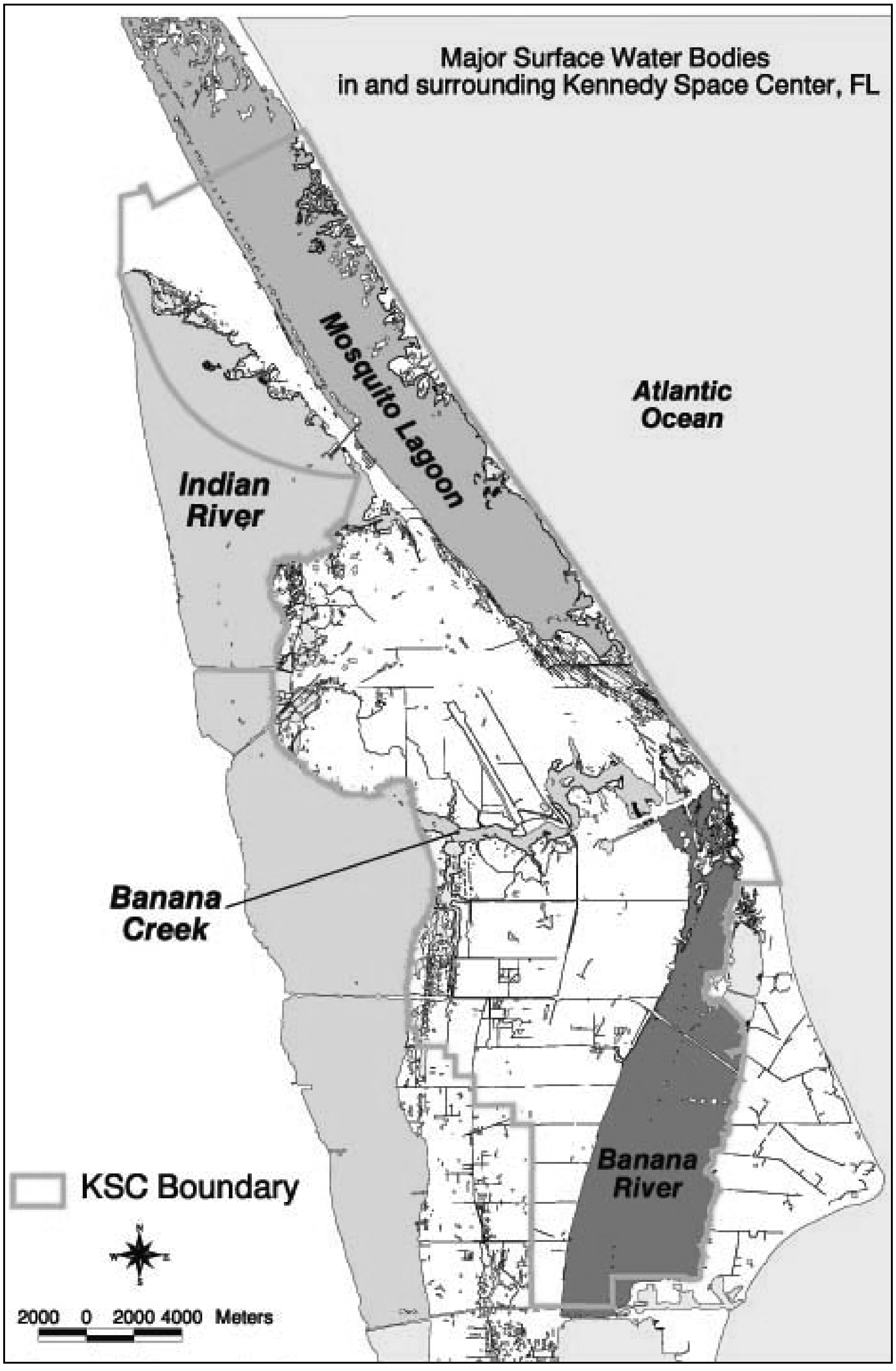
Much of the sound suppression system water used for a Space Shuttle launch is vaporized and is contained in the exhaust cloud. Post-launch, approximately 1.1 million l (300,000 gal) of the sound suppression system water is collected in tanks, treated to a neutral pH, and spread onto the unpaved ground near the launch pad. Although the quantity of sound suppression system water that would be used for Ares launches is not currently defined, it is expected that it would be treated similarly and would produce no substantial environmental impacts. The EA prepared in support of modifications to LC-39 Pad B has reported that no substantial impacts to surface water or groundwater would be anticipated from these actions (KSC 2007f).

Similar additions and modifications to LC-39 Pad A would be necessary to support Constellation Program activities. It is anticipated that surface water and groundwater resources and quality would not be adversely impacted at LC-39 Pad A as a result of planned construction activities.

The Constellation Program would not result in potable water and sanitary sewer demand beyond the capacity of the current KSC infrastructure.

#### 4.1.1.1.4 Noise

Implementation of the Proposed Action at KSC would be expected to result in the continuation of many of the types of noise presently occurring at the site. Noise generated at KSC has been extensively characterized (KSC 2003). Table 4-2 presents typical noise levels at the KSC Industrial Area from ongoing and historical operations, as well as estimated noise levels from sonic booms over the open ocean under the Space Shuttle flight path.




Source: KSC 2003

**Figure 4-1. Location of the Major KSC Water Bodies**

**Table 4-2. Measured Noise Levels at KSC**

| Source | dBA Range | | Remarks |
|---|---|---|---|
| | Low | High | |
| **Atmospheric Entry Sonic Boom [a]** | | | |
| Space Shuttle Orbiter | — | — | 101 $N/m^2$ maximum. (2.1 psf) |
| Space Shuttle SRB Casing | — | — | 96 to 144 $N/m^2$ (2 to 3 psf) |
| Space Shuttle External Tank | — | — | 96 to 192 $N/m^2$ (2 to 4 psf) |
| **Launch Noise** | | | |
| Titan IIIC | [b] | 94 | 21 Oct 1965 (9,388 m from pad) |
| Saturn I | [b] | 89 | Average of three measurements (9,034 m from pad) |
| Saturn V | [b] | 91 | 15 Apr 1969 (9,384 m from pad) |
| Atlas | [b] | 96 | Comstar launch (4,816 m from pad) |
| Space Shuttle | [b] | 90[a] | 9,384 m from pad |
| **Aircraft** | | | |
| F4 Jet | [b] | 107 | 18 km from Ground Zero |
| F4 Jet | [b] | 158 | Calculated at Ground Zero |
| NASA Gulfstream | 87 | 109 | Takeoff |
| NASA Gulfstream | 87 | 100 | Landing |
| **Industrial Activities** | | | |
| Multiple Facilities | 45 to 106 | 57 to 199 | Industrial Equipment Use |
| **Undisturbed Areas** | | | |
| Seashore | 50 | 69 | Medium Waves (Nice Day) |
| Riverbank | 48 | 48 | Light Gusts (No Traffic) |
| 150 m Tower | 50 | 64 | Light Gusts of Wind |

Sources: KSC 2003, NASA 1978

[a] Estimated noise levels over the open ocean under the vehicle flight path.
[b] Not measured or not applicable.

A number of aircraft are utilized at KSC for payload delivery, personnel transportation, and astronaut training. With adoption of the Proposed Action, intermittent aircraft noise would be expected to continue. Industrial activities associated with the Constellation Program would be similar in type and extent to those performed for the Space Shuttle Program, thus noise associated with industrial activities would be expected to continue at the present levels if the Proposed Action were adopted. The Proposed Action would include construction and modifications to existing facilities at KSC, which would result in localized noise around construction sites and from vehicular traffic supporting the construction activities. The workforce would be protected from undue noise impacts by the Occupational Safety and Health Administration (OSHA) safety practices in place at KSC.

Launch Noise

Launch vehicles generate very loud instantaneous noise that can usually be heard for several miles from KSC/CCAFS launch sites. In addition, a sonic boom is generated with some types of launches. Sonic booms associated with Ares launches from KSC are discussed in the next section. Table 4-2 provides measured peak sound levels for a number of vehicles launched from KSC/CCAFS over the years and compares those values with other KSC noise levels.

Both experimental observations and modeling indicate that the overall noise levels associated with a launch vehicle are approximately correlated with total engine thrust. The attributes of noise generated (*e.g.*, tone and frequency) are dependent on many engine parameters, including mechanical power in the exhaust, nozzle diameters, exhaust flows, and other factors. The magnitude of the acoustic noise and vibration generated would depend on many factors, including configuration of the launch pad and sound suppression features incorporated into the launch pad design. The sound levels heard and felt some distance from the launch vehicle would depend not only on the magnitude of the noise source, but also natural factors including attenuation of the sound due to absorption by plants, reflection by structures, refraction of the sound due to temperature inversions, wind speeds, and other meteorological factors.

Table 4-3 compares the expected thrust (and thereby relative noise levels) at launch of the proposed Ares I and Ares V (in its current planning configuration) with other launch vehicles. The total thrust of the Ares V at launch would exceed that of the Saturn V and Space Shuttle by as much as 40 and 50 percent, respectively. Launch of the Ares V would be expected to generate noise, including vibration and ground waves, in excess of that experienced with the Space Shuttle and likely of the magnitude of or exceeding that of the Saturn V launches. The exact magnitude of the acoustic noise and vibration generated by the Ares launch vehicles would depend on many factors as noted previously, including engineering considerations such as the sound suppression techniques incorporated into the launch pad design.

**Table 4-3. Sea Level Thrust of Various Launch Vehicles**

| Launch Vehicle | Sea Level Thrust at Launch |
|---|---|
| Ares V* | $45 \times 10^6$ N ($10 \times 10^6$ lbf ) |
| Saturn V | $33 \times 10^6$ N ($7.5 \times 10^6$ lbf ) |
| Space Shuttle | $31 \times 10^6$ N ($6.9 \times 10^6$ lbf ) |
| Titan IV | $15 \times 10^6$ N ($3.4 \times 10^6$ lbf ) |
| Ares I | $13 \times 10^6$ N ($3 \times 10^6$ lbf ) |
| Atlas V 551 | $9.8 \times 10^6$ N ($2.2 \times 10^6$ lbf ) |
| Delta 4 Heavy | $8.9 \times 10^6$ N ($2 \times 10^6$ lbf ) |

lbf = pounds force, N = Newton

* Current planning configuration with five RS-68B engines

Launch noise modeling was performed for both Ares I and Ares V (KSC 2007c) using techniques similar to those performed for the Space Shuttle and other current launch vehicles. Noise modeling was performed for both vehicles on the pad (where the noise pattern is significantly affected by the launch pad structures) and at an altitude of 91 m (300 ft) where each launch vehicle would be clear of the launch tower and the transmission of sound would be unabated and unobstructed.

The exposure to noise generated by Ares I and Ares V launches would last only for a very short duration (approximately 20 to 30 seconds). Audible frequencies (20 to 1,000 Hertz) generated by launch vehicles typically decrease as the launch vehicle travels away from the observer (*i.e.*, as the vehicle leaves the pad). Inaudible frequencies (between 1 to 20 Hertz) travel far, but do not affect human hearing.

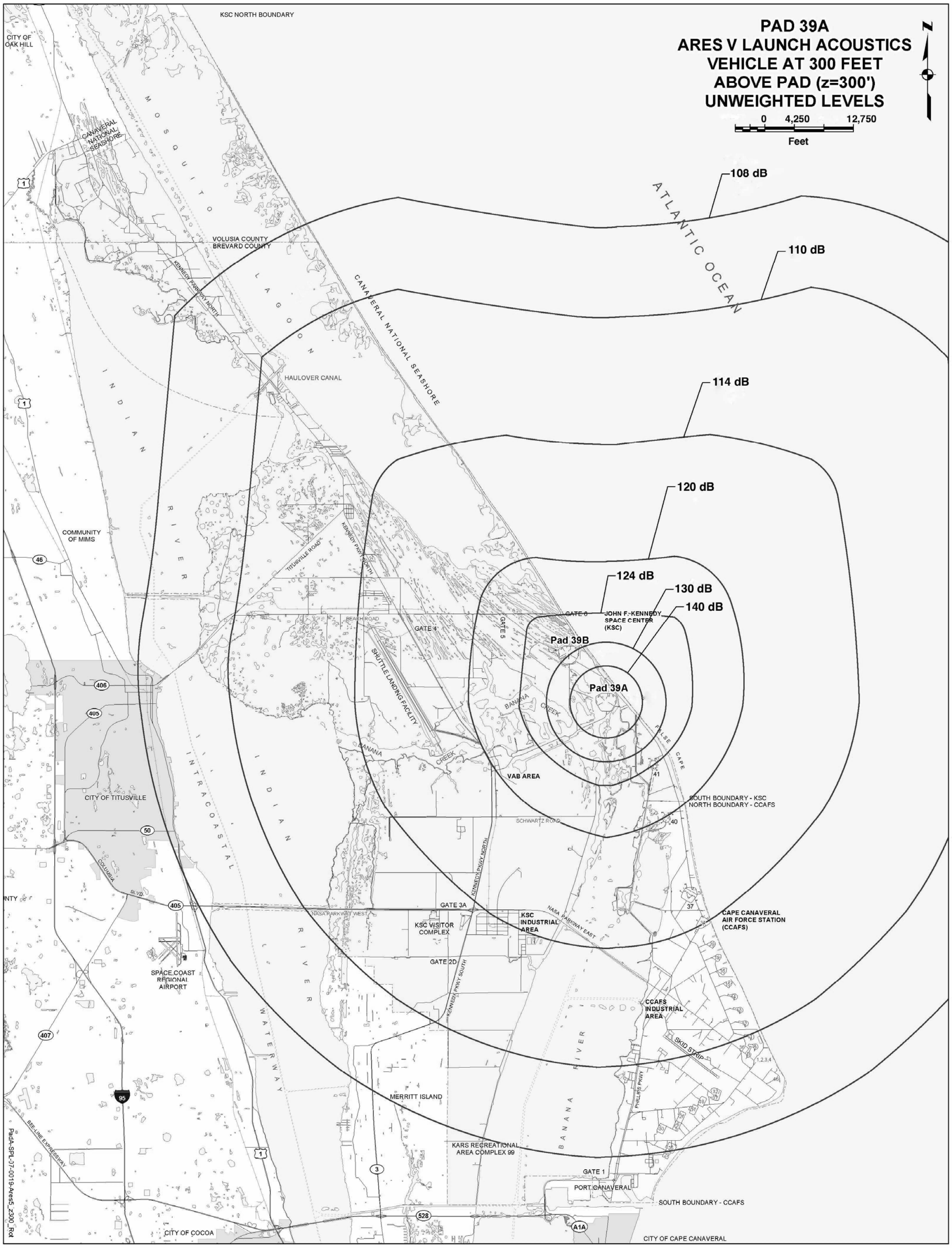
For both the Ares I and Ares V, overall sound pressure levels (OASPLs) were estimated. Both un-weighted (dB) and A-weighted (dBA) noise contours were overlaid on a KSC regional map. The dBA scale is commonly used in environmental noise measurement because it emulates how the human ear responds to noise across the entire sound frequency range. The dBA reflect how loud humans perceive the noise while dB reflect the actual sound pressures and the potential for psychological or structural damage.

Figure 4-2 presents the OASPLs in dB for the Ares V at 91 m (300 ft). Noise modeling for the Ares V was performed using a bounding launch configuration with a total thrust of about 54.7 million N (12.3 million lb) rather than the current planning configuration thrust of about 44 million N (10 million lb). A bounding launch configuration was used to consider potential variations in future engine designs and configurations. Short duration (approximately 20 to 30 seconds) sound pressure levels of about 106 to 109 dB are indicated for the city of Titusville. The KSC Visitor Center and KSC Industrial Area would experience 113 to 115 dB sound pressure levels. For the Ares I vehicle, short duration sound pressure levels were predicted to be approximately 8 to 9 dB lower at those locations.

Figure 4-3 presents dBA noise contours for the Ares V at 91 m (300 ft) using the bounding launch configuration. Short duration noise levels for the city of Titusville during an Ares V launch would be expected to be in the 78 to 82 dBA range. The predicted short duration noise levels at the KSC Visitor Center and KSC Industrial Area would be 88 to 92 dBA.

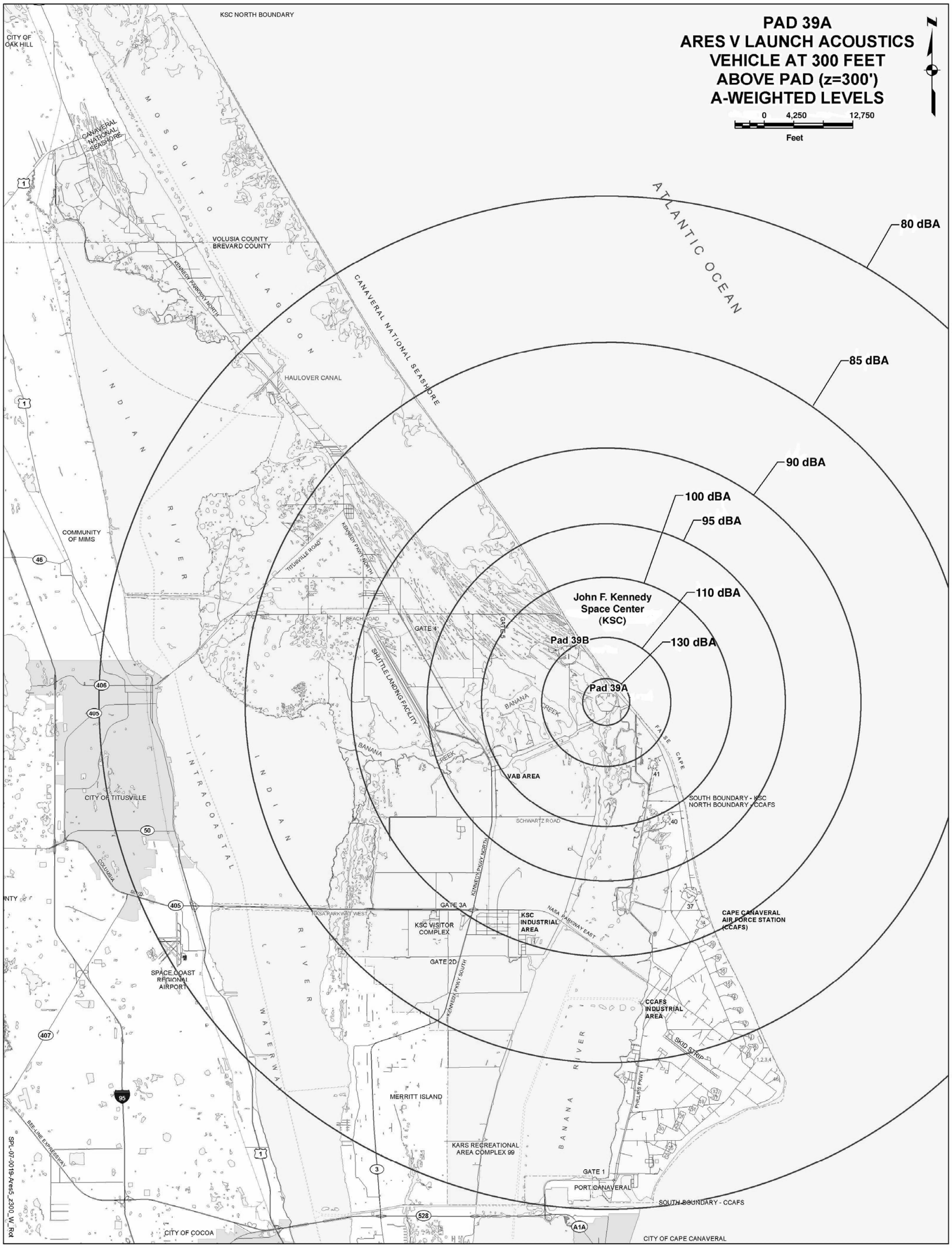
At 4.8 km (3 mi) away from the launch pad (the approximate distance to the Vehicle Assembly Building [VAB]), Ares V noise levels would be in the range of 99 to 102 dBA. Most KSC employees would be stationed beyond this distance. Noise levels of about 98 dBA would occur at the Saturn V viewing site with this bounding the Ares V launch vehicle configuration. These values are comparable to, but likely to be a few dBA (1 to 2) higher than, those of the Space Shuttle and the Saturn V used to launch the Apollo missions in the 1970s. For the Ares I, noise levels were predicted to be approximately 5 to 9 dBA lower at those locations.

Ares V offsite noise levels in Titusville of 78 to 82 dBA for 30 seconds would be much lower and experienced for significantly shorter duration than the 85 dBA 8-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). OSHA also requires that hearing protection or engineering controls be applied if workers are exposed to sound levels greater than 115 dBA for more than a quarter of an hour (29 CFR 1926.52).




Source: KSC 2007c

**Figure 4-2. Calculated Un-weighted Maximum Sound Pressure Level Contours for an Ares V Launch**




Source: KSC 2007c

**Figure 4-3. Calculated A-weighted Maximum Sound Pressure Level Contours for an Ares V Launch**

Sonic Booms Associated with Launch

Launch of an Ares I or Ares V would result in sonic booms similar to those that occur with each Space Shuttle launch from KSC or with expendable launch vehicle launches from CCAFS. Sonic booms are generated by the ascending Space Shuttle, with the atmospheric entry of jettisoned SRB casings, and with atmospheric entry of the jettisoned External Tank.

Sonic booms with the launch of an Ares I or Ares V would occur in similar locations to where Space Shuttle sonic booms occur. The focal zone of peak noise would be along the ground track of the flight path of the vehicle. The direction of the flight path, or launch azimuth, would vary with the destination of the vehicle (*e.g.*, International Space Station, Moon, or Mars). The largest sonic boom associated with the ascending Space Shuttle first reaches ground level about 60 km (37 mi) downrange with pressures as high as 290 Newtons per square meter ($N/m^2$) (6.0 pounds per square foot [psf]). The intensity diminishes downrange to 48 $N/m^2$ (1.0 psf) at approximately 85 km (53 mi) (NASA 1978).

In principle, sonic boom overpressures increase with the size of the vehicle and its exhaust plume, but the shape of the vehicle also would play an important role. Therefore, the Ares I overpressures should be less than the Space Shuttle, and the Ares V overpressures may be similar to the Space Shuttle.

For Space Shuttle launches, after SRB separation the Space Shuttle and External Tank continue to climb while the SRBs reenter the atmosphere. During descent and prior to parachute deployment, the spent SRBs generate sonic booms, which would strike the Atlantic Ocean surface over an area from 280 to 370 km (174 to 230 mi) downrange from the launch site. Maximum overpressures of 96 to 144 $N/m^2$ (2 to 3 psf) could occur in this area, which coincides with the SRB impact area (NASA 1978). For both the Ares I First Stage and Ares V SRBs, a similar effect would be expected.

The targeted entry of the Ares V LOX/LH Core Stage and the Ares I Upper Stage also would produce sonic booms, much like that which occurs with entry of the External Tank from the Space Shuttle, over the Indian or the Pacific Ocean. Atmospheric entry of the Space Shuttle External Tank produces a sonic boom with maximum overpressures in the range of 96 to 192 $N/m^2$ (2 to 4 psf) (NASA 1978). The exact location of the sonic boom footprints from Ares launches would depend on the mission destinations (*e.g.*, International Space Station, Moon, or Mars) and the targeted disposal area (roughly 28 to 30° South latitude, 84 to 90° East longitude).

Impacts of Launch Noise on People

The noise from an Ares I launch would be expected to be somewhat less than a Space Shuttle launch, while the noise from the Ares V launch would likely be greater than from the Space Shuttle. The extent to which these differences would be perceivable to either onsite spectators or the offsite public is not known. The variability in the transmission of the noise from the launch area and the ascending launch vehicle due to atmospheric factors and meteorology is likely to be at least as important as the actual variation in noise generated by the vehicle. This is illustrated in Table 4-2 with a smaller launch vehicle (the Titan IIIc) having produced higher sound levels than the Space Shuttle at a measuring point 9 km (5.6 mi) away.

The effects of extended noise exposure on humans are outlined in Table 4-4. The exposure to noise generated by Ares I and Ares V launches would last only for a very short duration (approximately 20 to 30 seconds) and therefore the impacts would not approach those in Table 4-4. NASA ensures that workers and visitors are protected from launch noise levels that exceed regulated limits by controlling proximity to the launch pad and employing structural protection measures to shield personnel and visitors. All public exposure levels have been below those requiring protective devices for such short exposure; consequently, Space Shuttle launch acoustic impacts have been well within acceptable limits. It would be expected that these policies and procedures would continue with the launch of the Ares I and Ares V.

**Table 4-4. Effects of Extended Noise Exposure on Humans**

| dBA Level | Potential Effect | dBA Level | Potential Effect |
|---|---|---|---|
| 20 | No sound perceived | 85 | Very annoying |
| 25 | Hearing threshold | 90 | Affect mental and motor behavior |
| 30 | — | 95 | Severe hearing damage |
| 35 | Slight sleep interference | 100 | Awaken everyone |
| 40 | — | 105 | — |
| 45 | — | 110 | — |
| 50 | Moderate sleep interference | 115 | Maximum vocal effort |
| 55 | Annoyance (mild) | 120 | — |
| 60 | Normal speech level | 125 | Pain threshold |
| 65 | Communication interference | 130 | Limit amplified speech |
| 70 | Smooth muscles/glands react | 135 | Very painful |
| 75 | Changed motor coordination | 140 | Potential hearing loss high |
| 80 | Moderate hearing damage | — | — |

Source: KSC 2003

Impacts of Launch Noise on Structures

Noise from Space Shuttle launches (and from Saturn V launches in the 1960s and 1970s) has occasionally resulted in minor damage, such as broken windows and cracked plaster within buildings both offsite and at KSC/CCAFS. The principal risk to structures, however, is to close-in structures at KSC/CCAFS that might be subjected to larger acoustic energies. The risks are highest when the meteorological conditions result in acoustic focusing, which could produce sound levels 10 to 20 dB higher than would normally be experienced.

The potential impact of Ares I launch noise on structures would be expected to be minimal, since these noise levels should be lower than those experienced with Space Shuttle launches. The potential noise and vibration levels associated with Ares V launches would likely be comparable to past Space Shuttle and Saturn V launches; therefore, the potential for minor localized damage to windows (onsite and offsite) and structures exists. NASA has procedures in place to evaluate such damage and provide for compensation, if warranted. As the noise levels generated by the

Ares I and Ares V would be similar to past launches, they should not adversely impact surrounding communities.

Impacts of Routine Operations Noise and Launch Noise on Wildlife

Historically, 24-hour average ambient noise levels away from the industrial areas at KSC have been appreciably lower than the U.S. Environmental Protection Agency (EPA) recommended upper level of 65 dBA (KSC 2003). The areas of KSC/MINWR that are away from operational areas are exposed to relatively low ambient noise levels in the range of 35 to 40 dBA (KSC 2003). This indicates that the noise from routine, non-launch related activities at KSC has minimal affect on wildlife in these natural areas.

Studies have been conducted on the noise impacts from launch operations on wood storks, a federally endangered species, and are reported in the KSC Environmental Resources Document (KSC 2003). This report indicated a startle response occurred during Space Shuttle launches, but 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.

A noise survey performed on March 14, 1990, assessed the noise levels in the habitat of Florida scrub jays and beach mice during a Titan 34D launch from LC-40 at CCAFS. No conclusions were drawn from the field data; however, ongoing observations of the scrub jay do not indicate any adverse impact. Studies of reproductive success and survival of Florida scrub jays have been conducted surrounding the CCAFS former Titan launch pads, LC-40 and LC-41. No acute or obvious direct impacts have been found resulting from several launches where noise levels approached 140 dB (KSC 2003).

Studies were conducted on wading bird colonies subjected to military overflights (at 150 m [500 ft] of altitude) with noise levels up to 100 dBA. No productivity limiting responses were observed. Nesting birds are apparently more startled by human presence in the vicinity of the nest than by noise impacts (KSC 2003).

Bald eagles utilizing a nest adjacent to the Kennedy Parkway at KSC have received episodic sound exposures of 102 dBA during Space Shuttle launches. Observation showed that the startle response to such noise levels was short-term and caused no significant impact (KSC 2003).

#### 4.1.1.1.5 Geology and Soils

No substantial environmental impacts to geology and soils have been identified from LC-39 Pad B construction activities described in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f). Similar modifications would be undertaken at LC-39 Pad A, and no substantial impacts to geology and soils would be anticipated. In addition to those facilities addressed in the EA, minor modifications are proposed for several processing facilities. These modifications are not believed to have any associated impacts, but would be subject to separate NEPA review and documentation, as appropriate.

Deposition of pollutants, principally HCl and $Al_2O_3$, from the exhaust cloud from the Ares I First Stage and the Ares V SRBs, would be similar to that currently experienced under the Space Shuttle Program. No long-term effects on geology or soils have been observed from the Space Shuttle launches (KSC 2003).

See Section 4.1.1.1.12 for a discussion of launch accidents and their potential impacts on geology and soils.

#### 4.1.1.1.6 Biological Resources

The principal Constellation Program activity that would impact biological resources at KSC would be Ares launches. Space Shuttle launches typically result in a temporary startle response from nearby birds and other wildlife. Bald eagles, wood storks, and Florida scrub jays near the launch complex do not appear to have sustained any long-term adverse impacts from the periodic Space Shuttle launches. Temporary depression of pH in the lagoons and impoundments near LC-39 due to HCl removal from the exhaust cloud often results in a fish kill, of up to several hundred individual fish. These periodic events do not appear to have had a long-term adverse impact on fish populations in these shallow waters. It is anticipated that Ares launches from LC-39 would result in similar impacts.

Construction of, modifications to, and operation of LC-39 Pad B necessary to accommodate Ares launches are addressed in The *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f). These modification/construction activities would not adversely impact habitats or vegetation at KSC. No currently undeveloped land would be taken, and none would be affected by normal operations (KSC 2007f). Nighttime lighting would be required for the construction and operation of the mobile launch platform and during modifications to and operation of LC-39 Pad B. The LC-39 Pad B lightning protection system will consist of three free-standing towers approximately 184 m (605 ft) tall with a network of nine catenary grounding cables extending between the towers and to the ground. The towers will be 24 m (80 ft) apart, forming an equilateral triangle around the launch pad surface. These characteristics raise the potential for daytime and nighttime bird strikes and nighttime bat strikes on the tall towers and grounding cables, and the potential for the tower lighting to adversely impact sea turtle hatchlings and nesting behavior at night during the nesting season. Several structural and operational mitigation strategies to reduce these potential impacts have been identified (KSC 2007f), including following KSC Exterior Lighting Guidelines to help reduce the potential impact on sea turtles. KSC also would continue to monitor potential sea turtle disorientation in accordance with its 2006 agreement with the USFWS. NASA also would implement a monitoring protocol for bird strikes based on USFWS Division of Migratory Bird Management recommendations. NASA has consulted with the USFWS under Section 7 of the Endangered Species Act regarding the potential impacts from the proposed Constellation Program (KSC 2007d). These mitigation measures are summarized in Chapter 5 of this Final PEIS.

At such time as similar additions and modifications to LC-39 Pad A become necessary to support Constellation Program activities, it is anticipated that construction activities would not adversely impact habitats or vegetation, and that similar mitigation and monitoring measures would be taken with respect to potential bird and bat strikes and sea turtle disorientation as performed at LC-39 Pad B.

Given that Constellation Program activities would take place in previously disturbed areas and existing facilities, it is unlikely that there would be any adverse impacts to floodplains or wetlands at KSC.

Although fish kills in lagoons and impoundments near the launch site can be expected following launches, no reports have been found documenting adverse effects on the Atlantic coastal region, including threatened and endangered species, and no substantial adverse effects are expected outside the near-launch area (NASA 1996). Nevertheless, the net effect of ocean currents in this region is for material suspended in the water column to be confined near the coast, with heavier material deposited near shore (NASA 1995b); consequently, if launch material is transported to the Atlantic Ocean via surface water, it would not be transported out of the region.

NASA has consulted with the National Marine Fisheries Service (NMFS) on essential fish habitat regarding launches of Ares vehicles from KSC (KSC 2007e). NASA has indicated to NMFS that over more than 25 years of Space Shuttle operations, there have been no documented long-term impacts to marine life or marine habitats. Similarly, the proposed Constellation Program launches are not expected to produce any measurable impacts to marine species or habitats.

Impacts of launch accidents on biological resources are discussed in Section 4.1.1.1.12.

#### 4.1.1.1.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.1.8 Cultural Resources

Table 4-5 lists the historic facilities on KSC that may be used by the Constellation Program. It is expected that minor upgrades and modifications to historic ground processing and launch facilities currently being used for the Space Shuttle Program and International Space Station activities would occur at KSC. While some of these modifications would be minor and have little or no effect on the use or status of the properties, some would be major and constitute an adverse effect as defined in 36 CFR 800.5, *Protection of Historic Properties*. Some of those impacts identified to date include: the removal of the Fixed and Rotating Service Structures from LC-39 Pad B and potentially from LC-39 Pad A; modifications to the remaining Firing Rooms in the Launch Control Center; and modifications to the Orbiter Processing Facility to accommodate Ares V Upper Stage or lunar payload processing. Additional adverse effects to other properties may be identified as the Program matures.

Any Constellation Program activities that may have an adverse effect on these or other historic resources at KSC would be managed in accordance with the KSC Cultural Resources Management

**Table 4-5. Proposed KSC Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Launch Complex-39, Pads A (Building J8-1708) and B (Building J7-0037) | Ares launch facilities | See Note at end of table. Demolition, modification, and rehabilitation of the launch complex. | NRHP and contributes to Historic District | Yes |
| SRB Assembly and Refurbishment facilities: Buildings 66250, L6-247, K6-494, L6-247, L7-251, 66251, 66240, 66242, 66244, 66310, 66320, 66249, and 66340. | Recovery and refurbishment of Ares I and Ares V launch vehicle elements. | Modification and rehabilitation of facility structures, features, and systems to handle higher throughput of Ares I First Stage and Ares V SRBs. | NRE (Buildings 66250, L6-247, and K6-494 only) | None |
| Missile Crawler Transporter Facilities | Crawlers used to transport Ares I and Ares V launch vehicles from VAB to launch pad | None currently identified | NRHP | None |
| Crawlerway | Roadbed used by crawlers to transport Ares I and Ares V launch vehicles between the VAB and launch pads | None currently identified | NRHP | None |
| Mobile Launch Platform(s) | Transport Ares V launch vehicles from VAB to launch pad | Modifications and rehabilitation of facility structures, features, and systems to support Ares V. | NRE | Possible |
| Launch Control Center (Building K6-099) | Launch control | Firing room 1 internal modifications including walls, ceilings, floors, HVAC, power, fire protection system. | NRHP | None |
| | | Firing rooms internal modifications including walls, ceilings, floors, HVAC, power, fire protection system. | NRHP | Yes |
| Vehicle Assembly Building (VAB) (Building K6-0848) | Vehicle assembly and integration | Modification and rehabilitation of facility structures, features, and systems such as new high bay platforms, landing structures, utilities, *etc.*, to provide necessary access to assemble and integrate the Ares launch vehicles. | NRHP | Possible |
| Operations and Checkout (O&C) Building (Building M7-0355) | Orion assembly and integration | Modification and rehabilitation of facility structures, features, and systems such as new vacuum chamber and refurbishment. | NRHP | None |
| Orbiter Processing Facilities (OPFs) (Buildings K6-894 and K6-696) | Ares V Core Stage assembly | Modification and rehabilitation of facilities' structures, features, and systems, including processing stands. | NRE | Yes |
| Parachute Refurbishment Facility (PRF) (Building M7-0657) | Process and refurbish parachutes for SRB and Orion operations | None currently identified | NRE | None |

NRHP = Asset is on the National Register of Historic Places (NRHP); NRE = National Register Eligible (asset is eligible for listing on the NRHP); NHL = National Historic Landmark;

Note: Modifications to Launch Complex-39 Pad B are addressed in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program at the John F. Kennedy Space Center Florida*. Future modifications to Launch Complex-39 Pad A and associated infrastructure are expected to be similar to those undertaken for Launch Complex-39 Pad B.

Plan and in consultation with the Florida State Historic Preservation Officer (SHPO). A Memoranda of Agreement (MOA) would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources at KSC associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

#### 4.1.1.1.9 Hazardous Materials and Hazardous Wastes

KSC's use of hazardous materials and generation of hazardous waste depend on launch processing, construction, and associated activities. The primary materials consumed are typically chemical propellants (rocket fuels and oxidizers), pressurants and purge gases, solvents, and hazardous vent gas neutralization materials.

Processing and launch activities would generate hazardous waste streams from propellant servicing, launch operations, and recovery operations. Processing the Ares I First Stage and Ares V SRBs would be similar to ongoing operations for the Space Shuttle, except that Ares I and Ares V would involve processing five and 10 solid rocket motor segments per launch, respectively, compared to eight solid rocket motor segments per launch for the Space Shuttle. All processing and recovery operations involving the solid rocket motor segments would be within current hazardous waste permits. The hazardous materials used by the Constellation Program for launch vehicle processing and the quantities of hazardous waste generated would be expected to be similar to that used by the Space Shuttle Program.

The demolition and construction activities associated with any modifications to KSC facilities would possibly involve the use of hazardous materials and the generation of hazardous wastes; however, these would not be ongoing activities. These hazardous materials would be handled in accordance with current KSC practices and prescribed laws and regulations.

#### 4.1.1.1.10 Transportation

Traffic levels on major roads and highways outside KSC are not expected to increase based on the Proposed Action. As with past NASA launches, KSC area vehicular traffic from workers and visitors would increase substantially on launch days when spectators would gather in the area to view the launch. No impacts to existing vehicular traffic levels within KSC would be expected.

The recovery and transportation of the spent Ares I First Stage and Ares V SRBs would follow Space Shuttle legacy procedures. However, the Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. Under normal recovery procedures, the spent Ares I First Stage and Ares V SRBs would be recovered via ships and transported to KSC for preparation for shipping back to Alliant Techsystems-Launch Systems Group (ATK) in Utah for refurbishment. The spent solid rocket motor casings would be loaded into the sealed containers they were originally shipped in and returned to ATK via rail. Rail transportation has been used approximately 300 times to transport fueled Space Shuttle solid rocket motor segments from Utah to KSC. Each of these has been followed with a return trip and in approximately 10 instances, return trips have carried fueled solid rocket motor segments. These shipments have complied with all applicable Department of Transportation (DOT) regulations for rail shipment of hazardous materials. As such, minor rail incidents, such as train derailments, have not resulted in ignition of the solid propellant. See Section 4.1.2.1.11 for a discussion on transportation accidents involving fueled solid rocket motor segments.

Transportation of Constellation Program components between contractor sites, KSC, and other NASA Centers would be performed following Space Shuttle protocols where applicable, and could use rail, airplane, flat-bed truck, water vessel, or a combination thereof. All shipments would strictly adhere to DOT and Coast Guard regulations. Transportation of Ares I and Ares V launch vehicles to the launch pad after assembly would be similar to the current crawler transporter method used by the Space Shuttle Program.

4.1.1.1.11 Environmental Justice

On February 11, 1994, President William J. Clinton signed Executive Order (EO) 12898, entitled, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The general purposes of the EO are to: 1) focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities with the goal of achieving environmental justice; 2) foster non-discrimination in Federal programs that substantially affect human health or the environment; and 3) give minority and low income communities greater opportunities for public participation in, and access to, public information on matters relating to human health and the environment.

EO 12898 directs Federal agencies, including NASA, to develop Environmental Justice strategies. Further, EO 12898 requires NASA, to the greatest extent practicable and permitted by law, to make the achievement of Environmental Justice part of NASA's mission. Disproportionately high adverse human health or environmental effects on minority or low-income populations must be identified and addressed. In response, NASA established an agency-wide strategy, which, in addition to the requirements set forth in the EO, seeks to: 1) minimize administrative burdens; 2) focus on public outreach and involvement; 3) encourage implementation plans tailored to the specific situation at each NASA Center; 4) make each NASA Center responsible for developing its own Environmental Justice Plan; and, 5) consider both normal operations and accidents (NASA 1995a). Each of the NASA Centers that would be involved in the Constellation Program have developed plans to comply with the EO 12898 and NASA's agency-wide strategy.

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed construction and launch activities at KSC would not be expected to generate pollutant emission levels or noise levels that would result in offsite adverse effects on human health and the environment. Construction activities would be implemented within the boundaries of KSC. The distance between the residential areas of Merritt Island and Titusville and the construction activity sites preclude any direct impacts to the public. In addition, due to remote location of the launch complexes, and by requiring launch trajectories to be over open ocean away from populated land areas, launch activities would not be expected to adversely impact human health in these communities. Launch accidents also pose no significant risk to the public. Toxic effects that could result from a liquid propellant spill during fueling operations would not extend beyond the immediate vicinity of the launch pad. Members of the public are excluded from the area at risk during launch operations. A fuel explosion on the launch pad or during the first few seconds of flight could temporarily increase the concentration of hazardous emissions outside of KSC/CCAFS boundaries. One-hour average concentrations of hazardous emissions from such an explosion would be expected to be less than the emergency response guidelines recommended by the American Industrial Hygiene Association and the National Research Council (USAF 1998). Implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of KSC.

NASA would continue to consider Environmental Justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy. Any disproportionately high or adverse human health or environmental effects of the Constellation Program at KSC on low-income or minority populations would be identified and action would be taken to resolve public concern.

#### 4.1.1.1.12 Launch Area Accidents

In the event of an anomalous launch, the point in the launch sequence when the failure occurs would determine the impact on the environment. The impacts of accidents that result in vehicle components hitting the ground on or near the launch pad or in the KSC vicinity are discussed in the following sections. Accidents that occur at higher altitudes and result in launch vehicle components falling into the Atlantic, Indian, and Pacific Oceans are discussed in Section 4.1.3.2.

An accident involving an Ares launch vehicle would produce air emissions and environmental impacts from the emissions similar in nature to those associated with normal launches. Specifically, emissions from a launch vehicle accident would not be expected to produce long-term environmental impacts, but rather local transient effects.

<u>KSC/CCAFS Range Safety</u>

A Range Safety process has been in effect since the establishment of NASA's launch facility at KSC in 1963 and parallels similar CCAFS processes. NASA's Range Safety Policy (NASA 2005c) is designed to protect the public, employees, and high-value property and is focused on the understanding and mitigation (as appropriate) of risk. The policy establishes individual and collective risk criteria for the general public (offsite public and onsite visitors) and onsite workforce for the risk of casualty from any means, including blast, debris, or toxic materials. KSC/CCAFS Range Safety protects people, as well as the range, by understanding the potential impacts of a launch area accident and establishing protection controls, including not launching if meteorological conditions might constitute a risk to the public in the event of a launch accident.

At KSC, the Range Safety process and the associated procedures ensure that:

- Direct impacts from launch accident debris are largely confined to the boundaries of KSC/CCAFS, and that those errant impacts are within acceptable limits
- Public risks are small, both from
  - Direct effects (via commanded destruction of errant launch vehicles)
  - Exhaust clouds (via launch constraints).

The most significant potential health hazard from an Ares I or Ares V launch accident outside the immediate vicinity of the launch pad would be the HCl emitted from burning solid propellant. Launch Range Safety uses models to predict launch hazards to the public and onsite personnel prior to every launch. These models calculate the risk of casualty resulting from HCl, debris, and blast overpressure from potential launch failures after accounting for local meteorological conditions. Launches may be postponed if the predicted collective public risk of injury exceeds approved levels (they may also be allowed to continue, given approval from the NPR 8715.5 designated authority, depending on the specific hazards posed and risk levels on the day of launch). This approach takes into account the probability of a catastrophic failure; the resultant hazard distributions for the principal Range Safety hazards (toxics, debris, and blast overpressure); and emergency preparedness procedures.

Program requirements and risk mitigation practices mandate the incorporation of commanded self-destruct systems on the Ares launch vehicles. In the event of destruct system activation, the propellant tanks and SRB casings would be ruptured and the propulsive capability of the entire launch vehicle would be rendered non-propulsive.

Emissions from a potential catastrophic event are routinely modeled by Range Safety in accordance with NASA's Range Safety policy. Part of this effort involves the modeling and evaluation of potential emissions by the USAF in their role as Range Safety Manager for the Eastern Test Range. While the bulk of potential risk from a launch vehicle accident is to the personnel and facilities at the launch site, a potential exists for emissions from a launch vehicle accident to reach surrounding communities. The USAF and NASA regularly coordinate with managers of the emergency preparedness organizations in the surrounding communities to review accident potentials and their associated impacts. This review establishes exposure limitations that, in conjunction with Range Safety policy, limit launch vehicle activity in periods where potential emissions could exceed the established criteria with local communities.

Models are tools that are used by safety and health professionals to aid in identifying potential impacts from an incident. While generally accepted, the modeling tools used to evaluate potential air emissions from a catastrophic launch incident are periodically updated and improved to reflect increased understanding and improved modeling capabilities. Any emissions model(s) utilized are or would be accepted by the USAF, NASA, and the launch risk community prior to its implementation. When these tools are approved for use, they would be applied to the Constellation Program launches as appropriate.

Potential Impacts of Ares I or Ares V Launch Area Accidents

An Ares I or Ares V launch vehicle accident either on or near the launch pad within a few seconds of liftoff presents the greatest potential for impact to the environment and human health, principally to visitors and workers. For either launch vehicle, a catastrophic accident on or near the launch pad would result in total destruction of the propulsive capabilities of the launch vehicle, through destruction of the Ares I First Stage or Ares V SRBs and the liquid propellant tanks.

Following a successful launch, after a few tens of seconds, the launch vehicle would be sufficiently far over the Atlantic Ocean that an accident occurring subsequently would result in components falling back to the ocean and presenting minimal threats to people or the environment. See Section 4.1.3.2 for the impacts of these accidents.

The impacts from a launch area accident can be due to several phenomena, including blast and fire, debris impacts, noise, and toxic combustion products from burning propellant.

*Blast and Fire*

In the immediate vicinity of the accident, a fireball from the ignition of the LOX/LH propellant would be expected, resulting in localized fires and other thermal effects. The burning solid propellant would be expected to induce similar localized fires. The explosion of a Delta II launch vehicle at CCAFS after launching on January 17, 1997 demonstrated that burning solid propellant could cause significant damage to facilities and structures with limited impacts to the natural environment. Vegetation burning occurred, but fires from lightning strikes are a part of the regenerative process in coastal scrub and strand ecosystems. The extensive cleanup of the debris left by the explosion reduced the potential longer-term impacts of the debris and unburned propellant in the vicinity of the Delta II launch pad (CCAFS 1998).

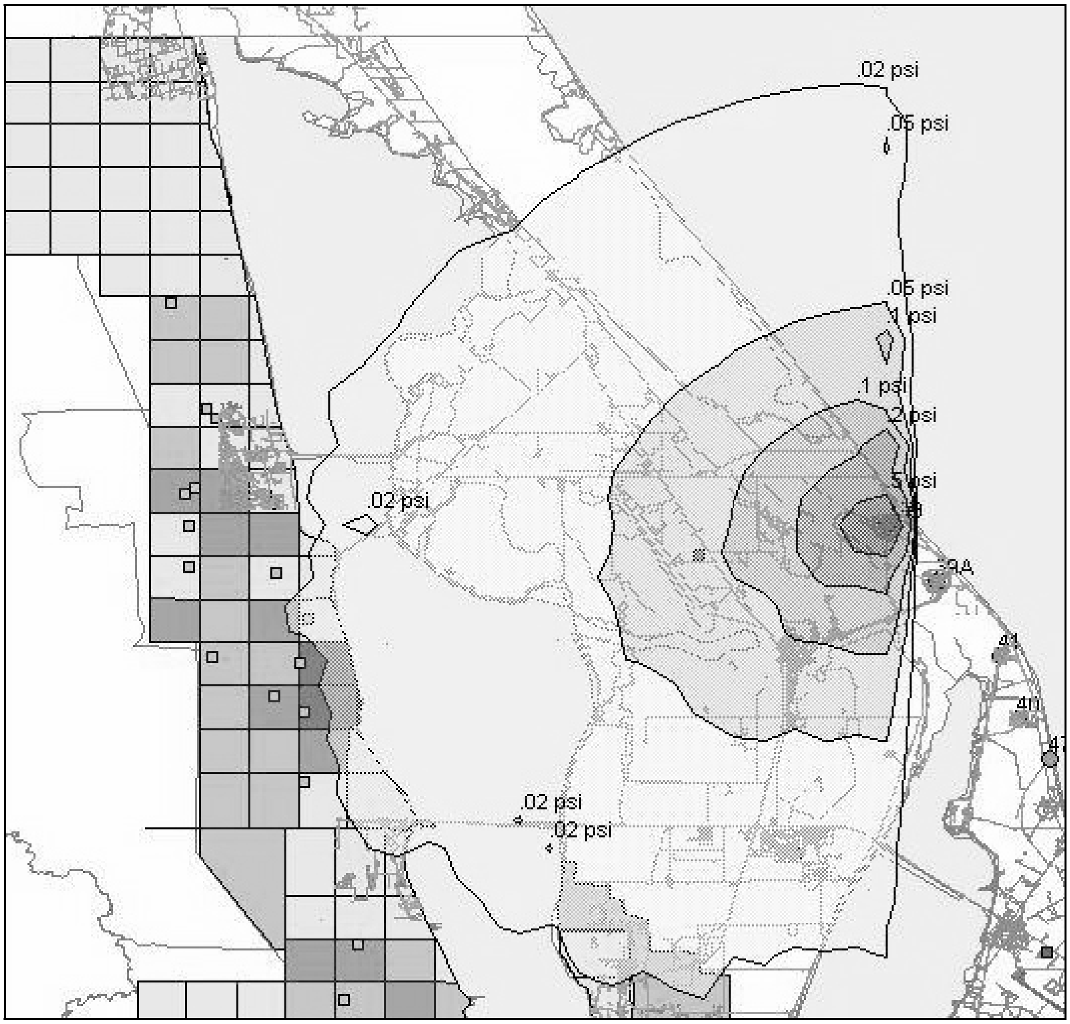
Depending on the nature of the launch vehicle accident, there could be a blast wave that would result in low-level, short-term overpressures out to several tens of kilometers. Threats to people or structures, however, would be limited to within a few kilometers of the blast.

Prior to each launch, Range Safety estimates the potential blast overpressures that might result from a catastrophic launch accident using the expected launch vehicle configuration. The calculations of the consequences of a catastrophic event consider a range of potential accident scenarios. These estimates are factored along with a number of other parameters to aid Range Safety in making the decision on whether to approve a launch. Figure 4-4 presents the results of one such calculation for a hypothetical accident during the December 2006 launch of the Space Shuttle mission STS-116 (USAF 2006). In this case, overpressures greater than 0.35 kPa (0.05 psi) (comparable to a public fireworks display from a viewing stand and sufficient to potentially cause damage to structures, including cracks in plaster and glass) would not be expected more than 10 km (6 mi) away from the blast.

Prior to an Ares I or Ares V launch, similar estimates of peak blast overpressures from hypothetical accidents would be made. Predicted peak overpressures from an Ares I or Ares V launch accident would be similar in character to those predicted for the Space Shuttle, but their absolute magnitude might vary, depending on the details of the accident assumptions and the final Ares I and Ares V vehicle designs. Pre-launch Range Safety modeling would ensure, however, that the risks to the range and public from these overpressures were controlled.

*Debris*

Range Safety also estimates the potential debris pattern that might result from a launch accident using the expected launch vehicle configuration. The calculations of the consequences of an accident consider a range of potential accident scenarios. Based on these calculations, Range Safety identifies areas within the launch area where debris may land following an accident. This may prompt the relocation of visitors and/or personnel prior to a launch and helps to ensure that risks to visitors and/or personnel and property from falling debris would be low for any accident. These estimates are also factored along with a number of other parameters to aid Range Safety in making the decision on whether to approve a launch.




Source: USAF 2006

**Figure 4-4. Predicted Blast Overpressures for a Hypothetical Space Shuttle Launch Accident Scenario**

Debris risks to onsite workers and visitors as well as to offsite areas and areas downrange under the flight path are calculated by Range Safety prior to each launch. For a typical Space Shuttle launch, onsite visitors face most of the debris risks from a Space Shuttle accident while offsite and downrange members of the public face a much smaller risk. The launch and ascent debris risks for Ares I and Ares V launches are expected to be similar to those estimated for the Space Shuttle. As with the Space Shuttle, prior to an Ares I or Ares V launch estimates of both onsite and offsite debris risks would be made by Range Safety. Debris risks from an Ares I or Ares V launch accident would be similar in character to those from the Space Shuttle, but their absolute magnitude might vary, depending on the details of the accident assumptions and the final Ares I and Ares V vehicle designs. Pre-launch Range Safety modeling would ensure, however, that the risks to the range and public from these overpressures were controlled.

*Noise*

There is very little information regarding noise levels during accidents. An explosion of a launch vehicle may produce significantly higher noise levels than those produced during normal operations. The USAF predicted a noise level of 200 dBA and an overpressure of 190 kPa (4,000 psf [28 psi]) at a distance of 33 m (100 ft) for a Titan IV/Centaur vehicle explosion (FAA 2001). However, the noise generated by an exploding Titan IV would not be representative of an Ares explosion, because the Titan IV core stage uses hypergolic propellants. In a failure, hypergolic propellants deflagrate (burn rapidly), rather than detonate, which produces less overpressure than the explosion of a launch vehicle employing solid fuel and cryogenic propellants (LOX/LH), such as an Ares launch vehicle. However, the destruct systems planned for the Ares I and Ares V should ensure that the vehicle propulsive components break up and burn rather than detonate. Thus, an accident involving an Ares would be expected to produce less noise than a smaller launch vehicle with hypergolic propellants as modeled by the USAF (FAA 2001).

*Toxic Combustion Products*

Any burning solid propellant that falls onto land would burn completely. Although $Al_2O_3$ would be deposited from a burning solid propellant exhaust cloud as it is carried downwind, little wet deposition of HCl would be anticipated from any burning solid rocket propellant. In the event of an accident on the launch pad, or very near the launch pad, the concentrations of HCl from the burning solid propellant could be expected to be in the same range as during a normal launch. These concentrations might be sufficient to damage or kill nearby biota.

The many variations in what might happen in a launch accident make predicting the maximum concentrations that might occur within a short distance (a few miles) of the pad difficult. However, these predictions are more straightforward when trying to estimate concentrations that might occur at a range of 8 to 16 km (5 to 10 miles) away, where spectators or the general public might be located. Range Safety could delay or cancel planned launches if meteorological conditions might constitute a risk to the public in the event of a launch accident.

The total amount of toxic material released from burning propellant following a launch accident would essentially be the same as is released in a normal launch. However, the burning propellant exhaust cloud would be concentrated in the area of the launch pad and solid propellant fire locations, rather than at the launch pad and along the flight trajectory as with a normal launch. If the accident occurs on or very near the launch pad, it is likely that the heat released by the burning solid propellant along with the heat released from a LOX/LH fireball would cause the solid propellant combustion products to rise to a high altitude. This would reduce close-in ground concentrations even though the quantity of solid propellant combustion products released at ground level would be greater than that released in a normal launch. The combustion products released at higher altitudes would travel much farther before settling back to the ground. This effect would tend to make the downwind concentrations of HCl, and other combustion products more like those from a normal launch. Specifically, the downwind concentrations of combustion products at a distance of several miles from an accident would be of similar magnitude to those for a normal launch.

Prior to each launch, Range Safety estimates the potential downwind air concentrations from both a normal launch and potential (hypothetical) accidents using real-time meteorology. Range Safety calculates the consequences of accidents considering a range of potential accident types, scenarios, and locations and then uses the range of possible weather conditions for the day and time of launch to predict the worst-case HCl concentrations that might result if a specific postulated accident occurred. These estimates are factored into a number of other parameters to aid Range Safety in making the decision on whether to approve a launch.

Various U.S. government agencies and industry groups have developed guidelines for potential short-term exposures to HCl by workers and the general public. These guidelines are summarized in Table 4-6.

**Table 4-6. Guidelines for Exposure to HCl**

| Organization | Guideline | Criteria |
|---|---|---|
| National Research Council | Short-Term Public Emergency Guidance Level (SPEGL) (suitable concentrations for single, short-term, emergency exposures of the general public) | 1 ppm |
| American Industrial Hygiene Association (AIHA) | Emergency Response Planning Guidelines (ERPG)-1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor. | 3 ppm |
| National Institute of Occupational Safety and Health (NIOSH) | Recommended Exposure Limit (REL) (ceiling must not be exceeded) | 5 ppm |
| OSHA | Permissible Exposure Limit (PEL) (ceiling must not be exceeded) | 5 ppm |
| AIHA | ERPG–2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. | 20 ppm |
| NIOSH/OSHA | Immediately dangerous to life and health (IDLH) | 50 ppm |
| AIHA | ERPG–3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects. | 150 ppm |

Source: NIOSH 2005

Table 4-7 and Figure 4-5 present the results of a potential downwind air concentration calculation for a hypothetical accident during the December 2006 launch of the Space Shuttle mission STS-116, provided as an illustrative case (USAF 2006). For this launch, a peak concentration of HCl of 7.1 ppm was predicted to occur approximately 11 km (6.8 mi) downwind, within KSC property. At that location, the exhaust cloud would pass in less than 10 minutes. As indicated in Table 4-6, a level of 5 ppm or less of HCl is considered acceptable by National Institute of Occupational Safety and Health (NIOSH) and OSHA for individuals to be exposed to on a routine basis in the workplace (NIOSH 2005). A level of 50 ppm is considered by NIOSH to pose an "Immediate Danger of Life and Health" and immediate actions would be needed to avoid harm (NIOSH 2005). In the case modeled, HCl levels in the downwind, offsite area would be less than 5 ppm, below levels of concern. Other criteria that could be used to indicate the potential for harm given short-term exposures to HCl have been developed by the American Industrial Hygiene Association (AIHA) in Emergency Response Planning Guides (ERPG). Their most restrictive classification, EPRG-1, sets a limit of 3 ppm while the ERPG-2 level, which is typically used for emergency planning situations, sets a guideline of 20 ppm.

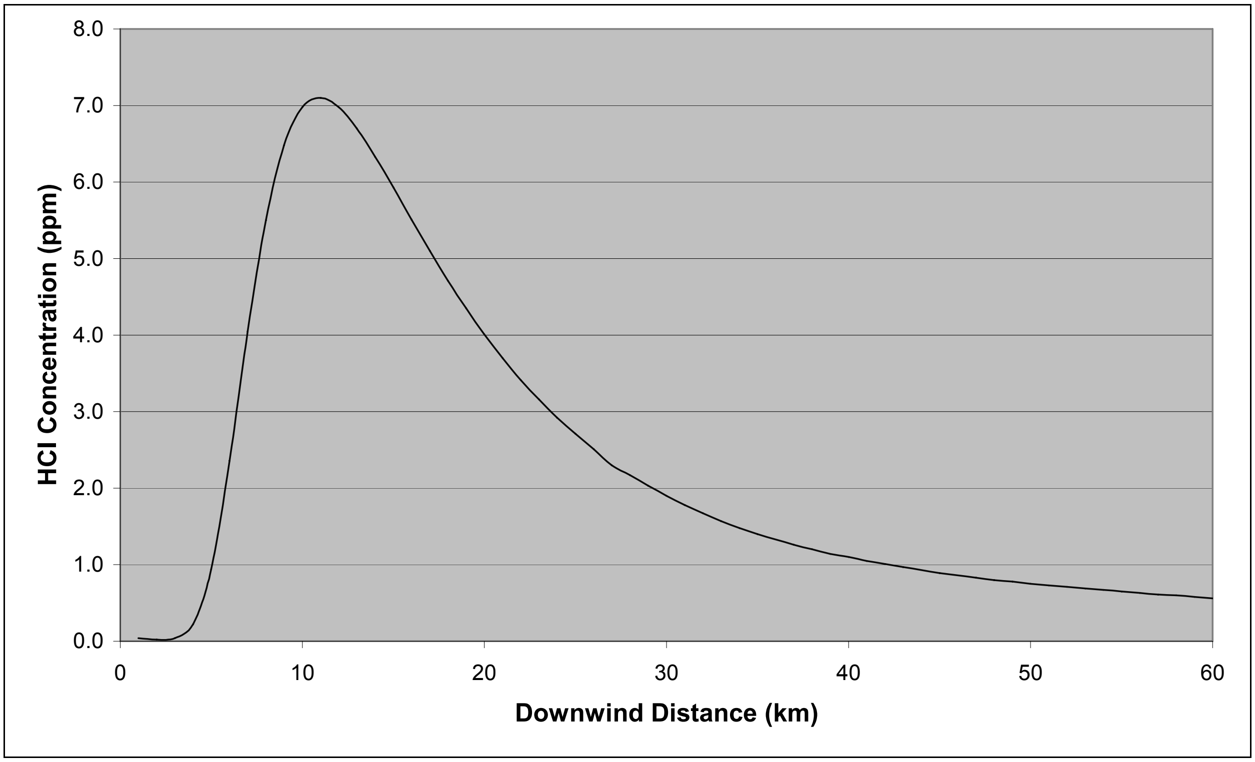
**Table 4-7. Predicted Concentrations of HCl as a Function of Distance for a Hypothetical Space Shuttle Launch Accident Scenario**

| Distance from Pad (km)* | Peak HCl Concentration (ppm) | Exhaust Cloud Arrival Time (min) | Exhaust Cloud Departure Time (min) |
|---|---|---|---|
| 1 | 0.04 | 0.0 | 2.5 |
| 2 | 0.02 | 0.0 | 4.3 |
| 3 | 0.04 | 0.2 | 7.0 |
| 4 | 0.22 | 2.0 | 10.4 |
| 5 | 0.94 | 3.7 | 12.2 |
| 6 | 2.36 | 5.5 | 13.9 |
| 7 | 4.05 | 7.3 | 15.7 |
| 8 | 5.50 | 9.0 | 17.5 |
| 9 | 6.48 | 10.7 | 19.3 |
| 10 | 6.98 | 12.4 | 21.1 |
| 12 | 6.98 | 15.9 | 24.6 |
| 14 | 6.33 | 19.4 | 28.2 |
| 16 | 5.51 | 22.9 | 31.8 |
| 18 | 4.71 | 26.3 | 35.4 |
| 20 | 4.01 | 29.7 | 39.0 |
| 22 | 3.41 | 33.2 | 42.6 |
| 24 | 2.92 | 36.6 | 46.2 |
| 26 | 2.51 | 40.0 | 49.9 |
| 28 | 2.17 | 43.5 | 53.5 |
| 30 | 1.90 | 46.9 | 67.1 |
| 35 | 1.40 | 55.5 | 66.2 |
| 40 | 1.10 | 64.0 | 75.2 |
| 45 | 0.89 | 72.6 | 84.3 |
| 50 | 0.75 | 81.1 | 93.4 |
| 55 | 0.65 | 89.7 | 102.5 |
| 60 | 0.56 | 98.2 | 111.6 |

Source: Adapted from USAF 2006

Notes: This table is provided for illustration purposes. Other meteorological conditions would result in different directions and concentrations. The wind direction (bearing from pad) is west-southwest (240 to 246 degrees).

* See conversion table on page xxiii to convert distance to miles.




Source: Adapted from USAF 2006

**Figure 4-5. Predicted Peak Concentrations of HCl as a Function of Distance for a Hypothetical Space Shuttle Launch Accident Scenario**

The estimated concentrations of combustion products at off-site locations resulting from postulated Space Shuttle accidents are well within applicable AIHA, NIOSH, and USAF guidelines/standards. It is also expected that emissions resulting from an accident during an Ares launch would not exceed any of the applicable guidelines/standards and would not create adverse impacts to air quality in the region, since the total amount of combustion products would be similar to that for a shuttle launch.

Potential Biological Impacts of Launch Area Accidents

*Impacts on Vegetation and Wildlife*—The results of a launch area accident, including extreme heat, fire, flying debris, and HCl deposition, could damage adjacent vegetation. Based on past experience from normal launches and launch accidents, damaged vegetation would be expected to re-grow within the same growing season because no lingering effects would be anticipated. The most sensitive nearby vegetative community, dune strand, was observed to sustain damage from a normal Space Shuttle launch, but recovered (CCAFS 1998).

The near-field impacts of accidents on vegetation and wildlife should be similar to the near-field impacts of normal launches. Observations of near-field impacts from launches have been documented following Space Shuttle launches. They include destruction of sensitive plant species followed by regrowth, a rapid drop in pH in nearby waters down to 1 m (3 ft) (resulting in fish kills) followed by a return to normal pH levels, and possibly deaths of burrowing animals in the path of the exhaust cloud or solid propellant fire plume (KSC 1985, CCAFS 1998).

Most if not all pieces of unburned solid propellant falling on land would be collected and disposed of as hazardous waste. Similarly, large, unburned pieces falling in shallow fresh water areas would be collected and disposed of as hazardous waste.

Birds, reptiles, and small mammals would be most at risk. Potential fires could result in temporary loss of habitat and mortality for species that do not leave the area. An accident on the launch pad would frighten nearby sensitive animal species that use the Indian and Banana Rivers (such as birds in rookeries and neo-tropical land birds). Threatened and endangered species, such as manatees, sea turtles, and other aquatic species would not be expected to be adversely affected by a launch accident.

*Essential Fish Habitat and Managed Marine Species*—Debris from launch failures has the potential to adversely affect managed fish species and their habitats. There are over 200 fish species that inhabit the waters in the vicinity of KSC that are currently managed by regional fishery management councils. NASA has consulted with the NMFS on essential fish habitat regarding launches of Ares vehicles from KSC (KSC 2007e). NASA indicated to NMFS that with over 25 years of Space Shuttle operations, there have been no documented long-term impacts to marine life or marine habitats from these operations. Similarly, the proposed Constellation Program launches are not expected to produce any measurable long-term impacts to marine species or habitats.

Potential Impacts on Ocean Environment

The predominant impacts of an early ascent accident or mission abort on the ocean environment would be due to unspent fuel and unrecoverable accident debris. The magnitude of the impact would depend on the physical properties of the materials (*e.g.*, size, composition, quantity) and the physical oceanography of the impact region. It is expected that the components would slowly corrode. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the volume of ocean water available for dilution (USAF 1996, NASA 2006d).

Falling launch vehicle fragments would be unlikely to strike a marine mammal due to the extent of the open ocean and the relatively low density of marine mammals in the surface waters of open ocean areas (USAF 1998).

Search and recovery operations would be expected to be similar to ongoing and past Space Shuttle operations that recover the SRBs. These types of operations have a negligible effect on the ocean environment.

See Section 4.1.3.2 for information on impacts of un-burned propellant on the ocean environment.

Potential Generation of Hazardous Materials

Recovered solid debris from a launch accident would be removed from coastal ocean and/or river environments, and treated as hazardous waste in accordance with Federal, state, and local regulations. After the explosion of the Delta II on January 17, 1997, an extensive cleanup of the debris left by the explosion reduced the potential longer-term impacts of the debris and unburned propellant (CCAFS 1998). Short-term impacts to the near-shore environments could result from debris generated by an Ares launch accident, but long-term impacts are not expected to be significant. Adherence to permit requirements and applicable regulations would minimize adverse impacts to water quality; therefore, no mitigation measures would typically be necessary.

#### *4.1.1.2 John C. Stennis Space Center*

Table 4-8 summarizes the major activities currently anticipated at the John C. Stennis Space Center (SSC) in support of the Constellation Program.

**Table 4-8. Description of Constellation Program Activities at SSC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Ares | Management and integration for rocket propulsion testing<br>Sea level and altitude development, certification and acceptance testing for Upper Stage J-2X engine<br>Ares V cluster testing<br>Ares V RS-68B engine testing<br>Support altitude development and certification testing for Upper Stage J-2X engine. |
| Ground Operations Project | Support:<br>• Design, development, testing, and evaluation of propellant test and delivery systems<br>• Ground engine checkout facility simulation and analysis<br>• Engine and launch facility planning and development |

At SSC, most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of the Space Shuttle Program. As such, the environmental impacts of implementing the Constellation Program at SSC would be expected to be similar to the environmental impacts from the ongoing Space Shuttle Program, which have been documented in various environmental documents including the SSC Environmental Resources Document (SSC 2005).

The principal activity at SSC in support of the Constellation Program would be full-scale ground testing of the LOX/LH liquid engines to be used on Ares I and Ares V launch vehicles. For Ares I and Ares V, this includes the J-2X Upper Stage engine, with approximately $1.3 \times 10^6$ Newton (N) (300,000 lbf) thrust (in vacuum). These engines would be similar to the Space Shuttle main engines, which provide approximately $1.7 \times 10^6$ N (397,000 lbf) thrust (at sea level) each, which are routinely tested at SSC. In addition, individual $3.1 \times 10^6$ N (688,000 lbf) thrust (at sea level) RS-68B Core Stage engines for the Ares V would be tested, and the cluster of RS-68B engines that would collectively serve as the Ares V Core Stage engines.

Several of the facilities at SSC identified for potential use in the Constellation Program may require modification. Many of the modifications would be modest such as internal upgrades to electrical wiring and moving interior walls; however, some modifications would be more extensive. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an

EA or an EIS. See Section 4.1.1.2.8 for discussion of historic/cultural impacts associated with the construction activities at SSC.

Engine testing activities for the Constellation Program would occur within the SSC Rocket Propulsion Test Complex, which includes the A-1 Test Stand, A-2 Test Stand and B-1/B-2 Test Stand Complex. The A-1 Test Stand is currently being prepared for testing the J-2X power pack and J-2X engine at sea level conditions. The B-1/B-2 Test Stand Complex possibly would be prepared for Ares V RS-68B single and Core Stage engine testing. These test stands are currently used to support other engine testing programs.

Test Complex “A” includes two single position test stands, a test control Center, observation bunkers and support systems for high-pressure gas (air, helium, nitrogen), water, electrical power, and propellants (LOX/LH). Test Complex “B” includes one dual position test stand, a test control Center, machine shop and docking and fuel transfer capabilities for liquid propellant barges. The B-2 Test Stand would require modifications in order to test the Ares V Core Stage engine cluster.

NASA is proposing to operate a new test stand (A-3) (currently under construction) in order to test J-2X engines in a vacuum, simulating altitude conditions. The environmental impacts of this new test stand are evaluated in detail in the *Final Environmental Assessment for Construction and Operation of the Constellation Program A-3 Test Stand, Stennis Space Center, Hancock County, Mississippi* (SSC 2007b). The test stand, currently called the A-3 Test Stand, would be used to test rocket engines capable of $1.3 \times 10^6$ N (300,000 lbf) thrust at a simulated altitude of approximately 30,480 m (100,000 ft). To achieve the simulated altitude environment, chemical steam generators using isopropyl alcohol, LOX, and water would run for the duration of the test and would generate approximately 2,096 kg (4,620 lbs) per second of steam to reduce the pressure in the test cell and downstream of the engine. The propellants used to test the engines would be LOX and LH. The test stand would include all systems required to run an engine test including propellant run tanks and replenishment barges. The engine to be tested would be located in a vacuum test cell at the top of the exhaust duct and would fire into a diffuser which would direct the engine exhaust away from the test stand. Gaseous nitrogen, helium, and hydrogen would be supplied to the test stand from existing onsite supply systems. The exhaust duct would be cooled by water supplied by the onsite high pressure industrial water distribution system. All water used for cooling or fire suppression would be contained in a new site retention pond.

The most notable environmental impacts from the construction and operation of the test stand would be air emissions from isopropyl alcohol and LOX/LH chemical steam generators, wetlands disturbance, noise from engine testing, cooling water usage, storm water runoff and ground water usage.

Figure 4-6 illustrates the principal anticipated activity at SSC, testing of LOX/LH engines such as the RS-68B and J-2X. Emissions from combustion of LOX/LH are primarily water vapor.


**Figure 4-6. Testing of a LOX/LH Fueled Rocket Engine at SSC**

4.1.1.2.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at SSC. The proposed activities are similar to previous uses for the Space Shuttle and other programs. The proposed modifications to existing test stands would not be expected to utilize previously undisturbed land areas or be expected to impact any undisturbed wetland areas. There are no coastal areas or essential fish habitats within the Center's boundaries.

The new A-3 Test Stand is being constructed on a site 0.40 km (0.25 mi) south of the A-1 Test Stand in an area designated in the SSC Master Plan for Medium Propulsion System Testing. The construction site is approximately 10 hectares (ha) (25 acres [ac]) located next to the SSC Access Canal. See Section 5.1.2 for a discussion of wetland mitigation measures at SSC associated with the construction of the A-3 Test Stand.

4.1.1.2.2 Air Resources

In support of the Constellation Program, air emissions at SSC would likely be generated from liquid rocket engine testing. The air quality impacts of engine testing were extensively evaluated in the *Final Environmental Impact Statement of Engine Technology Support for NASA Advanced Space Transportation Program*, referred to as the *Engine Technology Support EIS* in this Final PEIS (MSFC 1997a). That EIS evaluated the air impacts of liquid rocket engine testing for large, medium, and small thrust engines, as well as clusters of five large-thrust engines, three medium-thrust engines, and seven small-thrust engines. Most of these engines used a kerosene based fuel (RP-1) and LOX, and hence would emit a range of pollutants not expected with

LOX/LH engine testing. Emissions from the Constellation Program engine tests (see Table 2-11) would be expected to be primarily water vapor, with some $NO_x$ emissions from the high-temperature combustion of atmospheric nitrogen gas. Other permitted air emission sources at SSC (diesel generators, fuel dispensing, Freon® recovery, abrasive blasting, flare stacks, and other rocket test stands) would be assumed to continue at the same level of activity as the Space Shuttle Program and other ongoing SSC programs.

Testing of LOX/LH rocket engines is not expected to generate emissions of criteria or hazardous air pollutants other than $NO_x$. The quantities of $NO_x$ would vary based on rocket nozzle configuration, but would be within the limits allowed under the Clean Air Act (CAA) Title V operating permit for SSC. Based on the *Engine Technology Support EIS* (MSFC 1997a), which bounds planned Constellation Program test types, frequency, and engine size, the maximum quantity of $NO_x$ produced from engine testing processes is expected to be less than 0.9 metric ton (mt) (1 ton) per day.

Preliminary estimates for potential air emissions from the A-3 Test Stand indicate that for a 650-second test, the total amount of CO to be released would be 31.8 mt (35.1 tons). NASA would perform up to two rocket engine tests on the A-3 Test Stand each month during the peak development timeframe (2009-2011). This would correspond to an annual release of up to approximately 637 mt (702 tons) of CO (SSC 2007b).

Additionally, the new facility would require two flare stacks for burning excess hydrogen. The flare stacks would use natural gas or propane for ignition. The addition of these emission sources are considered an operational flexibility change to SSC's Title V Operating Permit and would require notification to the Mississippi Department of Environmental Quality (MDEQ).

Air emissions from the construction of the A-3 Test Stand include short-term fugitive air emissions from construction activities. Dust from the site is controlled using SSC best management practices.

The ambient air quality of the three southern-most Mississippi counties (Hancock, Harrison and Jackson) is considered to be in attainment or unclassifiable with the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants.

SSC currently holds a Title V Permit to Operate Air Emissions Equipment (number 1000-00005) issued by the MDEQ. This permit includes all existing air emission points at SSC including rocket engine and component test stands, diesel-fueled generators and pumps, fuel storage tanks, and flare stacks. NASA operations at SSC are considered to be a "major source" of air emissions because the potential emissions from the test facility exceed the 100 tons per year CAA criteria for air permitting.

Modifications to major sources are considered major modifications if they will increase the potential to emit by more than the Prevention of Significant Deterioration (PSD) annual significant emission threshold (100 tons per year for CO) or if they increase the potential to emit by any amount if the source is located within 100 km (62 mi) of a Class I area and the impact would be greater than 1 $\mu g/m^3$ (24-hour average) in the Class I area. The nearest PSD Class I area is the Breton National Wildlife Refuge in Louisiana which is located approximately 80 km (50 mi) from the test stand areas.

Since emissions from the A-3 Test Stand at the projected peak test schedule of two tests per month would exceed the 100 tons per year threshold, SSC performed a PSD review of this action. SSC prepared and submitted a PSD permit application to the MDEQ and consulted with the Federal Land Manager of Breton National Wildlife Refuge. The PSD permit review included a public comment period during which the public, the Environmental Protection Agency, and any other interested party could provide remarks to the MDEQ; no public comments were received. NASA has received the necessary permits and has begun the construction of the A-3 Test Stand. The proposed changes would also be reflected in the Title V Operating Permit renewal application due to the MDEQ no later than April 30, 2008.

4.1.1.2.3 Water Resources

Potential environmental impacts to surface water resources at SSC would principally be associated with rocket engine testing. SSC is permitted by the State of Mississippi to divert or withdraw water for beneficial use from the Access Canal. The canal is the primary source of water for the 250 million l (66 million gal) industrial water reservoir, which is used to provide water for fire protection and diffuser cooling water for the test stands. No additional cooling water storage would be required to meet Constellation Program testing needs. After use, the cooling water is discharged into the SSC canal system. Thermal studies of the current engine testing programs have not indicated any impact on the canal system associated with discharge water temperatures. Water from the canal is directed to the East Pearl River through a lock system. A spillway and overflow of the canal drains into Devil's Swamp, which discharges into Bayou LaCroix and the Bay of St. Louis to the Mississippi Sound (MSFC 1997a). Wastewater effluent from Constellation Program engine testing would be discharged to surface waters under a state discharge permit. Under the current permit, monitoring of these discharges would not be necessary.

SSC currently holds a MDEQ Large Construction Storm Water Permit and a U.S. Army Corps of Engineers wetlands disturbance authorization for the construction of the A-3 Test Stand, and a Mississippi Department of Marine Resources Waiver for construction of a bulkhead and mooring dolphins. SSC is preparing to apply for a MDEQ 401 Water Quality Certification and a U.S. Army Corps of Engineers 404 Permit to begin work within the SSC Access Canal. SSC is required to have a MDEQ National Pollutant Discharge Elimination System Permit to operate the A-3 Test Stand for the outfall of deluge water and steam condensate prior to commencing operations (SSC 2007d).

It is expected that any addition of workers in support of the Constellation Program would not overburden the sanitary wastewater treatment systems at SSC or increase the potable water demand beyond current system capacity. Potable water usage would increase during operation of steam generators at the new A-3 Test Stand. Thermal waste water release from A-3 Test Stand would be regulated.

The impacts of expanded engine testing on water resources at SSC were extensively evaluated in the *Engine Technology Support EIS* (MSFC 1997a). The Constellation Program engine testing activities proposed for SSC would be bounded by the engine testing activities evaluated in the *Engine Technology Support EIS*. Based on those analyses, the proposed Constellation Program testing would not result in wetland or floodplain disturbance.

The potential for groundwater, surface water, or wetland impacts from accidental propellant and/or other material spills, such as LOX/LH and isopropyl alcohol, would be minor. Any spills would be minimized through compliance with all applicable spill prevention and control requirements. No wetlands impacts other than those associated with construction of the A-3 Test Stand are anticipated. Deposition of particles from engine exhaust during test firings is anticipated to be an insignificant impact to the overall quality of wetland and floodplain areas.

No adverse impacts to floodplains at SSC would be expected as a result of the proposed Constellation Program activities.

#### 4.1.1.2.4 Noise

Construction activities associated with the A-3 Test Stand will have negligible noise impacts away from the construction site due to the large size of SSC and the Buffer Zone.

Testing of individual $2.9 \times 10^6$ N (660,000 lbf) thrust (at sea level) RS-68B LOX/LH engines would likely occur on the B-1 Test Stand. Testing of $1.3 \times 10^6$ N (300,000 lbf) thrust (in vacuum) J-2X LOX/LH engines would likely occur on the A-1 Test Stand with Upper Stage engine vacuum testing at the A-3 Test Stand. Testing of five engine RS-68B LOX/LH clusters (the current planning configuration for the Ares V Core Stage), each with a combined thrust of approximately $16 \times 10^6$ N ($3.5 \times 10^6$ lbf) (at sea level), would likely occur on the B-2 Test Stand.

The SSC test stands that would be used for the Constellation Program are located in the central portion of SSC and oriented to the north-northeast in a manner that directs sound to the north and east. Noise impacts from single-engine tests would be expected to be minimal. The test stands are well within the acoustic Buffer Zone surrounding SSC. The B-1/B-2, A-1 and A-2 test stands are currently being used for testing Space Shuttle main engines and were previously used for testing Saturn F-1 engines, including a cluster of five F-1s on the B-1/B-2 Test Stand with a combined thrust of approximately $33 \times 10^6$ N ($7.5 \times 10^6$ lbf). Other engines, including the RS-68, also have been tested at these stands in recent years.

The noise impacts of engine testing were extensively evaluated in the *Engine Technology Support EIS* (MSFC 1997a). That EIS evaluated the noise impacts of liquid rocket engine testing for large ($12 \times 10^6$ N [2.6 million lbf]) thrust, medium ($3.6 \times 10^6$ N [816,000 lbf]) thrust, and small ($1.7 \times 10^6$ N [386,000 lbf]) thrust engines, as well as clusters of five large-thrust engines, three medium thrust engines, and seven small thrust engines. Although the actual noise produced by a rocket engine is a function of several parameters, including thrust, specific impulse, exhaust velocity, throttle exit diameter, acoustic efficiency, and mechanical power, the noise generated generally scales with overall engine thrust. Thus, the noise from a single $1.3 \times 10^6$ N (300,000 lbf) thrust J-2X engine test or single $3.1 \times 10^6$ N (660,000 lbf) RS-68B engine test would be bounded by the noise generated by one $3.6 \times 10^6$ N (816,000 lbf) medium-thrust engine. Noise from the testing of a cluster of five RS-68B engines (the current planning configuration for the Ares V Core Stage), with a combined thrust of approximately $16 \times 10^6$ N (3.5 million lbf) (at sea level), would be bounded by the modeled noise impacts for the Saturn-like five F-1A engine cluster with a combined thrust of approximately $33 \times 10^6$ N ($7.5 \times 10^6$ lbf). Noise from larger clusters of RS-68B engines should also be less than that modeled for the Saturn V cluster as the overall thrust is substantially lower than the Saturn cluster. Noise modeling performed for the *Engine Technology Support EIS* therefore envelopes the offsite sound pressure levels that would be expected with engine testing proposed to support Ares I and Ares V development (MSFC 1997a).

Rocket engines produce predominantly low-frequency noise, which is particularly discernable several kilometers away from the engine(s). The human auditory system does not respond to this low frequency noise as much as it does to noise containing higher frequencies. The low-frequency sound is, however, detectable in the form of vibration in building walls and windows. Thus, two aspects of rocket engine sound are evaluated by NASA: low frequency sound that vibrates buildings and high frequency sound that is audible to humans (SSC 2005). NASA has determined, based on experience from previous testing programs at the George C. Marshall Space Flight Center (MSFC) and at SSC that the levels of significance within the respective communities are approximately 100 dB (OASPL) for low frequency noise and 70 dBA for high frequency noise (SSC 2005).

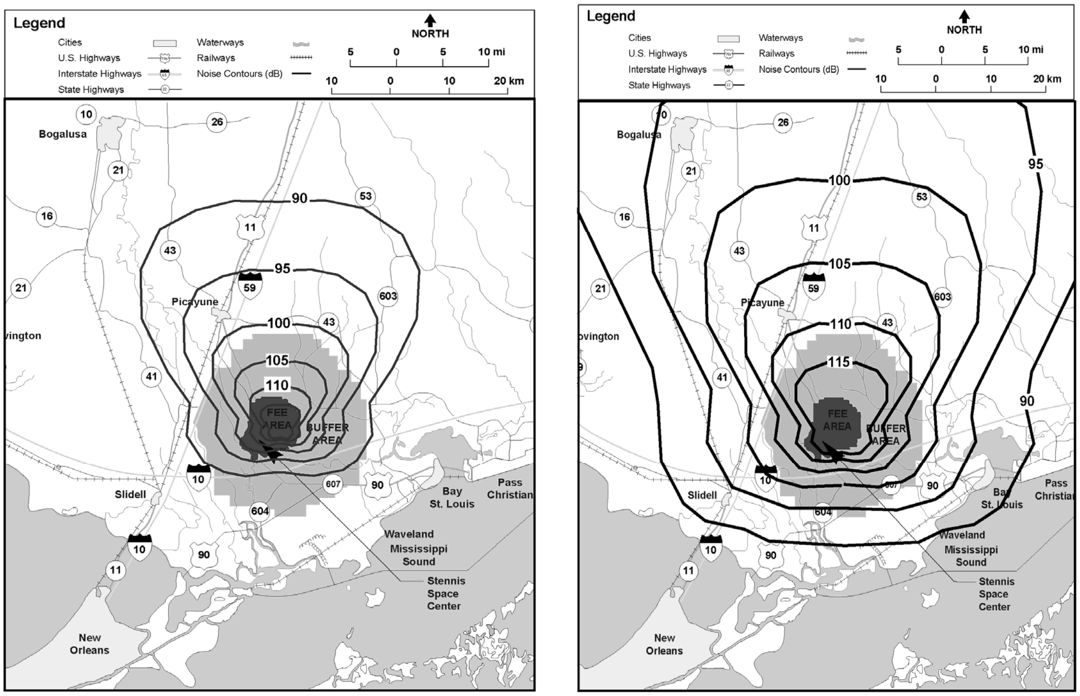
Operational Noise Predictions

Noise levels from testing large, medium, and small-thrust engines, and clusters of engines were modeled in the *Engine Technology Support EIS*. The results were reported in terms of OASPL (measured in dB) contours which did not take ground effects into account (ground effects would reduce noise levels). In addition, the modeling assumed no acoustic focusing of the noise due to unusual meteorological conditions.

The OASPL contours from the *Engine Technology Support EIS* for the medium-thrust engine (which bounds the RS-68B) and the five-large engine cluster (which bounds the current concept for the Ares V Core Stage RS-68B cluster) are shown in Figure 4-7. These noise contours were generated for the same A- and B-area test stands to be used for the Constellation Program tests. The maximum offsite OASPL for firing a cluster of five large engines was estimated to be 112 dB, at the northwestern edge of the Buffer Zone at SSC. At these levels, the chances of structural damage would be less than 0.2 percent or less than two per thousand households (MSFC 1997a).

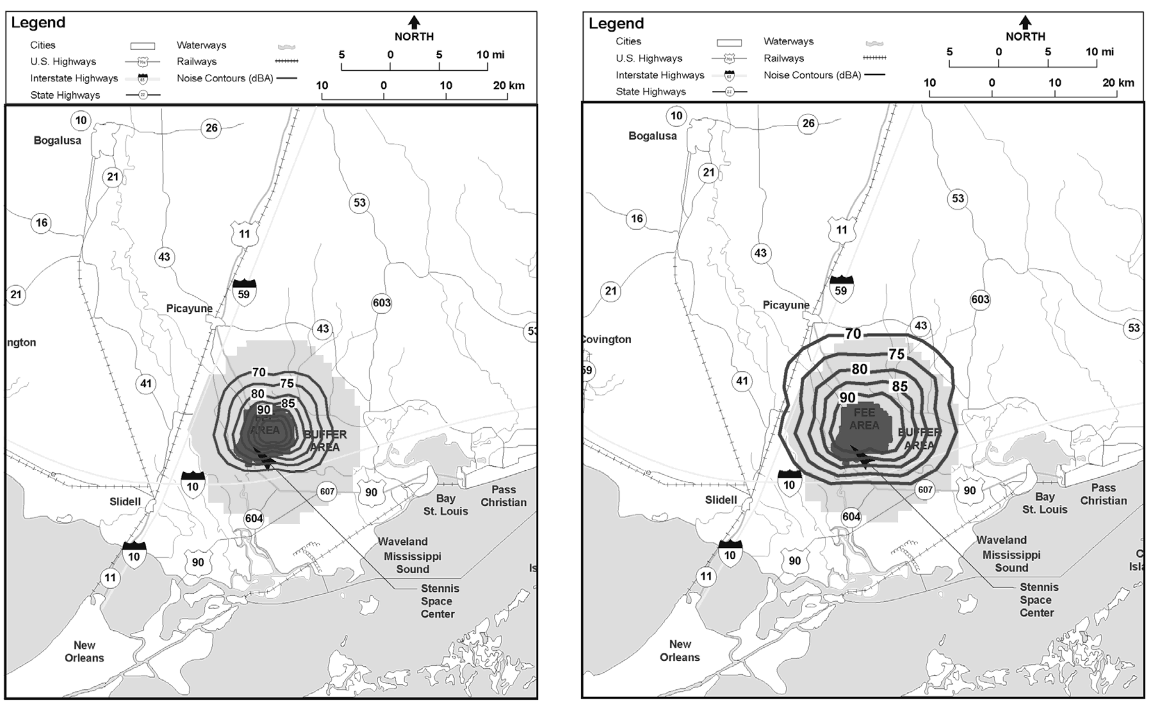
The dBA contours from the *Engine Technology Support EIS* for a single medium-thrust engine test and a test of a cluster of five large-thrust engines are shown in Figure 4-8 (MSFC 1997a). Table 4-9 summarizes the predicted noise levels. The highest offsite noise levels would be generally in a northerly direction.

These predicted noise levels, which were expected for six to seven minutes in some tests, were similar in magnitude to previous engine tests and were not expected to have a major impact on the population outside the Buffer Zone. Based on these noise levels, the *Engine Technology Support EIS* concluded that "all noise impacts are predicted to be small with the exception of the large multiple engine testing which would be considered a moderate impact." Since the engine testing in support of the Constellation Program would be bounded by the testing modeled in the *Engine Technology Support EIS*, the same conclusion is applicable with regard to Constellation Program engine testing at SSC.




Source: MSFC 1997a

**Figure 4-7. Sound Level Predictions (dB) for Testing One Medium-Thrust Engine (left) and Five Large-Thrust Engines (right) at SSC**




Source: MSFC 1997a

**Figure 4-8. A-Weighted Sound Level Predictions (dBA) for Testing One Medium-Thrust Engine (left) and Five Large-Thrust Engines (right) at SSC**

**Table 4-9. Maximum SSC Offsite Noise Levels**

| Engine | dBA | dB | Direction |
|---|---|---|---|
| Medium engine (bounds RS-68B) | 65 | 103 | North |
| Saturn-like cluster of five large engines (nearly twice the thrust of and bounding the Ares V cluster of five RS-68B engines) | 77 | 112 | North |
| J-2X on A-3 Test Stand | 77 | 96 | Southeast |

Source: Adapted from MSFC 1997a, SSC 2007b

Noise that would be produced from testing the J-2X engine, including the two stages of steam ejectors, on the A-3 Test Stand would be similar to the noise generated by Space Shuttle Main Engine tests that frequently occur at SSC but would be directed toward the south-east of the test stand through a 7 m (23 ft) diameter diffuser. The A-weighted sound pressure level at the edge of the Buffer Zone, 10.6 km (6.6 mi) from the A-3 Test Stand site is predicted to be approximately 77 dBA. Modeling of estimated sound generation predicts that the OASPL at the edge of the Buffer Zone would be approximately 96 dB. At this level the chance of structural damage outside of the SSC Buffer Zone would be negligible (SSC 2007b). Predicted J-2X values are shown in Table 4-9 for comparison with calculations from the *Engine Technology Support EIS* which bound noise levels from RS-68B engine tests. Maximum potential J-2X engine test frequency for the A-3 Test Stand would be two full duration tests per month for 650 seconds (10.8 minutes) each; for a collective total of 15,600 seconds (4.3 hours) per year.

Impacts of Noise on the Environment

Due to its large acoustical Buffer Zone, SSC was the only NASA test location considered suitable for multiple engine testing in the *Engine Technology Support EIS* Record of Decision (ROD) (MSFC 1998) for tests in which total thrust would exceed that of one large engine. The *Engine Technology Support EIS* concluded that noise impacts at SSC are expected only with large-thrust multiple engine tests.

Noise from Constellation Program engine tests at SSC would generally be similar to ongoing tests of the Space Shuttle Main Engines and the Delta IV RS-68 engine. Only the tests of the RS-68B cluster proposed for the Ares V Core Stage would potentially produce noise levels that exceed ongoing test activities. Noise levels for cluster tests would be expected to be similar to those experienced with Saturn V main engine testing between 1966 and 1970 and could result in similar noise impacts and complaints.

Health Effects

With the occupational noise controls that are already in place at SSC to protect workers from noise-related health effects from ongoing engine tests, no additional noise-related health effects among the workforce would be expected to occur during the Constellation Program engine testing activities.

As indicated in Table 4-9, the maximum predicted offsite noise levels would be 77 dBA during the Constellation Program engine testing. Offsite noise levels of 77 dBA for approximately

11 minutes would be much lower than the 85 dBA 8-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). Offsite-noise levels would also be much lower than levels at which OSHA would require hearing protection or engineering controls for workers. OSHA requires hearing protection or engineering controls be applied if workers are exposed to sound levels greater than 115 dBA for more than a quarter of an hour (29 CFR 1926.52). Therefore, no hearing effects among the general public would be anticipated.

Structural Damage Claims

The probability of structural damage from engine tests, as indicated by damage claims submitted by the public, has been found to be proportional to the intensity of the low-frequency sound. One claim in 10,000 households is expected at a level of 103 dB, one in 1,000 households at 111 dB, and one in 100 households at 119 dB (MSFC 2002a). The maximum predicted offsite noise levels for Constellation Program testing would be 103 dB for a medium engine and 112 dB for a five-engine cluster during the few minutes of engine testing (See Table 4-9). These levels indicate that as with the testing of the Saturn V engines, some structural damage to offsite structures might occur (SSC 2007b).

Speech Interference

Speech interference can occur at ambient noise levels above approximately 70 dBA, where people engaged in conversation outdoors would have to speak louder or move closer together to continue the conversation. In some locations, the noise level would be above 70 dBA during the brief Constellation Program engine tests and conversation would be momentarily interrupted. However, tests would be of short duration (J-2X test durations would be nearly 11 minutes, five cluster RS-68B test durations would be 5.5 minutes) and would be infrequent. The impacts of speech disruptions would be minimal.

Sleep Interference

Interference with sleep can occur at noise levels as low as 35 dBA. Daytime testing activities would not interfere with nighttime sleeping patterns. People who sleep during the day must normally learn to sleep with a greater level of exterior noise. At noise levels of 65 dBA (for single engine tests) and 77 dBA (for five engine cluster tests) during Constellation Program engine tests, some interference with daytime sleepers would be expected. However, due to the infrequency of tests and their short duration (less than 11 minutes), the impact would be expected to be minimal.

Mitigation

In the ROD for the *Engine Technology Support EIS* (MSFC 1998), NASA committed to take certain positive actions to mitigate the potential offsite noise impacts of testing large engines at SSC, including evaluating the potential for acoustic focusing. NASA would continue to follow those mitigative measures for Constellation Program engine testing at SSC. Details on mitigation measures are provided in Chapter 5 of this Final PEIS.

#### 4.1.1.2.5 Geology and Soils

No substantial impacts to geology or soils would be expected from refurbishing the existing test stands, constructing the A-3 Test Stand, or operating the test stands. Dust resuspension from engine testing and subsequent particulate deposition could be expected; however, no adverse impacts would be anticipated.

#### 4.1.1.2.6 Biological Resources

Constellation Program activities would not be expected to adversely impact any protected wetlands or biological resources at SSC, including Federal and state-protected species, state ranked species, and habitats. Engine testing noise and vibration would be expected to temporarily disturb wildlife in nearby areas, with some vacating the area for the duration of a given test. These effects have been observed to be temporary over the long history of engine testing at SSC.

No Federal or state-listed or state-ranked species or critical habitat has been observed in the engine test area. If a listed or ranked species is identified, the U.S. Fish and Wildlife Service would be consulted and a management procedure would be implemented.

Disturbance of the site for the A-3 Test Stand is not expected to have substantial impacts on wildlife in the area. Wildlife habitat in the immediate area of the test stand is considered marginal because of the present use of this facility complex. The site may be a suitable foraging area for various species such as deer, mice, song birds and raptors, however, activity associated with current engine tests limits its suitability as a nesting or roosting habitat (SSC 2007b).

A visual inspection of the site for the A-3 Test Stand was conducted on March 16, 2007 by a Mississippi State University research group. This was requested by the U.S. Fish and Wildlife Service prior to any earth or vegetation disturbance. No known Federal or state listed species or habitats were found. Therefore, based on prior studies, inspections, and U.S. Fish and Wildlife Service concurrence, there would be no effect on threatened and endangered species from the construction and operation of the A-3 Test Stand (SSC 2007b).

SSC manages wetlands within the facility in accordance with 14 CFR 1216.205, *Policies for Evaluating NASA Actions Impacting Floodplains and Wetlands*. In planning mitigation activities associated with development of the new A-3 Test Stand for the Constellation Program, SSC has delineated 118.54 ac (47.9 ha) wetlands credits (based on the U.S. Army Corps of Engineer's Charleston Method) which would be charged against its "Mitigation Bank."

#### 4.1.1.2.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.2.8 Cultural Resources

Table 4-10 lists the historic facilities on SSC that may be used by the Constellation Program. Modifications of the A-1 Test Stand (Building 4120) needed to support early developmental tests have been documented and mitigated through the Section 106 process completed with the Mississippi SHPO in November 2006. Additional consultation would be necessary regarding future actions involving the National Historic Landmarks at SSC, such as modifications to the B-2 Test Sand (Building 4220).

**Table 4-10. Proposed SSC Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| A-1 Rocket Propulsion Test Stand (Building 4120) | Ares I J-2X power pack and J-2X Upper Stage engine testing and Ares V J-2X Earth Departure Stage engine testing | Minor upgrades and reconfiguration | NHL | None |
| A-2 Rocket Propulsion Test Stand (Building 4122) | J-2X engine component testing | Minor repairs and modifications | NHL | None |
| B-1 Test Stand (Building 4220) | Ares V RS-68B engine testing | None currently identified | NHL | None |
| B-2 Test Stand (Building 4220) | Ares V RS-68B Core Stage engine testing | Major structural modifications – support structure, refurbishment, upgrades to structural steel | NHL | Possible |

NHL = National Historic Landmark

An area bounded by streets and including the old town site of Gainesville is NRHP-eligible and has been nominated for listing in the NRHP. Located 4.8 km (3 mi) from the Test Stand area and in the southwest part of SSC, this district would be affected by noise from Constellation Program test activities. In addition, NASA-owned land within Logtown is potentially NRHP-eligible. This district would also be affected by the noise from Constellation Program test activities.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the SSC Cultural Resources Management Plan and in consultation with the Mississippi SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

The construction of the A-3 Test Stand at SSC has not altered the historical attributes of the existing A and B test stands or affected their status as National Historic Landmarks.

#### 4.1.1.2.9 Hazardous Materials and Hazardous Wastes

SSC uses hazardous materials and generates solid and hazardous waste from its research and development operations, laboratories, instrument repair, and operations and maintenance functions. The primary activity that would result in the consumption of hazardous materials would be engine testing, which involves the use of LOX, LH, and pyrotechnic igniters. Some hazardous wastes would be generated during renovations of the engine test stands. This waste would be handled and disposed of in accordance with current SSC practices and prescribed laws and regulations.

The Constellation Program activities would likely generate similar hazardous wastes and volumes as current operations. Volumes of waste would be comparable to the current operations. Wastes would be from solvents, cleaning rags, and lead-based paint. SSC currently maintains several satellite accumulation areas and one 90-day accumulation point. Waste disposal would be performed in accordance with current SSC practice and prescribed laws and regulations.

#### 4.1.1.2.10 Transportation

Traffic levels on major roads and highways outside SSC are not expected to increase based on the Proposed Action. Operation of the test stands would require delivery of LOX, LH and, for the A-3 Test Stand, isopropyl alcohol by truck to SSC. Delivery and storage of LH and LOX is currently part of normal operations to supply propellants for testing Space Shuttle Main Engines and RS-68 engines. Each J-2X engine test would require delivery of nine truckloads of isopropyl alcohol. This would not impact transportation corridors.

Transportation of Constellation Program components between contractor sites, SSC, and other NASA Centers would strictly adhere to all DOT and Coast Guard regulations and could use rail, airplane, flat-bed truck, water vessel, or a combination thereof. Transport of J-2X and RS-68B engines between manufacturing, testing, and assembly locations would be via NASA- owned barges and flat-bed trucks, transportation methods currently utilized by the Space Shuttle Program. Traffic within the Center would be expected to remain at levels currently experienced under the Space Shuttle Program.

#### 4.1.1.2.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. Due to the size of the SSC Buffer Zone surrounding the Fee Area, the proposed engine testing and test stand construction activities at SSC would not be expected to generate pollutant emission levels or noise levels that would result in offsite adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of SSC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the

Constellation Program at SSC on low-income or minority populations would be identified and action would be taken to resolve public concern.

### *4.1.1.3 Michoud Assembly Facility*

Table 4-11 summarizes the major activities currently anticipated at Michoud Assembly Facility (MAF) in support of the Constellation Program. At MAF, these reasonably foreseeable activities would be similar to ongoing activities conducted in support of the Space Shuttle Program. For the Constellation Program, MAF would manufacture, assemble, and test components of the Orion Crew Module and Service Module and the Ares I Upper Stage. In addition, MAF could possibly manufacture and assemble the Ares V Core Stage and/or Earth Departure Stage.

**Table 4-11. Description of Constellation Program Work at MAF**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Fabrication and assembly of structural components |
| Project Ares | Manufacture and assembly of the Ares I Upper Stage and possible manufacture and assembly of the Ares V Core Stage and/or Earth Departure Stage |

While final decisions on where these activities would take place have not been made, the environmental impacts of manufacturing these components are addressed here to ensure they are captured in the overall analyses of this Final PEIS. Should these activities ultimately be accomplished elsewhere, they would be the subject of separate review and NEPA documentation, as appropriate.

The predicted environmental impacts of implementing the Constellation Program at MAF are similar to the environmental impacts of the ongoing Space Shuttle Program, which have been documented in various environmental documents, including the MAF Environmental Resources Document (MAF 2006b).

Several of the facilities at MAF identified for potential use in the Constellation Program may require modification. Many of the modifications would be modest such as internal upgrades to electrical wiring and moving interior walls. Table 2-10 summarizes the facility modifications being considered at this time to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.3.8 for discussion of historic/cultural impacts associated with facility modifications.

#### 4.1.1.3.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at MAF. There are no coastal areas at MAF; however, there is a critical habitat within MAF's boundaries (see Section 3.1.3.6 for details). The Proposed Action would utilize legacy Space Shuttle Program facilities; therefore, there would be no potential impact on the listed critical habitat.

#### 4.1.1.3.2 Air Resources

Currently, MAF is involved in the manufacture of the Space Shuttle External Tank and has historically produced about four tanks per year on average for the Space Shuttle Program. The Ares V Core Stage would use a modified version of the Space Shuttle External Tank. Given the planned launch manifest for the Ares V through 2020, it is not anticipated that MAF, if involved in the manufacture of the Ares V Core Stage, would require any major facility modifications to meet production demands for the Constellation Program.

Assembly of the Space Shuttle External Tanks includes activities that generate emissions. The LOX tank, LH tank, and intertank are welded, cleaned, have corrosion inhibitors and primer paints applied, and are coated with thermal protection systems (insulating foam and insulating ablators). Each of these processes results in air emissions of criteria and hazardous air pollutants. MAF also would be involved in fabricating the Orion Crew and Service Module structures which could result in air emissions similar to those resulting from fabrication of the External Tanks.

Because the types of manufacturing and manufacturing processes with implementation of the Constellation Program at MAF would not be expected to change substantially, the types and magnitude of hazardous air pollutants would be similar and would not measurably affect regional air quality associated with hazardous air pollutants.

Although the dimensions of the Space Shuttle External Tank would be different than the Ares V Core Stage, External Tank experience can be used to characterize the types and magnitude of Ares V toxic emissions as the manufacturing processes would be expected to be similar. In the 2003 Toxics Release Inventory, MAF reported 2,800 kg (6,200 lb) of methyl-ethyl-ketone (MEK) air releases and 1 kg (2 lb) of diisocyanate releases. The total reported emissions for the Orleans Parish in the 2003 Toxics Release Inventory exceeded 74,000 kg (162,000 lb), with the two largest emitters located within 3.2 km (2 mi) of MAF.

The 2002 National Emissions Inventory shows that the two large emitters located nearby to MAF released 962 mt (1,060 tons) of $NO_x$, 10 mt (11 tons) of $SO_2$, 101 mt (111 tons) of volatile organic compounds (VOCs), and 116 mt (128 tons) of CO. The total criteria pollutant emissions for Orleans Parish in 2002 were greater than 4,536 mt (5,000 tons) of particulate matter ($PM_{10}$); 4,536 mt (5,000 tons) of $SO_2$; 43,546 mt (48,000 tons) of $NO_x$; 97,978 mt (108,000 tons) of CO; and 19,051 mt (21,000 tons) of VOCs. Thus, the toxic air emissions from MAF are a very small fraction of the toxics released in the region. Similarly, the permitted emissions expected from the Constellation Program are very small.

Ozone depleting substances (ODS) used at MAF are associated with foam production activities for the Space Shuttle External Tank. Since 1990, NASA has reduced overall (nationwide) annual ODS usage from approximately 1.6 million kg (3.5 million lbs) down to less than 69,000 kg (150,000 lbs), a reduction of more than 96 percent. NASA is committed to finding safe and acceptable substitutes for remaining ODS uses.

The Upper Stage of the Ares I requires cryogenic insulation, or “cryoinsulation” as part of its Thermal Protection System to maintain the quality of the cryogenic propellants. It is possible that similar requirements may be identified for other Ares I and Ares V launch vehicle components as development progresses. Many Upper Stage performance requirements are expected to be similar to those of the Space Shuttle's External Tank, which uses cryoinsulation foams blown with HCFC 141b, a Class II ODS.

To comply with EPA requirements to phase out ODS, and to reduce the long-term supportability risk posed by ODS usage, NASA intends to develop cryoinsulation replacements for the Ares I Upper Stage that do not contain HCFC 141b or other phased out ODS. Building on and drawing from work done in support of the Space Shuttle Program, NASA has begun planning a research and development program to identify and qualify substitute cryoinsulation materials that meet Ares I Thermal Protection System technical requirements and fulfill the non-ODS objective. This test program would require relatively small amounts of HCFC 141b-blown foam for use in comparative studies. These studies are required to ensure that replacement cryoinsulation materials have similar properties and perform at least as well as the current materials in the challenging environments of launch, ascent, and atmospheric entry. The performance profile of the current Space Shuttle Program foams has been designated as the "performance baseline" for materials developed under these renewed research efforts. Successful implementation and operational performance of these materials will enable the Ares I and other space vehicle programs to use non-ozone depleting cryoinsulation.

Effects associated with global climate change and depletion of stratospheric ozone are discussed in Section 4.1.6.

#### 4.1.1.3.3 Water Resources

Currently, it is not anticipated that the level or nature of Constellation Program activities at MAF would substantially differ from those that have been experienced under the Space Shuttle Program. Thus, Constellation Program activities would not adversely impact surface water or groundwater resources at MAF. The manufacture and assembly of the Ares I Upper Stage and the possible manufacture and assembly of the Ares V Core Stage and/or Earth Departure Stage at MAF would not be expected to exceed the Space Shuttle External Tank production levels and it is unlikely that there would be substantial additions to the MAF workforce. Thus, the capacity of the existing potable water and sanitary systems should not be exceeded. There would be no adverse impacts to floodplains at MAF due to Constellation Program activities.

#### 4.1.1.3.4 Noise

None of the activities anticipated under the Proposed Action at MAF would be expected to result in excessive or unusual noise. Typical sources of noise at MAF include traffic and cooling towers. During peak traffic hours, noise levels are estimated to be between 70 and 74 dBA at 30 m (94.4 ft). Cooling towers are estimated to have noise levels of between 85 and 100 dBA at 1 m (3.3 ft), and between 61 and 83 dBA at 15 m (49.2 ft) (MAF 2006b).

#### 4.1.1.3.5 Geology and Soils

Due to past activities, the soils and geology at MAF can be described as previously disturbed. Portions of the soil at MAF are currently contaminated due to past spills and disposal methods

(See Section 3.1.3.5 for more details). Since there are no construction projects at MAF associated with the Proposed Action, there would be no impacts to current conditions.

4.1.1.3.6 Biological Resources

Although some facility modifications would be required at MAF, no substantial adverse impacts on terrestrial or aquatic biota or habitat are anticipated. No adverse impacts to Federal or state-listed threatened or endangered species, critical habitat, or wetlands habitat are anticipated.

4.1.1.3.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.3.8 Cultural Resources

Table 4-12 lists the historic facilities on MAF that may be used by the Constellation Program. It is expected that upgrades and internal modifications to several historic facilities would occur at MAF. While most of these modifications would be minor and have little or no effect on the use or status of the properties, some could possibly be major and constitute an adverse effect as defined in 36 CFR 800.5, *Protection of Historic Properties* (MAF 2006b).

**Table 4-12. Proposed MAF Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Vertical Assembly Facility (Building 110) | Ares I Upper Stage and Orion Crew Module, Service Module, back shell, and heat shield fabrication | Interior modifications | NRE | Possible |
| Acceptance and Preparation Building (Building 420) | Ares I Upper Stage | Major modifications, new floors, doors, tool sets, reconfiguration of the test control room | NRE | Possible |
| Pneumatic Test Facility and Control Building (Building 451 and Building 452) | Pressure and dynamic testing | Tooling structure and internal control modifications | NRE | Possible |
| High Bay Addition (Building 114) | Ares I Upper Stage and Ares V Core Stage assembly and foam application | Potential internal modifications | NRE | Possible |

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places [NRHP])

Potential adverse effects to these or any other eligible resources would be mitigated in consultation with the Louisiana SHPO in accordance with Section 106 of the National Historic Preservation Act (NHPA). An MOA would be developed and implemented for these actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

#### 4.1.1.3.9 Hazardous Materials and Hazardous Wastes

Activities undertaken at MAF in support of the Constellation Program would be within the scope of normal activities at MAF. Many processes at MAF utilize hazardous materials and generate hazardous wastes in the production of External Tanks under the Space Shuttle Program. The tanks are welded, cleaned, have corrosion inhibitors and primer paints applied, and are coated with thermal protection systems (insulating foam and insulating ablators). Similar activities and similar waste streams would be expected for the Constellation Program. These would be handled in accordance with current MAF practices and prescribed laws and regulations and the MAF plan for managing hazardous materials and waste.

#### 4.1.1.3.10 Transportation

Traffic levels on major roads and highways outside of MAF would not be expected to increase under the Proposed Action and would be expected to remain at levels currently experienced under the Space Shuttle Program. Currently, MAF uses the Mississippi River Gulf Outlet Canal to transport the Space Shuttle External Tank via barge to KSC. MAF has a Coastal Management Plan Permit to cover barge activities. MAF could use the Mississippi River Gulf Outlet Canal to transport Constellation Program components from MAF to either MSFC for testing or KSC for missions. Use of NASA's Super Guppy Aircraft would serve as backup to barge transport. Both barge and air transport would follow existing DOT transportation regulations.

In May 2007, the U.S. Army Corps of Engineers issued a draft report for public comment recommending that the Mississippi River Gulf Outlet Canal be closed. The final report will be a part of the Louisiana Coastal Protection and Restoration Report, and is due to Congress in December 2007. Congress would then consider legislation to authorize and fund the closure.

If the Mississippi River Gulf Outlet Canal is closed, a different route would need to be established for delivery of spacecraft components from MAF.

#### 4.1.1.3.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed building modifications and operation activities at MAF would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of MAF.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the

Constellation Program at MAF on minority or low-income populations would be identified and action would be taken to resolve public concern.

#### *4.1.1.4 Lyndon B. Johnson Space Center*

Table 4-13 summarizes the major activities currently anticipated at the Lyndon B. Johnson Space Center (JSC) in support of the Constellation Program. Most of these reasonably foreseeable activities that would occur at JSC, including Ellington Field and Sonny Carter Training Facility, would be similar to ongoing activities conducted in support of the Space Shuttle Program and the International Space Station. As such, the environmental impacts of implementing the Constellation Program at JSC would be expected to be similar to the environmental impacts of the ongoing Space Shuttle Program and the International Space Station. These impacts have been documented in various environmental documents, including the JSC Environmental Resources Document (JSC 2004).

**Table 4-13. Description of Constellation Program Work at JSC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Manage:<br>• Overall Project Orion<br>• Orion flight test program<br>• Crew Module and vehicle integration, contractor oversight, and independent analysis, test, and verification<br>• Flight test execution |
| Project Ares | Project Ares oversight<br>Develop:<br>• First stage recovery system<br>• Upper Stage Reaction Control System<br>• Abort certification<br>Support:<br>• Separation certification<br>• Ares I reliability and safety assessments<br>• Ares I mission operations planning<br>• Avionics simulation development |
| Ground Ops Project | Oversee Ground Operations activities |
| Mission Ops Project | Mission Operations project management<br>Development of capabilities and planning for mission operations, crew and flight controller training, and the Mission Control Center<br>Coordinate crew operations during missions |
| Lunar Lander Project | Manage Lunar Lander Project |
| Extravehicular Activities Systems Project | Manage Extravehicular Activities Systems Project |

Note: JSC provides overall Constellation Program Management, including Range Safety.

Several of the facilities at JSC identified for potential use in the Constellation Program may require modification. Many of the modifications would be minor such as internal upgrades to electrical wiring and moving interior walls. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.4.8 for discussion of historic/cultural impacts associated with the construction activities.

#### 4.1.1.4.1 Land Resources

There would be no major disturbances of land contained within JSC as a result of the Proposed Action. The Constellation Program would primarily use legacy Space Shuttle Program and current International Space Station planning, training, and support facilities.

#### 4.1.1.4.2 Air Resources

None of the activities anticipated under the Proposed Action at JSC would be expected to result in excessive or unusual air emissions.

Emissions generated as a result of the Proposed Action at JSC would likely be comparable to those associated with ongoing activities at the site. In addition to the minor occasional emissions generated at various research and test facilities, the largest potential source of emissions as a result of the Proposed Action would likely be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time. NASA would coordinate with state and local air quality planning agencies to ensure that any increased emissions conform to the State Implementation Plan for attainment with the ozone NAAQS.

#### 4.1.1.4.3 Water Resources

Constellation Program activities would not adversely impact surface water or groundwater resources at JSC. No floodplains would be adversely impacted.

Most Constellation Program activities at JSC would take place in existing facilities and would not be expected to result in increased wastewater generation from those facilities. Wastewaters from existing Center facilities that either meet or are treated to meet Texas Natural Resource Conservation Commission pollutant limits are discharged to the Clear Lake City Water Authority treatment facility as noted in Section 3.1.4.3. Some wastewaters are disposed of separately (*e.g.*, photographic chemical wastewater from the Photographic Technology Laboratory).

#### 4.1.1.4.4 Noise

None of the activities anticipated under the Proposed Action at JSC would be expected to result in excessive or unusual noise.

#### 4.1.1.4.5 Geology and Soils

Due to the amount of NASA activity at JSC over the past 50 years, the land can accurately be described as previously disturbed soil. There is also possible contamination from a Freon® 113 plume (see Section 3.1.4.3 for more details). The Proposed Action would not result in increased Freon® 113 contamination. There would be no destruction of native and pristine geology/soil conditions.

#### 4.1.1.4.6 Biological Resources

Constellation Program activities would not adversely impact biological resources at JSC. Most Constellation Program activities would take place in existing facilities. No Federal or state-protected species or habitat nor wetlands would be adversely impacted.

#### 4.1.1.4.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.4.8 Cultural Resources

Table 4-14 lists the historic facilities on JSC that may be used by the Constellation Program. Mission operations that would be needed to support Constellation Program would be conducted in Building 30, but would not involve or pose an adverse effect on the Apollo Control Room, which is a National Historic Landmark or the Mission Control Center, which is eligible for listing in the NRHP. Anticipated modifications to Building 30 would be limited to rewiring or other minor modifications that would not affect the historic status of either property.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the JSC Cultural Resources Management Plan and in consultation with the Texas SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources at JSC associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

#### 4.1.1.4.9 Hazardous Materials and Hazardous Wastes

JSC currently uses hazardous materials for various research and development activities and generates hazardous wastes. Similar activities and similar waste streams could be expected for the Constellation Program. These would be handled in accordance with current JSC practices and prescribed laws and regulations and the JSC plan for managing hazardous materials and waste.

**Table 4-14. Proposed JSC Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Crew Systems Laboratory, 3rd Floor (Building 7A) | Component and small unit bench top testing | None currently identified | NRE | Possible |
| Crew Systems Laboratory, 8- ft Chamber (Building 7) | Uncrewed integrated EVA life support system operational vacuum testing | None currently identified | NRE | Possible |
| Crew Systems Laboratory, 11- ft Chamber (Building 7) | Crewed EVA system vacuum testing | None currently identified | NRE | Possible |
| Crew Systems Laboratory, Thermal Vacuum Glovebox (Building 7) | Thermal vacuum testing of gloves and small tools | None currently identified | NRE | None |
| Communications and Tracking Development Laboratory (Building 44) | Orion test and verification | None currently identified | NRE | Possible |
| Mission Control Center (Building 30) | Mission control activities, astronaut – ground personnel interface | Internal modifications, computer and communications systems upgrades | NRE and contains Apollo Control Room NHL | Possible |
| Jake Garn Simulator and Training Facility (Building 5) | Astronaut training | Construct new Constellation Training Facility within existing Building 5 complex | NRE | Possible |
| Systems Integration Facility (Building 9) | Astronaut training | New facility within existing structure | NRE | Possible |
| Sonny Carter Training Facility (Building 920) | Astronaut training | None currently identified | NRE (Neutral Buoyancy Lab only [Building 920N]) | None |
| Space Environment Simulation Laboratory – Chamber A (Building 32) | Crewed thermal vacuum testing and altitude chambers | None currently defined for thermal vacuum testing and no modifications to the altitude chamber | NHL | Possible |

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)
NHL = National Historic Landmark

### 4.1.1.4.10 Transportation

Traffic levels on major roads and highways outside JSC are not expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, JSC, and other NASA Centers would strictly adhere to DOT regulations and could use rail, airplane, flat-bed truck, or a combination thereof. Traffic within the Center is expected to remain at levels currently experienced under the Space Shuttle and International Space Station Programs.

4.1.1.4.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed building modifications and operation activities at JSC would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of JSC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at JSC on minority or low-income populations would be identified and action would be taken to resolve public concern.

### *4.1.1.5 George C. Marshall Space Flight Center*

Table 4-15 summarizes the major activities currently anticipated at MSFC in support of the Constellation Program. At MSFC, most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of ongoing programs and projects. As such, environmental impacts of implementing of the Constellation Program at MSFC would be expected to be similar to the environmental impacts from ongoing programs and projects, which have been documented in various environmental documents, including the MSFC Environmental Resources Document (MSFC 2002a).

**Table 4-15. Description of Constellation Program Work at MSFC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Launch Abort System prime contractor oversight and independent analysis<br>Service Module prime contractor oversight and independent analysis<br>Abort Test Booster requirements development and validation |
| Project Ares | Manage Project Ares<br>Upper Stage design, development, testing, and evaluation<br>First Stage design<br>Upper Stage and Earth Departure Stage development<br>Upper Stage and Earth Departure Stage Main Propulsion Test Article engine testing<br>Ares I and Ares V Ground Vibration Testing<br>Ares V Core Stage design, development, testing, and evaluation<br>Ares V SRB design and development<br>RS-68B engine development |

Several of the facilities at MSFC identified for potential use in the Constellation Program may require modification. Many of the modifications are relatively minor such as internal upgrades to electrical wiring and moving interior walls. However, some are more extensive. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an

EIS. See Section 4.1.1.5.8 for discussion of historic/cultural impacts associated with the construction activities.

Although Table 2-10 indicates the current plans for new facility construction or major rehabilitation of existing facilities associated with Constellation Program activities at MSFC, over the longer term, additional modifications would be reasonably expected. Should such requirements develop at MSFC during the course of implementing Constellation Program activities, these activities would be subject to separate NEPA review and documentation, as appropriate.

#### 4.1.1.5.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at MSFC. Wheeler National Wildlife Refuge is located in close proximity to MSFC, an area with a high concentration of waterfowl. There are also multiple wetland areas within the Center's boundaries. None of these habitats would be impacted by the Proposed Action. There are no coastal areas or essential fish habitats within the Center's boundaries.

#### 4.1.1.5.2 Air Resources

Under the Proposed Action, no new emission source categories would be added at MSFC. The air emissions from activities addressed in the Proposed Action are consistent with those listed in MSFC's CAA Title V Air Operating Permit (2005).

A new spray-on foam insulation spray booth would be constructed in one or more existing buildings at MSFC to support the development of the Ares I Upper Stage Thermal Protection System. This activity would potentially require modification to the existing CAA Title V air permit.

Emissions from a range of potential engine testing activities at MSFC were modeled in the *Engine Technology Support EIS* (MSFC 1997a). Detailed emissions projections for the range of engine types, including engines more powerful than those anticipated for the Constellation Program, are reported in that EIS. Ongoing and proposed Constellation Program-related engine testing at MSFC would fall in the small- and medium-size thrust categories that were evaluated in the *Engine Technology Support EIS* (MSFC 1997a).

Plans for engine testing at MSFC are consistent with the February 28, 1998 ROD for the *Engine Technology Support EIS* (MSFC 1998). That ROD concluded that:

> *SSC will be used for all multiple engine testing whose collective thrust level exceeds that of one large engine. Small, medium, and large single engine testing may be conducted at either SSC or MSFC, depending on schedule and other programmatic needs established by SSC in its role as NASA's lead Center for propulsion testing.*

Thus, the emissions generated at MSFC as a result of the Proposed Action would be consistent with the existing permitted sources.

#### 4.1.1.5.3 Water Resources

Constellation Program activities at MSFC would not be expected to adversely impact surface water or groundwater resources. Wastewater discharges at MSFC are released to Indian Creek, Huntsville Spring Creek, and Wheeler Lake via 21 outfall points in accordance with an NPDES permit (MSFC 2002a). Ares Upper Stage engine testing at the Advanced Engine Test Facility (Building 4670) in the West Test Area would not require modification of the existing NPDES permit. Cooling water for engine testing would be supplied by Redstone Arsenal, and would be discharged into a 4-ha (11-ac) detention pond, which flows into Indian Creek under an NPDES permit. While small quantities of waste solvents, oils and lubricants, and dust particles may be washed into the cooling water discharge, it is not anticipated that NPDES permit requirements would be exceeded.

The water supply system from Redstone Arsenal is capable of providing $34 \times 10^6$ l per day (9 million gallons per day [mgd]) of potable water and $130 \times 10^6$ l per day (34 mgd) of industrial water. MSFC's 2001 demand of $3.8 \times 10^6$ l per day (0.85 mgd) potable water and $6.6 \times 10^6$ l per day (1.74 mgd) of industrial water was well within the facility's capabilities (MSFC 2002a). Constellation Program activities would not be expected to increase demand above these levels.

#### 4.1.1.5.4 Noise

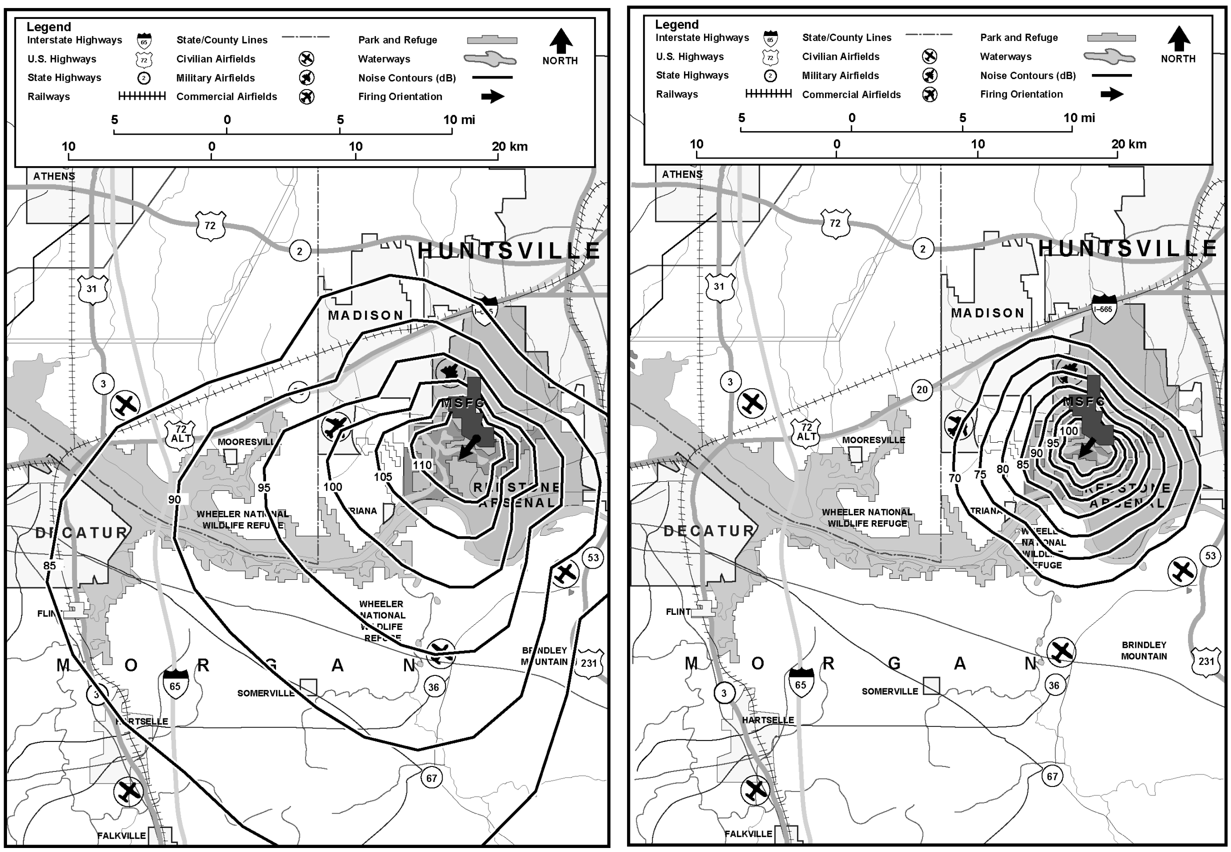
None of the activities identified in the Proposed Action would generate a major, new type of noise source at MSFC. Minor increases in noise could be experienced during construction activities. MSFC would have major responsibilities in the development of the J-2X Upper Stage engine and would perform full-scale J-2X engine testing (Main Propulsion Test Article) and engine component testing. Rocket engine testing is consistent with ongoing development and testing activities at MSFC. All engine test facilities are located in the southern portion of MSFC approximately 4 to 12 km (2.5 to 7 mi) from the nearest private property. Ground vibration testing of the Ares I launch stack and possibly the Ares V launch stack also would be performed at MSFC.

The Main Propulsion Test Article testing would occur in the Advanced Engine Test Facility, in the West Test Area. This engine test would produce approximately $9.3 \times 10^5$ N (210,000 lbf) of thrust (in vacuum) using LOX/LH and produce primarily water vapor as exhaust. The thrust of this engine is somewhat smaller than the thrust of the Space Shuttle Main Engine that was tested at MSFC. The 100% power thrust of the Space Shuttle Main Engine is $1.67 \times 10^6$ N (375,000 lbf) at sea level and $2.09 \times 10^6$ N (470,000 lbf) in a vacuum.

The noise impacts of engine testing were extensively evaluated in the *Engine Technology Support EIS* (MSFC 1997a). The *Engine Technology Support EIS* was reviewed in May 2007 in relation to proposed Constellation Program engine testing activities. That EIS evaluated the noise impacts of liquid rocket engine testing for large ($12 \times 10^6$ N [2.6 million lbf]) thrust, medium ($3.6 \times 10^6$ N [816,000 lbf]) thrust, and small ($1.7 \times 10^6$ N [386,000 lbf]) thrust engines at MSFC. Although the actual noise produced by a rocket engine is a function of several engine parameters, including thrust, specific impulse, exhaust velocity, throttle exit diameter, acoustic efficiency, and mechanical power, the noise generated generally scales with overall engine thrust.

Modeling reported in the *Engine Technology Support EIS* indicated that for the range of engine sizes evaluated, the maximum sound pressure at the closest private property to MSFC test sites would be 107 to 119 dB. This corresponds approximately to A-weighted sound levels of 97 dBA, 96 dBA, and 94 dBA for the large, medium, and small-thrust engines, respectively, modeled in that EIS (MSFC 1997a). Constellation Program engine testing at MSFC would fall in the small and medium size categories.

Figure 4-9 presents the sound level predictions for a small-thrust engine, which bounds the J-2X engine (the noise from a single $9.3 \times 10^5$ N [210,000 lbf] thrust J-2X engine test would be bounded by the noise generated by the $1.7 \times 10^6$ N [386,000 lbf] small-thrust engine as evaluated in the *Engine Technology Support EIS* [MSFC 1997a]). The sound pressure contours are presented on the left side and the A-weighted sound pressure contours are presented on the right side of Figure 4-9.




Source: MSFC 1997a

**Figure 4-9. Sound Level Predictions (dB) [left] and A-Weighted Sound Level Predictions (dBA) [right] for Testing One Small-Thrust Engine at MSFC**

The A-weighted noise contours in Figure 4-9 show the extent of middle- and high-frequency noise that humans can hear. These contours cover a much smaller area than the sound pressure (OASPL) contours because of the low content of middle- and high-frequency sounds produced by rocket engines. The A-weighted process attenuates the overall sound pressure spectrum to match the frequency response of the human auditory system. The predicted maximum offsite

A-weighted sound levels would be approximately 94 dBA. These noise levels would be very noticeable but would represent an insignificant noise impact because of the short duration (190 second maximum full duration test). People are exposed to similar noise levels from traffic, aircraft, and other normal daily activities.

The *Engine Technology Support EIS* modeling indicated that while rocket test noise would be readily apparent offsite, it would not cause significant damage to structures or impacts to the public. This is consistent with what has been historically observed in the nearby communities. Natural obstructions (trees) and short test durations would lower the risk of structural damage. The likelihood of structural damage from the small-thrust engine tests (as indicated by damage claims from the public) is less than 1 in 1,000, resulting in insignificant impacts to the community (MSFC 1997a).

The MPTA testing would produce noise levels lower than those modeled in the *Engine Technology Support EIS* for small-thrust engines but the duration of the tests would be up to seven minutes, substantially longer than the 190-second tests considered in the *Engine Technology Support EIS*. At the projected sound pressure levels, the longer duration tests would increase the nuisance potential of the tests for nearby residents and the potential disturbance of wildlife.

The maximum predicted offsite noise levels would be 94 dBA during Constellation Program engine testing. Offsite noise levels of 94 dBA for up to seven minutes would be lower than the 100 dBA two-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). The offsite noise levels would also be much lower than levels at which OSHA would require hearing protection or engineering controls for workers. OSHA requires hearing protection or engineering controls be applied if workers are exposed to sound levels greater than 115 dBA for more than a quarter of an hour (29 CFR 1926.52). Therefore, no hearing effects among the general public would be projected.

The impacts of noise from MSFC engine tests are mitigated by the physical separation of the test facilities from the general public. MSFC is surrounded by a large federally owned area consisting of the Redstone Arsenal and the Wheeler National Wildlife Refuge. These areas provide an effective noise barrier between MSFC activities and the general public.

*Speech Interference*—Speech interference can occur at ambient noise levels above approximately 70 dBA, where people engaged in conversation outdoors would have to speak louder or move closer together to continue the conversation. In some locations near MSFC, the noise level would be above 70 dBA during the brief Constellation Program engine tests and conversation would be momentarily interrupted. However, tests would be of short duration (J-2X test durations would be up to seven minutes), and would be infrequent. The impacts of speech disruptions would be minimal.

*Sleep Interference*—Interference with sleep can occur at noise levels as low as 35 dBA. Daytime testing activities would not interfere with nighttime sleeping patterns. People who sleep during the day must normally learn to sleep with a greater level of exterior noise. At noise levels of 94 dBA during Constellation Program engine tests, some interference with daytime sleepers would be expected. However, due to the infrequency of tests and their short duration (J2-X test durations up to seven minutes), the impact would be expected to be minimal.

*Mitigation*—In the ROD for the *Engine Technology Support EIS* (MSFC 1998), NASA committed to monitor meteorological conditions prior to testing at MSFC to reduce the potential impacts of acoustic focusing of the engine noise. NASA would continue to follow this practice for engine testing at MSFC during the Constellation Program. See Chapter 5 for more details.

Although MSFC has been used for space propulsion engine testing since its establishment in 1960, NASA anticipates that the testing of the full-scale, large rocket engines for the Constellation Program, including the RS-68B and clusters of five RS-68B engines, would occur at the SSC. Since full-scale, large rocket engine testing would occur at SSC, the noise generated at MSFC as a result of the Proposed Action would be limited to the typical types of engine testing, industrial and vehicular noise that are already present at the site.

#### 4.1.1.5.5 Geology and Soils

Due to past activities, the geology and soil of MSFC can be described as previously disturbed. MSFC is listed in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (EPA 2006c) because it contains preexisting soil contamination. Proposed activities would be expected to have minimal impacts to the geology and soils at MSFC. Modifications to facilities located within MSFC CERCLA site would comply with access requirements contained in Marshall Procedural Requirements (MPR) 8500.1, *MSFC Environmental Management Program*.

#### 4.1.1.5.6 Biological Resources

Constellation Program activities at MSFC would not be expected to adversely impact biological resources. Most Constellation Program activities would take place within existing structures; no new major facility construction is anticipated at MSFC. Engine testing at the Advanced Engine Test Facility in the West Test Area would be located within the boundary of Wheeler National Wildlife Refuge, approximately 1,000 feet from the Wheeler Lake wetlands. The 4-ha (11-acre) detention pond serving the Advanced Engine Test Facility is a non-jurisdictional wetland receiving NPDES-permitted engine test cooling water.

Engine tests would generate high levels of noise on an intermittent basis during a test campaign. This noise would be expected to elicit a startle response from some wildlife in nearby areas. However, engine test noise is temporary, with no long-term adverse impacts on resident species (MSFC 2002a).

Constellation Program activities would not be expected to adversely impact Federal protected species or habitat, or state-ranked species at MSFC. The Alabama cave shrimp (*Palaemonias alabamae*) (Federal endangered) inhabits cave water pools and possibly subterranean caverns in bedrock. No caves with surface entrances are known to exist in the Advanced Engine Test Facility area. The Tuscumbia darter's (*Etheostoma tuscumbia*) (state protected) only known habitat is more than a mile northwest and upstream of the West Test Area and the Advanced Engine Test Facility. A site survey has been conducted which did not reveal any protected species onsite (MSFC 2002b).

#### 4.1.1.5.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.5.8 Cultural Resources

Table 4-16 lists the historic facilities on MSFC that may be used by the Constellation Program. NASA is proposing major modifications to the Structural Dynamic Test Facility (Building 4550) to support Ares I ground vibration testing. The modifications would include updates to and refurbishment of electrical (*e.g.*, power, lighting, and communications), mechanical (*e.g.*, plumbing, fire protection, utilities, and special gas supplies) and architectural (*e.g.*, control rooms, security enhancements, and storage rooms) in support of the structural dynamic test activities. This facility was used for dynamic testing of both Saturn V and Space Shuttle launch vehicles. This action is addressed in the *Final Environmental Assessment for Modification and Operation of TS 4550 in Support of Ground Vibration Testing for the Constellation Program*.

**Table 4-16. Proposed MSFC Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Hardware Simulation Laboratory (Building 4436) | Ares Upper Stage engine control system and software testing and avionics and systems integration | Minor upgrades. May need to add air conditioning, walls, and power | NRE | Possible |
| Avionics Systems Testbed (Building 4476 ) | Ares Upper Stage avionics integration | Minor upgrades | NRE | None |
| Test Facility 116 (Building 4540) | Ares Upper Stage component testing. Subscale injector tests, RD-68 gas generator igniter tests, Main Injector Igniter Test Program | Modify test equipment to accommodate test requirements and component interfaces. | NRE | Possible |
| Structural Dynamic Test Facility (Building 4550) | Ares I and Ares V Ground Vibration Testing | See note at end of table. Major modifications | NHL | Possible |
| Hot Gas Test Facility (Building 4554) | Ares I First Stage design configuration certification and Upper Stage hot gas testing | Improvements/repairs, minor modifications, and test equipment modifications | NRE | Possible |

**Table 4-16. Proposed MSFC Historic Facilities Supporting the Constellation Program (Cont.)**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Propulsion and Structural Test Facility (Building 4572) | Testing Ares I First Stage and Ares Upper Stage pressure vessel components | Minor modifications | NHL | Possible |
| Test and Data Recording Facility (Building 4583) | Ares Upper Stage spark igniter testing, turbo-pump and combustion devices testing | Modify propellant supply lines and vacuum chamber | NRE | Possible |
| Materials and Processes Laboratory (Building 4612) | Materials testing | Minor upgrades to install equipment, plating facility may need minor modifications. | NRE | Possible |
| Structures and Mechanics Lab (Building 4619) | Ares Upper Stage engine vibration testing, structural testing, avionics thermal/vacuum testing, and heat treatment processing | Minor upgrades including installation of test equipment and reconfiguration of equipment | NRE | Possible |
| Huntsville Operations Support Center (HOSC/NDC) (Building 4663) | Engineering support for Ares Upper Stage development operations; data gathering, processing and archiving for engine and propulsion behavior analysis | Minor modifications | NRE | Possible |
| Advanced Engine Test Facility (Building 4670) | Ares Upper Stage engine testing | Major reactivation work, structural changes necessary | NRE | Possible |
| Multi-purpose High Bay and Neutral Buoyancy Simulator Complex (Building 4705) | Ares Upper Stage fabrication | Minor upgrades – new tooling, installation of equipment. | NHL | Possible |
| National Center for Advanced Manufacturing (Building 4707) | Ares Upper Stage support actions and evaluations | Substantial upgrades | NRE | Possible |
| Engineering and Development Laboratory (Building 4708) | Final assembly and preparation for Ares Upper Stage testing | Minor modifications | NRE | Possible |
| Wind Tunnel Facility (Building 4732) | Ares wind tunnel testing | None currently identified | NRE | None |

NHL = National Historic Landmark
NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)

Note: The Final *Environmental Assessment for Modification and Operation of TS 4550 in Support of Ground Vibration Testing for the Constellation Program* has addressed this action.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the MSFC Cultural Resources Management Plan and in consultation with the Alabama SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources at MSFC associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

#### 4.1.1.5.9 Hazardous Materials and Hazardous Wastes

MSFC uses hazardous materials for various research, development, and flight hardware assembly and testing activities, which in turn generate hazardous wastes. The Proposed Action would not result in hazardous material use or hazardous waste generation significantly different than current activities.

#### 4.1.1.5.10 Transportation

Traffic levels on major roads and highways outside MSFC are not expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, MSFC, and other NASA Centers would strictly adhere to all DOT and Coast Guard regulations and could use rail, airplane, flat-bed truck, water vessel, or a combination thereof. ATK plans to transport the Ares I First Stage test articles to MSFC for structural dynamic testing via rail. The railhead at Redstone Arsenal would be structurally modified to accommodate the delivery and offloading of the test article at MSFC. The proposed modifications to the railhead would be subject to separate NEPA review and documentation, as appropriate (MSFC 2007h). A barge or flat-bed truck would be used to transport Ares test articles from MAF for structural dynamic testing at MSFC. Currently, these are the transportation methods utilized by the Space Shuttle Program. Traffic within the Center is expected to remain at levels currently experienced under the Space Shuttle Program.

#### 4.1.1.5.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. Due to the size of the buffer zone between the general public and the engine test stand and the buildings to be modified, the proposed activities at MSFC would not be expected to generate noise levels that would result in offsite adverse effects on human health and the environment (MSFC 2007g). Additionally, air emissions would be within permitted levels. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of MSFC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at MSFC on minority or low-income populations would be identified and action would be taken to resolve public concern.

#### *4.1.1.6 John H. Glenn Research Center (Lewis Field and Plum Brook Station)*

Table 4-17 summarizes the major activities that would be supported by GRC for the Constellation Program. Most of these reasonably foreseeable activities at GRC would be similar to ongoing activities conducted in support of other NASA programs. As such, the environmental impacts of implementing the Constellation Program at GRC would be expected to be similar to the environmental impacts from the other ongoing programs, which have been documented in various environmental documents, including the GRC Environmental Resources Document (GRC 2005).

**Table 4-17. Description of Constellation Program Work at GRC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Manage:<br>• Integrated Orion qualification testing<br>• Orion Service Module and spacecraft adapter development<br>• Preliminary production module for the Service Module and Spacecraft Adapter<br>Design and develop simulated Orion spacecraft for Ares I-X |
| Project Ares | Design and development of Ares I Upper Stage subsystems<br>Upper Stage simulator for Ares I-X flight tests<br>Possible site for Upper Stage J-2X engine testing |
| Extravehicular Activities Systems Project | Provide power, communications, informatics, and avionics support |

At least two facilities at GRC identified for potential use in the Constellation Program may require modification. Most of the modifications would be relatively minor such as internal upgrades to electrical wiring and moving interior walls. However, some would be more extensive. Table 2-10 summarizes modifications being considered to support the Constellation Program where the changes might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.6.8 for discussion of historic/cultural impacts associated with the construction activities.

##### 4.1.1.6.1 Land Resources

Activities described under the Proposed Action would not impact or conflict with current land use plans at Lewis Field or Plum Brook Station (PBS). There are no coastal areas or sensitive habitats that would be affected under the Proposed Action.

##### 4.1.1.6.2 Air Resources

None of the activities anticipated under the Proposed Action at Lewis Field or PBS would be expected to result in excessive or unusual emissions.

Modifications to existing facilities could potentially generate air emissions during construction. Once operational, none of the modified facilities would be expected to generate excessive or unusual emissions.

Emissions generated as a result of the Proposed Action at Lewis Field and PBS would likely be much like the ongoing activities at those two sites. In addition to the minor occasional emissions generated at various research and test facilities at the two sites, the dominant source of emissions as a result of the Proposed Action would be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time.

Potential impacts at PBS would include air emissions from Ares J-2X engine testing in the Spacecraft Propulsion Research Facility (B-2 Facility) (Building 3211). These tests would be conducted in a large vacuum chamber. Exhaust products from the engine would include water vapor from the LOX/LH combustion which would be captured by the facility's exhaust system.

#### 4.1.1.6.3 Water Resources

Constellation Program activities at Lewis Field would not be expected to adversely impact surface water or groundwater resources. No new construction or major facility rehabilitation is anticipated at Lewis Field. Wastewater generated by Constellation Program activities would be within the quantities currently generated at Lewis Field and would not necessitate modification of the existing discharge permits. Site stormwater discharges to the Rocky River are subject to two state NPDES permits. There is no evidence to date that these discharges have had an adverse environmental impact on the river. Discharges from limited printing, plating, and metal shop operations have largely been eliminated by process substitution, recycling, or containerization for offsite disposal. The Industrial Waste Sewer System receives primarily cooling water discharges and some wastewaters. Discharges from the Industrial Waste Sewer are first accumulated in detention basins prior to discharge to the sanitary sewer system. The sanitary sewer system flows to the Southerly Wastewater Treatment Plant of the Northeast Ohio Regional Sewer District for tertiary treatment. No impact on groundwater or floodplains would be anticipated as a result of Constellation Program activities.

Constellation Program activities at PBS would not adversely impact surface water or groundwater resources. Wastewater generated by Constellation Program activities at PBS would not necessitate modifications of the existing permits. Wastewater discharges include stormwater, noncontact cooling water, cooling tower and boiler blowdown, and sanitary discharges. There are currently no significant sources of process wastewater at PBS with the exception of test engine cooling water, which will be contained in a closed loop system discharging to lined settling ponds.

Constellation Program activities at Lewis Field or PBS would not be expected to adversely impact either potable water supplies or sanitary sewer services provided by the county.

#### 4.1.1.6.4 Noise

None of the activities anticipated under the Proposed Action at Lewis Field or PBS would be expected to result in excessive or unusual noise. Construction activities during modifications to existing facilities could potentially be a minor noise source. Once operational, none of the modified facilities that would support the Constellation Program would be expected to generate excessive or unusual noise.

In addition to the occasional minor noise generated at various research and test facilities at the two sites, the dominant sources of noise resulting from the Proposed Action would be from vehicles (traffic) and cooling towers. Traffic noise would be approximately proportional to workforce levels for the Proposed Action. Because of the large size of the site and the background noise from the nearby airport and industrial activities at the Lewis Field site, any incremental noise associated with the Proposed Action would not directly affect the offsite population.

Additional noise generated as a result of the proposed engine testing at PBS would likely be similar to ongoing and past activities at the site. Operation of the mechanical equipment supporting the large vacuum chamber would generate noise near the building. The potential impacts associated with noise from Ares J-2X engine testing in the B-2 Facility would be minor. The tests would be conducted in a large vacuum chamber facility which is largely underground; thus, reducing the direct noise associated with the tests and the potential for impacts to people offsite and to wildlife.

#### 4.1.1.6.5 Geology and Soils

Due to past activities, the soils and geology of Lewis Field can be described as previously disturbed. There have been multiple instances of soil contamination documented at the Center (see Section 3.1.6.5 for more details). Since there are no construction requirements under the Proposed Action, there would be no impacts to current conditions at Lewis Field.

Minor soil disturbances would occur at PBS during the construction and rehabilitation phases of renovation of the Spacecraft Propulsion Research Facility (B-2 Facility-Building 3211) and the Space Power Facility (Building 1411). Installation of a seismic floor in the Space Power Facility would require some excavation. All excavations would be assayed for potential soil contamination and managed according to existing PBS policies and procedures.

#### 4.1.1.6.6 Biological Resources

Constellation Program activities at Lewis Field would not be expected to adversely impact biological resources at the site. Lewis Field is highly developed and supports typical urban wildlife. Only two known Ohio-listed potentially threatened species, pigeon grape (*Vitis cinerea*) and American chestnut (*Castanea dentata*), are located on Lewis Field. Neither species would be adversely impacted by Constellation Program activities. No activities proposed for Lewis Field are located within floodplains. Wetlands at the Lewis Field site have not been officially designated. A 2002 survey indicated four areas as probable wetlands. None of these areas would be adversely impacted by Constellation Program activities.

It is not anticipated that Constellation Program activities would adversely impact any of the federally or state protected species or special management areas on PBS. No PBS facilities are in the 100-year floodplain and no potential wetland areas are expected to be adversely impacted by Constellation Program activities.

#### 4.1.1.6.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.6.8 Cultural Resource

Table 4-18 lists the historic facilities at Lewis Field and PBS that may be used by the Constellation Program. Testing of the J-2X engine at PBS would require modifications to the B-2 Vacuum Facility, which is part of the Spacecraft Propulsion Research Facility (Building 3211), a National Historic Landmark. The modifications would be considered an adverse effect and would therefore have to be managed in consultation with the Ohio SHPO and in compliance with Section 106 of the NHPA.

**Table 4-18. Proposed GRC Historic Facilities Supporting the Constellation Program**

| Government Facility | | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|---|
| GRC-Lewis Field | Instrument Research Laboratory (Building 77) | Miniature sensor and associated validation software development for LH and LOX leak detection. | None currently identified | NRE | None |
| | 10-ft by 10-ft Supersonic Wind Tunnel Office and Control Building (Building 86) | Integrated design analysis and independent verification and validation in support of Orion vehicle design | None currently identified | NRE | None |
| GRC-Plum Brook Station | Spacecraft Propulsion Research Facility (B-2 Facility) and associated buildings (Building 3211) | Alternate site option for Ares Upper Stage and/or Earth Departure Stage testing | If selected for testing, construction and/or modifications of test chamber, cold wall, cryogenic liquid and gas systems, spray chamber modifications, new boilers and ejector systems, and building refurbishment | NHL | Yes |
| | Space Power Facility (SPF) – Disassembly Area (Building 1411) | Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing | New seismic floor and shaker system and new acoustic chamber within disassembly highbay area. | NRE | None |

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)
NHL = National Historic Landmark

The Space Power Facility (Building 1411) at PBS is eligible for listing on the NRHP and would be used for Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing. Use for this purpose would require excavating the existing floor and installing a new concrete floor. If unknown or unevaluated cultural resources are located during excavation, NASA would comply with the draft GRC Cultural Resources Management Plan, Section 106 of the NHPA, and consult with the Ohio SHPO if required.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be reviewed by the GRC Historic Preservation Officer and conducted in consultation with the Ohio SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

No specific ground-disturbing activity at Lewis Field is associated with the Proposed Action. In addition, archeological investigations have demonstrated that although Lewis Field is located in an area that would ordinarily be considered sensitive for archeological resources, it is highly disturbed throughout its extent and significant resources are unlikely to be present (GRC 2005).

There are no known archeological resources at PBS associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

#### 4.1.1.6.9 Hazardous Materials and Hazardous Wastes

Under the Proposed Action, GRC would undertake design, fabrication, assembly, test, and development activities which fall within the range of normal activities performed at GRC. The Proposed Action would not result in hazardous material use or hazardous waste generation significantly different from current activities.

#### 4.1.1.6.10 Transportation

Traffic levels on major roads and highways outside Lewis Field are not expected to increase based on the Proposed Action. Any transportation of Constellation Program components between contractor sites, Lewis Field, and other NASA Centers would be accomplished using rail, airplane, flat-bed truck, or a combination thereof, and would strictly adhere to all DOT regulations. Traffic within Lewis Field is expected to remain at current levels.

Deliveries of cryogens to support engine testing at the B-2 Facility at PBS would be expected to increase; however, local traffic patterns would not be affected. Risk reduction measures, as necessary, would be coordinated with local and state law enforcement for the safe delivery of these fuels. Normal traffic routes onsite would be redirected as necessary to reduce risk while these deliveries are made. No new transportation issues would be expected related to the transportation of test articles to and from the Space Power and B-2 Facilities.

#### 4.1.1.6.11 Environmental Justice

The Proposed Action is not expected to produce any consequences at Lewis Field or PBS related to Environmental Justice. The proposed building modifications at PBS and operation activities at both sites would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the Lewis Field and PBS vicinities.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at Lewis Field or PBS on minority or low-income populations would be identified and action would be taken to resolve public concern.

### *4.1.1.7 Langley Research Center*

Table 4-19 summarizes the major activities currently anticipated at Langley Research Center (LaRC) in support of the Constellation Program. Most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of NASA programs.

**Table 4-19. Description of Constellation Program Work at LaRC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Orion drop testing<br>Manage:<br>• Development and production of the Launch Abort System<br>• Crew Module landing system development<br>Produce:<br>• Crew Module test articles for the first pad abort and first ascent abort flight tests<br>• Separation Rings for all abort flight tests<br>Support Thermal Protection System development |
| Project Ares | Aerodynamic characterization of integrated launch vehicle, aerodynamic database development, and aeroelasticity test and analysis<br>Vehicle integration activities for Ascent Development Flight Test<br>Support Upper Stage design, development, testing, and evaluation |

There are several facilities at LaRC identified for potential use in the Constellation Program that may require modification. Most of the modifications would be relatively minor such as internal upgrades to test equipment and components. Table 2-10 summarizes modifications being considered in support of the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.7.8 for discussion of historic/cultural impacts associated with the construction activities.

#### 4.1.1.7.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at LaRC. There are wetlands located near the Impact Dynamics Facility (Gantry) (Building 1297);

however, they would not be impacted by the Proposed Action. In addition, since the Proposed Action is within the Center's current scope of activity, no sensitive habitats would be impacted.

LaRC is located within the "coastal zone" as defined under the Virginia Department of Environmental Quality's Virginia Coastal Resources Management Program. Therefore, the proposed activities under the Constellation Program must be consistent with the Virginia Coastal Resources Management Program's enforceable policies regarding coastal resources. Given the location and nature of activities to be conducted at LaRC under the Proposed Action, the following enforceable policies would not be applicable: fisheries, subaqueous land, wetlands, dunes and beaches, and shoreline sanitation. Pollution control (point and non-point source) and air pollution would be in accordance with existing Virginia Department of Environmental Quality permits as further detailed in Sections 4.1.1.7.2 and 4.1.1.7.3, respectively. LaRC has determined that these activities can be implemented within the existing framework of environmental regulations and would be consistent with the enforceable programs and advisory policies of the Virginia Coastal Resources Management Program.

#### 4.1.1.7.2 Air Resources

None of the activities anticipated under the Proposed Action at LaRC would be expected to result in excessive or unusual emissions.

Construction activities are limited and of the type to produce very few emissions. Painting of the Gantry would produce air emissions. Areas consisting of old paint that require repainting have been tested and were found to contain lead. Lead removal/abatement would be conducted in accordance with health, safety, and environmental laws and regulations. Other construction activities during facility modifications could potentially be minor emissions sources during construction. Once operational, none of the modified facilities would be expected to increase or generate unusual emissions.

Emissions generated as a result of the Proposed Action would likely be much like the ongoing activities at the site. In addition to the minor occasional emissions generated at various research and test facilities, the dominant source of additional emissions as a result of implementing the Proposed Action would be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time.

#### 4.1.1.7.3 Water Resources

Constellation Program activities at LaRC would not be expected to adversely impact surface water or groundwater resources. Most actions would be conducted inside existing buildings in accordance with the current regular usage of those buildings in support of research and development operations. LaRC does not withdraw water from any surface water resources and does not have any collection or treatment facilities. The Center operates under three discharge permits: one from the Hampton Roads Sanitary District for nonhazardous industrial wastewater and sanitary discharges, and two from the State of Virginia. The State permits govern surface water discharge outfalls from stormwater and facility industrial wastewater, primarily from cooling towers. These discharges are monitored in accordance with permit requirements. Floodplains would be unaffected by Constellation Program activities at LaRC.

Constellation Program activities at LaRC would not be expected to adversely impact potable water demand (LaRC receives potable water from independent and municipal sources) or sanitary wastewater service provided to the Center.

#### 4.1.1.7.4 Noise

None of the activities anticipated under the Proposed Action at LaRC would be expected to result in excessive or unusual noise. Noise that might result from the Proposed Action would likely be similar to the ongoing activities at the site.

The extent to which the Constellation Program might require use of existing wind tunnels and other research facilities at LaRC is not known at this time, but it is reasonable to assume that some of these facilities could be utilized. It is anticipated that the Transonic Dynamics Tunnel would be used to support the Constellation Program. It has a very low maximum operating noise level of 47 dBA (LaRC 2005).

Due to the size of the site, nature of nearby aviation activities, and lack of major residential development in the immediate vicinity of LaRC, there have not been significant community complaints regarding noise or vibrations from LaRC operations (LaRC 2005).

Construction activities from modifications to existing facilities could potentially be minor noise sources during construction. Once operational, none of the modified facilities would be expected to produce excessive or unusual noise.

In addition to the wind tunnel, supporting utility systems, and minor occasional noise generated at various research and test facilities at the site, the dominant sources of additional noise resulting from the Proposed Action would be vehicular (traffic) noise, electrical substation noise, and utility/cooling tower noise. Traffic noise would be approximately proportional to workforce levels for the Proposed Action.

#### 4.1.1.7.5 Geology and Soils

Due to past activities, the geology and soil of LaRC can be described as previously disturbed. LaRC and Langley Air Force Base are jointly listed on the CERCLA National Priorities List (EPA 2006c) for soil and water contamination. Since there would be no major construction projects associated with the Proposed Action, there would be no impacts to current conditions.

#### 4.1.1.7.6 Biological Resources

Constellation Program activities at LaRC would not be expected to adversely impact biological resources at or near the Center. Constellation Program activities would be conducted at existing facilities. No Federal or state-protected species would be adversely impacted by Constellation Program activities.

The Impact Dynamics Facility (Gantry) (Building 1297) is located approximately 200 m (656 ft) south of marsh wetlands very near a small patch of forested wetland. Should this facility be utilized, Constellation Program actions undertaken there should not adversely affect the wetlands.

#### 4.1.1.7.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.7.8 Cultural Resources

Table 4-20 lists the historic facilities on LaRC that may be used by the Constellation Program. Although several of these properties may be modified to support Constellation activities, it is expected that most of these modifications would be minor and have little or no effect on the properties.

Use of the Impact Dynamics Facility (Gantry) (Building 1297), a National Historic Landmark, for drop testing the Crew Module, may require refurbishing or modification. NASA has completed consultation with the Virginia SHPO, the Advisory Council on Historic Preservation, and the National Park Service, notifying them of the proposed modifications. NASA will comply with Stipulation III of the Programmatic Agreement it has with the National Park Service and conduct Level I Historic American Engineering Record documentation of the Gantry. The Virginia SHPO has concurred with the proposed mitigation, indicating there would be no adverse effect to the Gantry from the proposed modifications (NASA 1989).

LaRC recently conducted a center-wide architectural survey to determine the historic status of several existing facilities that may be used by the Constellation Program. LaRC is awaiting final determination from the Virginia SHPO as to the historic status of these facilities, which are listed in Table 4-20. Any Constellation Program activities that may have an adverse effect on historic resources would be reviewed by the LaRC Historic Preservation Officer and conducted in consultation with the Virginia SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

#### 4.1.1.7.9 Hazardous Materials and Hazardous Wastes

Activities under the Proposed Action would be expected to result in hazardous material use and hazardous waste generation similar to ongoing activities. Small-scale propulsion tests would require using minor amounts of propellants. Some small quantity of pyrotechnics could be used in testing at LaRC. Lead paint waste from repainting of the Gantry would be contained and disposed of in accordance with applicable State, Federal, and local regulations.

## Table 4-20. Proposed LaRC Historic Facilities Supporting the Constellation Program

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Materials Research Lab (Building 1205) | Testing of materials and test components for Orion and Ares | None currently identified | TBD | None |
| Structures and Materials Lab (Building 1148) | Testing of materials and test components for Orion and Ares | None currently identified | TBD | None |
| COLTS Thermal Lab (Building 1256C) | Stress testing for Orion, small articles/thermal protective materials | None currently identified | TBD | None |
| Thermal Structures Lab (Building 1267) | Stress testing for Orion, small articles/thermal protective materials | None currently identified | TBD | None |
| Fabrication and Metals Technology Development Lab (Building 1232A) | Fabrication of models and test items for Orion and Ares | Floor modifications for new roll press. | TBD | None |
| CF4 Tunnel (Building 1275) | Scale model testing for Orion | None currently identified | TBD | None |
| Unitary Wind Tunnel (Building 1251) | Scale model wind tunnel testing for Orion and Ares | None currently identified | TBD | None |
| 31-Inch Mach 10 Tunnel (Building 1251) | Scale model testing for Orion | None currently identified | TBD | None |
| Vertical Spin Tunnel (Building 645) | Scale model testing for Orion, including the Launch Abort System | None currently identified | TBD | None |
| Transonic Dynamics Tunnel (Building 648) | Scale model wind tunnel testing for Orion and Ares | Modify test equipment for wind tunnel models | TBD | None |
| Gas Dynamics Complex – 20-inch Mach 6 Tunnel (Building 1247D) | Scale model wind tunnel testing for Orion and Ares | None currently identified | TBD | None |
| Impact Dynamics Facility (Gantry) (Building 1297) | Orion drop tests | Replace elevator, complete painting of upper section and repair/replacement of components | NHL | None |
| Hangar (Building 1244) | Possible assembly of some large Orion flight test articles inside hangar | None currently identified | TBD | None |

NHL = National Historic Landmark
TBD = To Be Determined (awaiting final determination from the State Historic Preservation Officer)

Wind tunnel testing could use carbon tetrafluoride ($CF_4$) and HFC-134a (1,1,1,2-tetrafluoroethane – a refrigerant gas) in closed systems. Both $CF_4$ and HFC-134a have high global warming potential; 6,500 and 1,300 times greater than $CO_2$ respectively. See Section 4.1.6.2 for the potential impacts of the Constellation Program on global climate change.

4.1.1.7.10 Transportation

Traffic levels on major roads and highways outside LaRC would not be expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, LaRC, and other NASA Centers would strictly adhere to all DOT regulations and could use rail, airplane, flat-bed truck, or a combination thereof. Traffic within the Center is expected to remain at levels currently experienced.

4.1.1.7.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed building modifications and operation activities at LaRC would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of LaRC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at LaRC on minority or low-income populations would be identified and action would be taken to resolve public concern.

#### *4.1.1.8 Ames Research Center*

Table 4-21 summarizes the major activities currently anticipated at Ames Research Center (ARC) in support of the Constellation Program. At ARC, most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of NASA programs. As such, the environmental impacts of implementation of the Constellation Program at ARC would be expected to be similar to the environmental impacts of ongoing NASA programs, which have been documented in various environmental documents, including the ARC Environmental Resources Document (ARC 2005).

**Table 4-21. Description of Constellation Program Work at ARC**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Manage Orion Thermal Protection System development |
| Project Ares | Design and develop Ares I fault detection<br>Ascent abort blast analysis |
| Mission Ops Project | Support design, development, test, and evaluation of command and control systems |

#### 4.1.1.8.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at ARC. In addition, since the Proposed Action would be within the Center's current scope of activity, no sensitive habitats would be impacted.

#### 4.1.1.8.2 Air Resources

None of the activities anticipated under the Proposed Action at ARC would be expected to result in excessive or unusual emissions.

Emissions generated as a result of the Proposed Action would likely be much like the ongoing activities at the site. In addition to the minor occasional emissions generated at various research and test facilities, the dominant source of additional emissions as a result of the Proposed Action would be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time.

#### 4.1.1.8.3 Water Resources

Quantities of wastewater generated by Constellation Program activities would not expect to require modifications to existing NPDES permits. No impacts to surface water or groundwater resources at ARC would be anticipated. Constellation Program activities would not impact floodplains at ARC.

Constellation Program activities would not be expected to adversely impact the sanitary wastewater treatment systems at ARC or increase the potable water demand beyond current system capacity.

#### 4.1.1.8.4 Noise

None of the activities anticipated under the Proposed Action at ARC would be expected to result in excessive or unusual noise. The noise that might result from the Proposed Action at ARC site would be expected to be similar to the noise generated by the ongoing activities at the site.

Noise generated by wind tunnels and aircraft operations at ARC and Moffett Field has historically been a source of complaints from surrounding communities (ARC 2005). The extent to which the Constellation Program might require use of wind tunnels and other research facilities at ARC is not known, but it is reasonable to assume that use of some of these facilities would occur.

Construction activities for modifications to existing facilities could potentially be minor noise sources during construction. Once operational, none of the modified facilities that would support the Constellation Program would be expected to result in excessive or unusual noise.

In addition to the wind tunnel, supporting utility systems, and minor occasional noise generated at various research and test facilities at the site, the dominant source of additional noise as a result of the Proposed Action would likely be vehicular (traffic) noise, electrical substation noise, and utility/cooling tower noise. As indicated in Chapter 3, these types of routine noises are ongoing at

ARC, and because of the large size of the site and the nature of the nearby Moffett Field aircraft activities, these noise sources would not be expected to directly affect the offsite population.

#### 4.1.1.8.5 Geology and Soils

Due to past activities, the soils and geology at ARC can be described as previously disturbed. Moffett Field is listed on the CERCLA National Priorities List (EPA 2006c), with other areas of ARC known to have soil contamination (see Section 3.1.8.5 for more details). Since there are no new construction anticipated under the Proposed Action there would be no impacts to current conditions.

#### 4.1.1.8.6 Biological Resources

Constellation Program activities would not adversely impact biological resources or wetland resources at ARC. No Federal or state-protected species would be adversely impacted nor would any designated habitat or essential fish habitat.

#### 4.1.1.8.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.8.8 Cultural Resources

Table 4-22 lists the historic facilities on ARC that may be used by the Constellation Program. No modifications to these facilities are currently identified. Thus, none of these properties would experience an adverse effect as defined in 36 CFR 800.5.

**Table 4-22. Proposed ARC Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| 11-foot Transonic Tunnel (Building N227A) (part of Unitary Plan Wind Tunnel [Building N227]) | Ares scale model testing. | None currently identified | NHL | None |
| Arc Jet Laboratory (Building N238) | Orion components and Thermal Protection System testing. Ares support. | Under evaluation to support Thermal Protection System testing | NRE | None |
| Unitary Plan Wind Tunnel (Building N227) | Orion components and Thermal Protection System testing. Ares support. | None currently identified | NHL | None |

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)
NHL = National Historic Landmark

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the ARC Cultural Resources Management Plan and in consultation with the California SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

##### 4.1.1.8.9 Hazardous Materials and Hazardous Wastes

Activities under the Proposed Action would entail hazardous material use and hazardous wastes would be generated as a result of these activities, which would be similar to ongoing activities. Modifying existing facilities may result in some temporary additional hazardous material use and/or hazardous waste generation. All hazardous waste would be handled and disposed of in accordance with current NASA practices and prescribed rules and regulations.

##### 4.1.1.8.10 Transportation

Traffic levels on major roads and highways outside ARC would not be expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, ARC, and other NASA Centers would strictly adhere to DOT regulations and could use rail, airplane, flat-bed truck, or a combination thereof. Traffic within the Center is expected to remain at current levels.

##### 4.1.1.8.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed activities at ARC would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of ARC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at ARC on minority or low-income populations would be identified and action would be taken to resolve public concern.

#### *4.1.1.9 White Sands Missile Range/Johnson Space Center White Sands Test Facility*

Table 4-23 summarizes the major activities currently anticipated at the U.S. Army's White Sands Missile Range (WSMR) and NASA's JSC White Sands Test Facility (WSTF) in support of the Constellation Program.

**Table 4-23. Description of Constellation Program Work at WSMR and WSTF**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Orion | Conduct launch abort flights tests at WSMR<br>Reaction Control System tests at WSTF |
| Project Ares | Thrust Vector Control and Reaction Control System testing at WSTF |

The Constellation Program would perform uncrewed launch pad abort tests and ascent abort flight tests at WSMR to evaluate the effectiveness of the Launch Abort System. NASA has prepared the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center, White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b) which evaluates the potential environmental impacts of both the planned tests and construction necessary to support the tests.

Several of the facilities at WSTF and WSMR identified for potential use in the Constellation Program would require modification. Table 2-10 summarizes the proposed modifications to facilities which are being considered for use by the Constellation Program where the changes might impact historic facilities or the changes might have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.9.8 for discussion of historic/cultural impacts associated with the construction activities. Modifications to launch complexes at WSMR are being addressed in separate NEPA documentation (WSTF 2007b).

#### 4.1.1.9.1 Land Resources

Activities described under the Proposed Action would not conflict with the current land use plan at WSTF. Testing of the Thrust Vector Control and Reaction Control System would occur in existing WSTF 300 and 400 area Small Altitude Simulation Systems facilities. These facilities are currently being used for similar tests for Minuteman missiles and the Space Shuttle Program and would not require new construction. No impacts to land resources are expected.

Activities described under the Proposed Action also would not conflict with the current land use plan at WSMR. There are multiple recreation, wilderness, and wildlife areas that surround WSMR. The Trinity Site National Historic Landmark is contained within WSMR. None of these areas would be impacted by any actions described in the Proposed Action, as WSMR is regularly used for rocket and munitions tests.

The construction of a new launch complex and associated facilities at LC-32 is proposed for Launch Abort System pad abort and ascent abort testing at WSMR (WSTF 2007b). LC-32 is an existing launch site designed for rocket flight tests, which are typical activities carried out at WSMR. The areas downrange (along the Launch Abort System flight trajectory) are also used for landing other test rockets and vehicles at WSMR.

Impacts on airspace from the Proposed Action would be minimal. Proposed Launch Abort System testing would involve overflights of the range from LC-32 to downrange landing sites. For the two pad abort tests, the test articles would land within 1.3 km (0.8 mi) downrange from the launch pad. The test article would be recovered for post-flight inspections. For the up to four ascent abort flight tests proposed to demonstrate separation and recovery under flight conditions, the test articles are estimated to land within 114 km (71 mi) downrange from the launch pad. In all cases, the test articles would land within WSMR. The use of WSMR controlled airspace ensures that there is no impact on commercial air traffic. Activities would fall within the scope of normal activities in WSMR-controlled airspace. Coordination efforts would minimize any airspace conflicts with concurrent testing or training operations being conducted on WSMR.

#### 4.1.1.9.2 Air Resources

During testing of the Thrust Vector Control and Reaction Control Systems at WSTF, monomethylhydrazine and nitrogen tetroxide are combined, producing water vapor and nitrogen as the primary combustion products. These emissions would be captured by the test facilities' vacuum systems. These facilities are currently being used for similar tests for Minuteman missiles and Space Shuttle Programs therefore no new types of air emissions are expected.

Construction at LC-32 at the WSMR would generate dust; thus, dust control measures such as spraying water from water trucks or dust suppressants would be used. Launch Abort System vehicle exhaust, combustion products from fuels burned in internal combustion engines, and dust raised by vehicles off unpaved roads would be the principal impacts to air quality as a result of Proposed Action activities.

Portable generators may also be used for construction. Depending on their proposed use and duration of use, permits may be required by the State of New Mexico to operate the generators.

Dust, or soil particulate matter, would be dispersed into the air at vehicle landing sites from vehicles impacting the ground and from recovery vehicles. However, only small quantities of dust would be generated during these short and infrequent events.

The most significant activity at WSTF and WSMR that would generate air emissions are the test launches at WSMR. Two launch pad abort tests and up to four ascent abort tests are planned. Each ascent abort test would use an Abort Test Booster. The Abort Test Boosters would collectively utilize 202,500 kg (445,500 lb) of solid propellant. Each Launch Abort System would use 2,300 kg (5,200 lbs) of solid propellant.

A maximum of 217 mt (239 tons) of propellant would be burned over the course of the pad abort and ascent abort tests. Preliminary estimates of air emissions were made using typical emission factors previously used for solid rocket motor air permit modeling (SECOR 2001). These factors or weight fractions (relative to the amount of burned polybutadiene acrylonitrile (PBAN) propellant) are 30 percent for total suspended particles (TSP), 12.5 percent for $PM_{10}$, 2.67 percent for $NO_x$, and 20.5 percent for HCl. Using these factors, the total expected emissions from the pad abort and ascent abort tests are 65 mt (72 tons) of TSP, 27 mt (30 tons) of $PM_{10}$, 5.8 mt (6.4 tons) of $NO_x$, and 44 mt (49 tons) of HCl. If the bounding assumption is made that all $PM_{10}$ emissions are less than 2.5 microns in diameter, the $PM_{2.5}$ emissions may be conservatively estimated as 27 mt (30 tons).

The largest Abort Test Booster that would be used for Launch Abort System flight tests uses about 10 percent of the propellant of the five-segment First Stage planned for Ares I. As with similar launches of Space Shuttle SRBs, abort test launches would have minimal air quality impact at WSMR due to their short burn duration and the wide dispersion of the materials along the flight path. Testing the smaller Abort Test Boosters at WSMR would not be expected to exceed Federal regulatory limits.

The WSMR launch pads are distant from residential and commercial areas. As a result, exhaust clouds from Launch Abort System abort tests would be expected to dissipate and not measurably affect air quality in surrounding communities.

Based on daily activities at WSMR, and the short duration of the actual vehicle testing, there would be no long-term cumulative effects or significant impacts to air quality.

#### 4.1.1.9.3 Water Resources

Launch Abort System testing at WSMR would not be expected to impact either surface water or groundwater resources nor generate substantial quantities of wastewater. At this time, there are no plans to substantially increase the workforce at WSMR or WSTF to accommodate Constellation Program activities, so no substantial increase in groundwater consumption would be expected.

#### 4.1.1.9.4 Noise

Noise associated with the Constellation Program activities would include activities at WSTF in support of Launch Abort System tests, which are currently limited to assembly operations; launch pad and flight testing of the Launch Abort System at WSMR; and vehicular traffic associated with the workforce and special operations.

WSTF Noise Impacts

Launch Abort System test assembly operations would be typical of current activities at WSTF therefore would not generate noise impacts. Testing of the Thrust Vector Control and Reaction Control System would occur in existing facilities at WSTF and would not generate abnormal noise. A 7.2-km (4.5-mi) buffer zone separates WSTF's industrial area from the nearest private home further reducing the impacts of WSTF noise on the local community.

WSMR Noise Impacts

Construction activities at WSMR would create noise; however, they are not anticipated to exceed regulatory levels. Launch activities at the launch complex could create loud but short duration noise. For the safety of workers, proper protective equipment including hearing protection would be required. Any loud noise or vibration generated during testing activities would be infrequent and very short in duration, and is not expected to affect local wildlife. Additionally, the WSMR facility is a remote location with no nearby communities. Thus, the proposed testing would have no adverse impacts beyond the conditions that currently exist.

The noise generated from each launch would be roughly proportional to the amount of thrust of the launch vehicle. Short-term noise levels and overpressures generated from these rocket launches would be expected to be equal to or lower than past rocket launches at WSMR.

The impacts of the complete range of WSMR activities, including space vehicle and test rocket launches, were evaluated in the *Final White Sands Missile Range Range-Wide Environmental Impact Statement* (WSMR 1998). That EIS indicated that the launch complexes and airspace over WSMR were both major noise sources on the range. Training activities in the WSMR airspace include bomb delivery, Air Combat Command and Air National Guard air-to-air combat and supersonic flight tactics, and other military exercises. In addition, drone flights and tests of missiles, rockets, and space vehicles occur in WSMR airspace. Large areas of the airspace are used as safety buffer zones for missile and rocket firings (WSMR 1998).

With respect to rocket launches, the *Final White Sands Missile Range Range-Wide Environmental Impact Statement* indicated:

> *Effects on human health with respect to space system vehicle noise levels are not anticipated to be adverse. Space vehicle test rocket launches will produce short duration (less than one minute) noise levels of approximately 65 dBA, 6.4 km (4 mi) from the launch site. Launch site test stands and sound buffer zones should limit main engine propulsion system testing levels to 70 dBA. Test Support personnel not under protective cover supporting a launch or launch test will be required by WSMR safety regulations to use hearing protection devices. Personnel under cover would be afforded proper sound mitigation through sound attenuation building construction. Sonic boom noise footprints are anticipated to occur over unpopulated areas many miles uprange and downrange from the launch or recovery location during space system vehicle launch and reentry. The low intensity and extreme infrequency of these sonic booms is not expected to produce effects other than a startle reaction in those people who hear the boom. The relatively long duration of a space system vehicle sonic boom pressure wave also may rattle loose windows* (WSMR 1998).

The EIS also concluded that for the range of activities at the WSMR, including rocket launches:

> *The overall environmental consequences of noise on human health and wildlife due to WSMR testing and training activities are considered potentially adverse but mitigable… Each of the major noise source areas, assessed individually, is either not adverse or mitigable by providing hearing protection to WSMR personnel and avoiding sensitive wildlife. As a result, any cumulative effects of noise are also anticipated to be minimal* (WSMR 1998).

#### 4.1.1.9.5 Geology and Soils

The greatest potential for soil disturbance would be associated with the landing of the Launch Abort System vehicle downrange. The effect of a test vehicle striking the ground would be variable depending on soil density at the landing site, and velocity of the vehicle at landing. Since the test vehicle is designed to support human life in the event of an emergency, the parachutes and other features required for a safe landing should decrease ground impact velocity and minimize soil disturbances at landing.

There would also be minimal soil disturbance at the launch site due to construction of new facilities. WSMR launch complexes are developed areas located on previously disturbed soil. Overall the soil and soil quality would not be significantly affected by the proposed Launch Abort System testing.

#### 4.1.1.9.6 Biological Resources

The impacts of the proposed construction and Launch Abort System testing activities were evaluated in the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b) and are summarized here.

Construction and modification of the launch complex would occur in previously disturbed areas. No new vegetation disturbances would occur. Some vegetation could be disturbed at the Launch Abort System landing sites, but only a relatively small area would be anticipated to be affected. Ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Off-road traffic would be restricted in accordance with WSMR regulations to minimize disturbance and vegetation. Overall there would be no long-term significant impacts to site vegetation.

In the event of a launch vehicle failure, either due to vehicle malfunctions or intentional destruction by Range Safety, small fires could be initiated by burning propellant. Emergency fire response crews from WSMR and WSTF would be able to prevent such fires from spreading. Revegetation and best management practices to minimize erosion would be included in the recovery plan following a fire.

Wildlife could be affected due to launch pad construction activities and vehicle landing and recovery activities. Noise from sources such as vehicles, heavy machinery, and general human activities related to construction and other test activities would lead to species-specific reactions. Most small mammals would avoid excessive noise by retreating into burrows while larger more mobile species of mammals and birds would temporarily vacate the area. Reproductive activities of some small mammals and birds may be temporarily disrupted by noise and the presence of humans while other animals may become increasingly habituated and display little modification in behavior with ongoing exposure.

During the construction of the launch pad, a gantry support tower would be erected. Due to its size, Federal Aviation Administration (FAA)-approved lighting would be required. Towers pose a collision risk to migratory birds that typically travel in large flocks at night. There is also the possibility of daytime bird strikes from low-visibility structures and wires. Tower lights are known to confuse birds, which increases the likelihood of bird strikes. Also, depending on the final design of the tower, it could be an attractive nesting spot for some bird species.

Most migratory birds are not listed as threatened or endangered but are protected under the Migratory Bird Treaty Act. Mitigation factors that would reduce the potential for bird mortalities were identified in the *Final Environmental Assessment for NASA Launch Abort*

*System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* and are summarized in Chapter 5 of this Final PEIS (WSTF 2007b).

Other potential consequences of testing activities include injury to fauna from flying debris or test articles. The probability that fauna would be directly hit by debris or the test vehicle is inherently low. Debris generated during a test flight or flight termination would be collected to minimize the impact to vegetation and wildlife.

No threatened, endangered, or sensitive species are known to occur at LC-32, or the proposed landing sites within WSMR. Therefore, is unlikely that Launch Abort System testing would affect any threatened, endangered, or sensitive species at WSMR.

#### 4.1.1.9.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.1.9.8 Cultural Resources

Table 4-24 lists the historic facilities on WSMR that may be used by the Constellation Program. Launch Abort System tests are proposed for launch at WSMR from LC-32; the Dog Site, LC-33, Lance Extended Range-4, and the Small Missile Range are considered as alternative locations.

**Table 4-24. Proposed WSMR Historic Facilities Supporting the Constellation Program**

| Government Facility | Proposed Use of Facility | Proposed Modifications to the Facility | Historic Status | Anticipated Adverse Effects to Historic Properties |
|---|---|---|---|---|
| Launch Complex-33 (alternate location to Launch Complex-32) | Launch Abort System pad abort and ascent abort testing | Unknown | NRHP | Possible |

NRHP = Asset is on the National Register of Historic Places

LC-33 is listed on the NRHP (DOI 2007a) and the V-2 Launching Site, located in the South Range Complex, is recognized as a Natural Historic Landmark (DOI 2007b). Based on previous surveys of LC-32, the proposed alternative complexes, and the proposed landing sites, there are no known cultural resources that would be affected by the proposed activities. LC-33 and the V-2 Launch Site are the closest (about 3.7 km [1.7 mi]) known resources that could be impacted. To confirm that the structural integrity of the historic buildings and structures are not affected, a vibration monitor would be installed prior to testing of the Launch Abort System.

There is also the potential of striking previously unknown subsurface archeological resources during construction. A dig permit describing the proposed location of construction would be required prior to any activities. In the event that a previously unknown resource is located, all activity would cease and an archeologist would be notified.

Any Constellation Program activities that may have an adverse effect on historic resources at WSMR/WSTF would be reviewed by the WSMR/WSTF Historic Preservation Officers and conducted in consultation with the New Mexico SHPO and applicable Tribal Historic Preservation Officer(s). Appropriate MOAs would be developed and implemented for such actions. Mitigation activities are discussed in Chapter 5 of this Final PEIS.

WSMR has identified four federally recognized Indian tribes with affiliations and interests in WSMR cultural resources: the Mescalero Apache Tribe of Mescalero, New Mexico; the Fort Sill Apache Business Committee of Apache, Oklahoma; the Pueblo of Isleta, New Mexico; and the Ysleta del Sur Pueblo of El Paso, Texas. Four traditional cultural properties have been identified on WSMR. Although all four are outside the range of the Proposed Action, WSMR would continue to consult with interested parties regarding possible adverse effects to traditional cultural properties.

#### 4.1.1.9.9 Hazardous Materials and Hazardous Wastes

Activities described under the Proposed Action would result in hazardous materials being used. Testing of the Thrust Vector Control and Reaction Control Systems would occur in existing WSTF 300 and 400 area Small Altitude Simulation Systems facilities. The Thrust Vector Control and Reaction Control Systems use hazardous materials, including monomethylhydrazine and nitrogen tetroxide. The WSTF 300 and 400 area Small Altitude Simulation Systems facilities are currently being used for similar tests for Minuteman missiles and the Space Shuttle Program and handle these types of hazardous materials. The types and amounts of monomethylhydrazine and nitrogen tetroxide used for the Space Shuttle Program are comparable to that planned for the Constellation Program test activities.

The Constellation Program testing activities would generate hazardous wastes, similar to ongoing activities. Modifying existing facilities may result in some temporary additional hazardous material use and/or hazardous waste generation. All hazardous waste would be handled and disposed of in accordance with current NASA practices and prescribed regulations.

Launch Abort System testing at WSMR would utilize solid propellants for the booster and the Reaction Control System would utilize $CO_2$ and ethanol as propellants. As discussed in Section 4.1.1.9.2, a bounding estimate of the quantity of high-energy solid propellants to be used over the six planned Launch Abort System tests is less than 220,000 kg (480,000 lbs).

Following flight, hazardous materials in the spent Abort Test Booster, remaining fluid in liquid propellant Reaction Control System tanks, and potentially unexploded ordnance from test malfunctions would remain. Small debris may also be present. These materials would be recovered for final disposal and do not pose a significant source of solid or hazardous waste. For routine flights, the solid propellant is expected to be completely expended prior to landing. All hazardous material and hazardous wastes would be recovered immediately, transported, stored, and disposed of in accordance with WSMR regulations. No hazardous or toxic materials would be stored at LC-32. Non-hazardous waste would be handled as solid waste or non-regulated waste. All solid waste generated at WSMR is collected by an offsite contractor and is disposed of in the Otero County landfill (WSTF 2007b).

In the event of a failure of a test vehicle, NASA would have a contingency plan in place to handle the corrective action, as well as clean-up and disposal of the vehicle debris and any contaminated materials. WSMR would also be consulted on the preferred methods to rehabilitate the area if it is deemed necessary.

Some modifications would be required at the selected WSMR launch pad. This construction may involve the use of hazardous materials and the generation of hazardous wastes. In the unlikely event of accidental petroleum, oil, or lubricant spills, contaminated soil would be cleaned using the most appropriate remediation method.

#### 4.1.1.9.10 Transportation

Traffic levels on major roads and highways outside WSMR would not be expected to increase based on the Proposed Action. The Launch Abort System test articles would be shipped to WSTF via rail or flat-bed truck strictly adhering to DOT regulations. After checkout and validation, the test articles would be transported via roadway from WSTF to the WSMR launch area. Approximately 16.1 km (10 mi) must be traveled over public roadway between WSTF and WSMR.

Increased vehicle traffic at LC-32 and the landing sites may result from the Proposed Action, but would not be considered significant. Existing roads and parking structures are considered adequate to handle the demands under the Proposed Action. The transportation of waste or hazardous materials would be in compliance with WSMR regulations. Only approved or existing routes would be used (WSTF 2007b).

Proposed activities may require occasional blocking of traffic on WSMR roads and U.S. Highway 70. The proposed testing program would not significantly affect transportation as roadblocks would impede vehicular traffic infrequently and only temporarily (WSTF 2007b).

#### 4.1.1.9.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. Due to the size of the buffer zone between the test complexes (including construction sites) and the general public, the proposed activities at WSMR and WSTF would not be expected to generate pollutant emission levels or noise levels that would result in offsite adverse effects on human health and the environment. In addition, the downrange landing sites are remote (within the WSMR boundary) and not considered to be near populated areas. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of WSTF/WSMR.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at WSMR and WSTF on low-income or minority populations would be identified and action would be taken to resolve public concern.

4.1.1.9.12 Launch Accidents

During Launch Abort System tests, Range Safety would be ensured through cooperation between NASA-WSTF and U.S. Army-WSMR personnel. The Constellation Program would operate under NASA's Range Safety Policy (NASA 2005c) and WSMR Regulation 385-17, "Missile Flight Safety." Beginning with pre-launch activities for the Launch Abort System test, the Range Safety team would review a variety of factors in their assessment of safe operating procedures. These factors include the status of the range (whether or not the range is cleared for test activities), launch complex, and range assets. As a safety precaution, personnel would be evacuated to safe areas during the launch and landing of the vehicle. At a minimum, viewers would be placed outside a safety buffer zone.

The Range Safety team also would monitor meteorological conditions to determine effects on the test event and the general public. During launch, the Range Safety Officer monitors the trajectory of the launch vehicle. The Launch Abort System would have a flight termination system to destroy the vehicle if abnormal functioning is detected during the flight. If the vehicle is found to be straying outside its assigned flight corridor, the Range Safety Officer would activate the flight termination sequence, which would eliminate the risk of impacts outside of the flight corridor. Under normal launch conditions, after landing the Range Safety team would monitor the landing site and determine when it is safe for recovery crews to locate the Launch Abort System test article and flight components.

The U.S. Army uses models (*e.g.*, exhaust diffusion and debris analysis) that are accepted by the Range Safety community to predict launch risks to the public and launch site personnel from launch tests at WSMR. Range Safety criteria and practices at WSMR would be similar to those currently employed at both KSC and CCAFS. The range (land area and airspace) would be closed to the general public during Launch Abort System tests and these tests would be monitored for any anomaly which would result in non-acceptable risk levels.

#### *4.1.1.10 Other U.S. Government Facilities*

Constellation Program activities associated with Dryden Flight Research Center (DFRC), Goddard Space Flight Center (GSFC), and Jet Propulsion Laboratory (JPL) would largely be limited to support roles that would include, but not be limited to, project management, engineering and data analysis, and procurement and administrative support. Only limited physical testing, fabrication, or assembly of Constellation Program components would be expected to be performed at these facilities. Activities at other U.S. Government facilities, such as U.S. Air Force's wind tunnels and other test facilities, would be expected be within the normal realm of operations at each facility.

If any modifications to buildings would be needed to support Constellation Program activities at these or other U.S. Government facilities, it is anticipated that these modifications would be minor, such as internal upgrades to electrical wiring and moving interior walls. Any future construction of new buildings or major modifications needed to support future Constellation Program activities at these facilities would be subject to separate NEPA review and documentation, as appropriate. Minor changes in personnel may be anticipated at these facilities; however, it is expected that such changes would not impact or burden existing baseline conditions. Furthermore, little or no impacts to land resources, air resources, water resources, noise, geology or soils, biological resources, socioeconomics, historical or cultural resources, hazardous materials or hazardous wastes, transportation, or environmental justice would be anticipated.

### 4.1.2 Potential Environmental Impacts at Commercial Facilities

#### *4.1.2.1 Potential Environmental Impacts at Alliant Techsystems – Launch Systems Group – Clearfield and Promontory, Utah*

Table 4-25 summarizes the major activities currently anticipated at Alliant Techsystems-Launch Systems Group (ATK) facilities in Clearfield and Promontory, Utah, in support of the Constellation Program.

**Table 4-25. Description of Constellation Program Work at ATK**

| Constellation Program Project | Project Responsibilities |
|---|---|
| Project Ares | Prime Contractor for the Ares I First Stage<br>Ares solid rocket motor segment manufacturing and refurbishment<br>Ares solid rocket motor hot fire testing |

At ATK, most of the reasonably foreseeable activities are similar to ongoing activities conducted in support of the Space Shuttle Program. The environmental impacts associated with implementing the Constellation Program at this site would be similar to the ongoing actions undertaken to support the Space Shuttle.

For the Constellation Program, ATK would provide solid rocket motors for the Ares I First Stage and the Ares V SRBs. ATK may perform additional work for the Constellation Program awarded through competitive procurements. Most of these activities would be expected to be within the scope of activities normally undertaken at ATK.

The Promontory facility has been ground testing solid rocket motors since the late 1950s and continues to be used for solid propellant fabrication and solid rocket motor production, using both PBAN and HTPB propellant binders, and testing of solid rocket motors. Current launch vehicles/missiles supported include Delta II, Delta IV, Minuteman, and the Space Shuttle. Figure 4-10 illustrates ground testing of a five-segment solid rocket motor at Promontory, Utah.

The Clearfield Refurbishment Center (CRC) is located in Davis County north of Salt Lake City and is used to refurbish solid rocket motor hardware for the Space Shuttle Program.

##### 4.1.2.1.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at either the Promontory facility or the CRC. There are no coastal areas, critical habitats, or essential fish habitats within or in close proximity to either facility. Primary land use outside the Promontory facility solid rocket motor production and test areas is livestock grazing.

Source: ATK 2006

**Figure 4-10. Test Firing of a Five-Segment Solid Rocket Motor at Promontory, Utah**

4.1.2.1.2 Air Resources

Activities Generating Emissions

Most Constellation Program production activities that generate air emissions at the ATK sites would be expected to produce emissions at the same levels as current operations (*e.g.*, boilers, emergency generators, paint booths, wastewater treatment, degreasers, grit blasters, and solvent usage). Any changes in these activities would likely be minor compared to those emission levels from solid rocket motor testing.

The new five-segment solid rocket motors for the Constellation Program would be test-fired at existing test stands at the Promontory facility. Air emissions from test firings were estimated for the solid rocket engine tests and flights identified in Table 2-11, a total of five solid rocket motor tests from 2008 to 2012.

The expected emission from test firings of five-segment solid rocket motors would be similar to emissions from an Ares I launch from KSC with the exception that all of the propellant would be ignited at ground level at ATK's T-97 test site. The extent and amount of deposition from the exhaust cloud would be similar to levels currently experienced during testing for the Space Shuttle Program.

The duration of each test firing would be approximately 124 seconds, in which 640,000 kg (1.4 million lb) of solid propellant would be burned. Emissions would primarily consist of HCl, $NO_x$, particulate matter, and suspended particles. Based on the emission factors developed for the *Space Shuttle Advanced Solid Rocket Motor Program* EIS (MSFC 1989), the weight percent of emissions for PBAN propellant are 30 percent $Al_2O_3$, 24 percent CO, 3.5 percent $CO_2$, 21 percent HCl, 9.5 percent water, nine percent nitrogen, two percent hydrogen, and one percent other products. Thus, each test firing of a five-segment solid rocket motor would produce approximately 190 mt (210 tons) of $Al_2O_3$, 150 mt (170 tons) of CO, 22 mt (24 tons) of $CO_2$, 130 mt (150 tons) of HCl, 60 mt (66 tons) of water, 57 mt (63 tons) of nitrogen, 12.8 mt (14 tons) of hydrogen, and 6.4 mt (7.0 tons) of other materials. Therefore, the cumulative airborne releases associated with ground testing solid rocket motors for the Constellation Program (based on the planned five tests) from 2008 to 2012 would include approximately 950 mt (1,100 tons) of $Al_2O_3$, 760 mt (840 tons) of CO, 110 mt (120 tons) of $CO_2$, and 670 mt (740 tons) of HCl.

Air quality measurements conducted previously have indicated the primary emissions of concern, HCl, $NO_x$, and particulate matter, from ground test firings of solid rocket motors at the Promontory facility were well below Federal and Utah regulatory limits. This facility is in an attainment area and operates under a CAA Title V permit, which includes ground firings of solid rocket motors (also see Section 4.1.6.2).

#### 4.1.2.1.3 Water Resources

Constellation Program activities at the Promontory facility and CRC would not be expected to result in the generation and discharge of wastewaters in excess of those allowed under current facility discharge permits administered under State of Utah laws and regulations. As with current operating practice, all wastewaters at the Promontory facility would be treated prior to discharge under Utah Pollution Discharge Elimination System permit UT0024805. Liquid wastes are no longer discharged to unlined surface impoundments (see Section 4.1.2.1.9); therefore, surface water and groundwater resources would not be adversely impacted from Constellation Program activities.

At the Promontory facility, ongoing studies at old inactive landfill sites under the Resource Conservation and Recovery Act (RCRA) would not be adversely affected.

#### 4.1.2.1.4 Noise

The Proposed Action would not result in any new types of noise sources introduced into either the CRC or Promontory sites. Under the Proposed Action, ATK would continue to manufacture and test solid rocket motors similar to ongoing activities in support of the Space Shuttle Program. The noise sources associated with manufacturing operations and rail, truck, and other vehicular activities would be similar to those for ongoing activities in support of the Space Shuttle and other solid rocket motor production programs.

The CRC is located in a high-density industrial complex and the Promontory facility is located in a sparsely populated area where the nearest house is approximately 5 km (3 mi) away. For both facilities, areas where the noise levels can exceed 85 dBA have been identified as being on-site and have been mapped. Hearing protection is required in these areas. The bulk of operations in the noise hazard areas produce noise levels that range from 90 to 95 dBA with a few, such as grit blasting operations, producing noise levels between 100 and 105 dBA. Most activities occur within enclosed structures and noise levels are significantly attenuated before reaching populated areas. Under the Proposed Action, the production of solid rocket motors for the Constellation Program would follow existing production processes with corresponding noise levels.

As a part of the past and ongoing programs, ATK has conducted test firings of solid rocket motors at its Promontory facility. Each test firing results in high noise levels in the immediate vicinity of the test area for approximately two minutes.

ATK has conducted a full scale test of the five-segment solid rocket motors similar to that proposed for the Ares launch vehicles. A five-segment solid rocket motor burns 640,000 kg (1.4 million lbs) of propellant in just over two minutes, which is similar in duration to a four-segment solid rocket motor. The currently envisioned final design of the five-segment solid rocket motor planned for the Constellation Program would, as compared with a four-segment solid rocket motor, contain 24 percent more propellant, deliver seven percent more thrust, and burn at a rate that is six percent lower. Since the acoustic noise and vibration from a solid rocket motor is generally proportional to the logarithm of the energy released, the expected differences in the noise generated by the five-segment and the four-segment solid rocket motors would be minimal. Overall noise levels have been comparable to the four-segment solid rocket motors used for the Space Shuttle.

The noise generated by four-segment solid rocket motor test firings was calculated for the *Final Environmental Impact Statement for the Space Shuttle Program* (NASA 1978). That analysis indicated that the noise generated by a test firing is locally intense with predominantly low frequencies. The maximum predicted sound level from a ground test firing at the Promontory facility to which the public might be exposed was 95 dBA on State Route 83. The 24-hour time-weighted average (Leq) corresponding to this sound level (for a 20- min test) is 67 dBA, assuming a background noise level of 60 dBA, which is less than EPA's daytime 70 dBA limit for hearing protection. Measured values have been significantly less than calculated values, showing the calculations to be conservative. Sound levels of 80 to 83 dBA were measured on State Road 83 during tests in 1977 (NASA 1978).

Although no direct noise-related health effects would result from these tests, large areas would be subjected to sound pressures of 100 dBA or more, predominantly at low frequencies. Temporary disturbance to nearby wildlife would be possible.

At the CRC site, there are no major noise sources that would impact areas outside of the site. There are also no sensitive noise receptors in the immediate vicinity of CRC (ATK 2006).

#### 4.1.2.1.5 Geology and Soils

The soils and geology underlying all of CRC are described as previously disturbed and paved. Portions of the Promontory facility are highly disturbed while others are not.

The T-97 test facility at the Promontory facility would be upgraded to accommodate Constellation Program solid rocket motor testing. No impacts to geology or soils are anticipated.

There are no construction or refurbishment plans scheduled for the CRC; therefore, there would be no impacts to soils or geology associated with the Proposed Action at the CRC.

#### 4.1.2.1.6 Biological Resources

Biological resources at both the Promontory facility and CRC would not be adversely impacted. There are no Federal or state-protected species or habitats on either of ATK's facilities, although the federally protected bald eagle (*Haliaeetus leucocephalus*) and federally threatened snowy plover (*Charadrius alexandrinus)* have been found in the vicinity of the Promontory facility.

#### 4.1.2.1.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

#### 4.1.2.1.8 Cultural Resources

Buildings and structures already in use for the Space Shuttle Program would continue to be used for the Constellation Program. No properties listed in the NRHP are located at either facility. No specific Native American issues have been identified directly associated with the ATK locations.

#### 4.1.2.1.9 Hazardous Materials and Hazardous Wastes

Hazardous Material Use

Many of the same or similar hazardous materials currently used for the ongoing Space Shuttle Program would be required for the Constellation Program. Ares solid rocket motor cases would be expected to be insulated with a newly formulated insulating material. The current insulating materials used for the Space Shuttle solid rocket motors (acrylonitrile butadiene rubber, asbestos, and silicon dioxide and/or silica-filled ethylene propylene diene monomer) are being replaced to eliminate the chrysotile (asbestos) fiber. Each Ares solid rocket motor would require approximately the same amount of insulation as a Space Shuttle SRB (15,500 kg [34,000 lb]).

Propellants

As for the Space Shuttle Program solid rocket motors, propellant for the Ares solid rocket motors would consist of a PBAN binder, epoxy curing agent, ammonium perchlorate oxidizer, and aluminum powder fuel. Small quantities of iron oxide (as ferric oxide) are added to normalize the burn rate. Propellant ingredients and approximate quantities per solid rocket motor are:

| | | |
|---|---|---|
| Aluminum Powder | 100,000 kg | (220,000 lb) |
| Ammonium Perchlorate | 435,000 kg | (957,000 lb) |
| HB Polymer | 75,000 kg | (165,000 lb) |
| Epoxy Resin | 12,300 kg | (27,000 lb) |
| Ferric Oxide | 1,860 kg | (4,100 lb) |

Quantities of propellant that would be produced annually for the Space Shuttle Program and the Constellation Program at the Promontory facility are shown in Table 4-26.

**Table 4-26. Projected Propellant Production at ATK**

| Year | Propellant Produced per Year in Millions of Pounds* | | |
|---|---|---|---|
| | Constellation Program | Space Shuttle Program | Total |
| 2006 | 0 | 4.1 | 4.1 |
| 2007 | 0 | 9.7 | 9.7 |
| 2008 | 4.1 | 9.7 | 13.8 |
| 2009 | 0 | 4.4 | 4.4 |
| 2010 | 4.1 | 0 | 4.1 |
| 2011 | 5.5 | 0 | 5.5 |
| 2012 | 6.9 | 0 | 6.9 |
| 2013 | 6.9 | 0 | 6.9 |
| 2014 | 9.6 | 0 | 9.6 |
| 2015 | 9.6 | 0 | 9.6 |
| 2016 | 8.2 | 0 | 8.2 |
| 2017 | 5.5 | 0 | 5.5 |
| 2018 | 9.6 | 0 | 9.6 |
| 2019 | 9.6 | 0 | 9.6 |
| 2020 | 9.6 | 0 | 9.6 |

* See conversion table on page xxiii for metric units

Ozone Depleting Substances

The design for the Ares solid rocket motors assumes the continued use of 1,1,1-trichloroethane (TCA). NASA and ATK have an EPA essential use exemption for the use of TCA for tackifying rubber and in other critical bonding operations. In 2004, NASA purchased and stockpiled 75,000 l (20,000 gal) of TCA to support its solid rocket motor production through 2020. The TCA is stored in five 15,000 l (4,000 gal) tanks in two separate locations. It is used at the rate of approximately 371 l (98 gal) per solid rocket motor. The EPA has concurred with the continued use of TCA on solid rocket motors for the Constellation Program for the same functional purposes as approved for the Space Shuttle Program and for the same period (EPA 2007b).

ATK also uses small quantities of HCFC 141b in foam used to fill test holes in foam insulation on the exterior surface of the Space Shuttle solid rocket motors (current rate of use is 12 kg/year [26 lb/yr]). ATK is currently working with NASA to determine the requirements for the Ares I First Stage. See Section 4.1.1.3.2 for additional information.

Hazardous Waste Generation

Until 1988, ATK had been disposing contaminated liquid wastes in an unlined impoundment at the Promontory facility. The area was contaminated with trichloroethene (TCE) and perchlorate. Currently, all waste disposal actions meet current state and Federal regulatory standards. There are other solid waste units at the Promontory facility currently undergoing state investigation.

Solid rocket motor production for the Constellation Program would generate hazardous wastes. It is anticipated that the types and amounts would be consistent with current operations and include waste propellant, paints, coatings, solvents, cleaning rags, catalysts, curing agents, polymers, and similar compounds. In 2004, the CRC and Promontory facilities collectively generated and disposed of or otherwise treated 1.1 million kg (2.4 million lb) of hazardous wastes. Hazardous waste is managed by offsite treatment and/or disposal at permitted facilities, onsite thermal treatment by open burning, and via onsite landfills.

#### 4.1.2.1.10 Transportation

Traffic levels on major roads and highways outside the Promontory facility and CRC are not expected to increase based on the Proposed Action. Currently, ATK follows a rigorous routine when loading solid rocket motors containing solid propellant and transporting them to KSC. This process also includes the delivery and transport of fuel constituents between facilities. Each mode of transportation, rail or truck, must be certified to handle hazardous materials. Solid rocket motors are loaded into specialized railroad cars prior to transportation to KSC and are escorted by ATK personnel in transit to KSC. For more detail on the transport between the CRC, Promontory facility, and KSC see Section 3.2.1.7.

It is expected the Constellation Program would follow the same protocols as the Space Shuttle Program when transporting solid rocket motors. No adverse impacts to the public would be anticipated during transportation. Traffic within each ATK facility is expected to remain at levels currently experienced under the Space Shuttle Program.

#### 4.1.2.1.11 Accidents

Accidents associated with the manufacture, testing, and transportation of solid rocket motors for the Space Shuttle Program, as well as other programs at ATK, have been evaluated in a number of safety analyses and environmental documents, including the *Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program* (MSFC 1989). That EIS evaluated potential accidents associated with the production, testing, and transportation of four-segment solid rocket motors and concluded that accident consequences could include:

- Possible explosion, fire, and loss of life during manufacture of raw materials and production
- Possible truck or rail accidents resulting in material spills, with possible explosion or fire
- Accidental detonation resulting in loss of life or production capability
- Accidental release of asbestos, chemical vapors, and discharge of solvents during refurbishing.

Each of these types of accidents is addressed in current ATK safety plans and procedures in order to prevent their occurrence, to the extent practicable, and to mitigate their consequences. Since the processes for production, testing, and shipment of solid rocket motors for the Constellation Program would be similar to the Space Shuttle Program, the potential accidents and consequences should be similar to those previously evaluated for the Space Shuttle Program. The major types of potential accidents would be expected to be similar if the Proposed Action were adopted.

Manufacturing Accidents

The production of solid rocket motors involves processing large quantities of materials that are highly flammable and, as such, require a great deal of care to ensure that major fires or explosions do not occur and threaten the lives of the workforce. The prevention of these process accidents is a central aspect of the safety programs at ATK. The potential localized impacts of these types of accidents were addressed in the *Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program* (MSFC 1989).

Although an unlikely event, an explosion during the mixing and casting process could result in damage to structures up to several hundred meters from the processing area. In March 1984, an explosion at the Promontory facility, then a Morton Thiokol plant, occurred while pouring uncured propellant. A blast over-pressure equivalent of 13.6 mt (15 tons) of trinitrotoluene (TNT) resulted from a violent explosion of over 113,000 kg (250,000 pounds) of uncured propellant. Due to quick personnel response and fortuitous circumstances, no injuries occurred beyond smoke inhalation and minor cuts and bruises. Blast and incendiary effects were observed up to several hundred meters from the point of explosion. Structural damage occurred to buildings 430 m (1,400 ft) from the blast area. Window breakage occurred as far as 1,200 m (4,000 ft) from the explosion area (MSFC 1989). All damage was confined within Morton Thiokol's facilities.

Modifications to equipment and facilities, including remote operations where practicable, as well as safety plans and procedures, are in place at ATK to reduce the probability of this type of accident.

Deflagration During Ground Testing

The presence of voids in cured rocket motor propellant can result in a locally increased burning rate within a motor being fired. This may produce excess pressure inside the case, leading to case rupture. Case rupture also may occur as the result of structural flaws in the case, including the insulation, seals, adhesives, or other case materials. Explosive effects associated with the case rupture of a four-segment solid rocket motor during ground testing have been evaluated (MSFC 1989). If the case rupture were to occur near the end of a test firing, when the maximum volume of pressurized gases is contained in the case, an explosion equivalent to approximately 1,500 kg (3,300 lb) of TNT could occur. This is the maximum conceivable energy release for a case rupture. An explosion of this magnitude could be inferred to have the following effects:

- Lethality at distances of up to 19 m (62 ft)
- Structural damage of massive multi-story buildings at distances of up to 19 m (62 ft)
- Lung damage at distances of up to 35 m (115 ft)
- Total structural damage of light-frame construction at distances of up to 50 m (164 ft)
- Ear drum rupture at distances of up to 65 m (213 ft)
- Window glass breakage at distances of up to 220 m (720 ft).

Case rupture also would allow propellant to spill out onto the ground as an uncontrolled fire. Since the Promontory test firing area would be cleaned of other combustible materials, a fire of this type would simply burn until the available fuel was consumed (MSFC 1989). A deflagration involving a five-segment solid rocket motor could involve up to 25 percent more propellant and theoretically result in similar consequences as the four-segment solid rocket motor, but out to farther distances.

Transportation Accidents

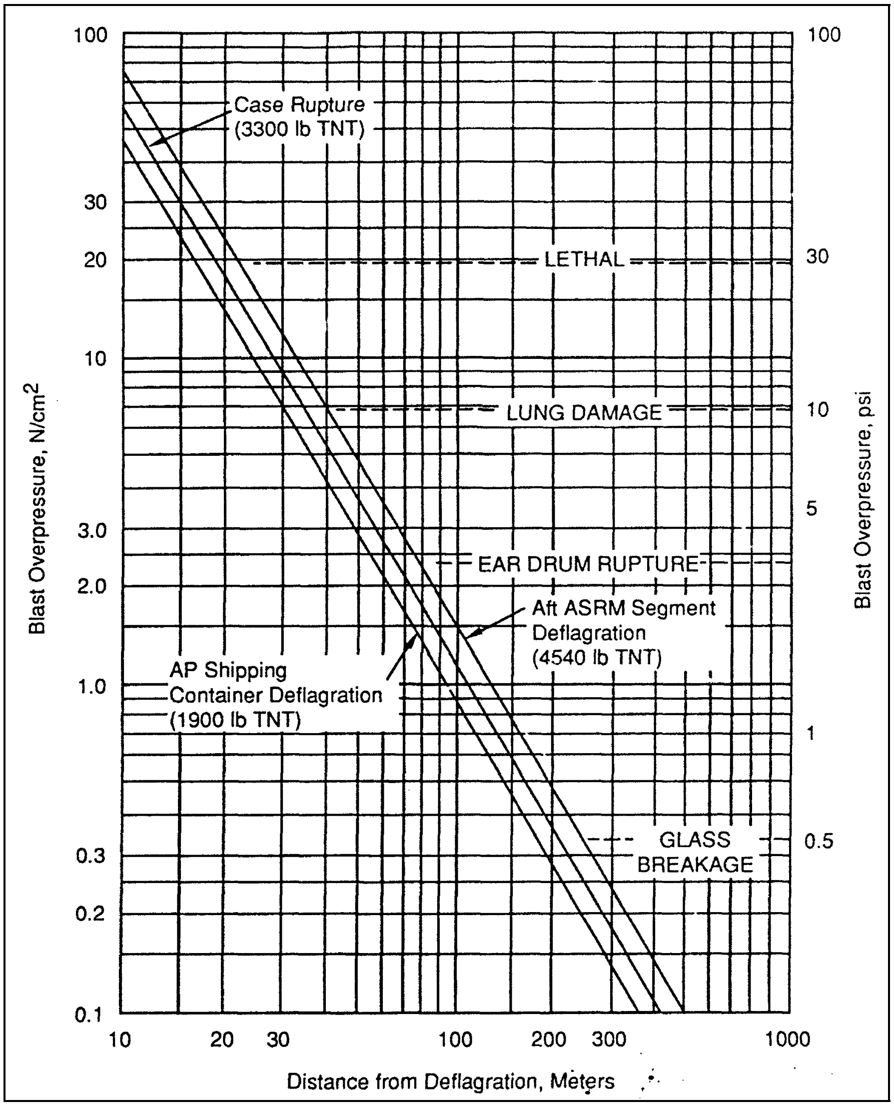
The primary transportation hazard relates to the potential for accidents involving fueled solid rocket motor segments. Each Space Shuttle solid rocket motor segment contains an average of 136,000 kg (300,000 lb) of propellant, which, under accident conditions, might ignite and burn at a high rate. Depending on location and surrounding conditions, such an event could potentially have serious consequences. Ignition of a solid rocket motor segment could be caused by high temperature, static discharge, or impact. The most likely origin of these conditions would be a transportation accident, such as a collision or train derailment, and vandalism or sabotage. Environmental influences would be unlikely to cause ignition, although static discharge in the form of lightning could not be ruled out. Specific triggering mechanisms from a train or truck accident could include fires or explosions resulting from the ignition of other hazardous materials in the same shipment or at the accident site (MSFC 1989).

The initial consequences of accidental ignition of Space Shuttle solid rocket motors were estimated based on propellant volume and ignition characteristics (MSFC 1989). Those analyses indicated that the accident scenarios identified above, including sabotage with high explosives, would at most cause rapid burning with a low equivalent explosive yield. A worst-case scenario involving detonation of other explosives on a nearby railcar would not detonate the solid rocket motors. Blast wave damage from rapid burning with low explosive yield would cause total destruction for light frame construction within 50 m (164 ft), and major repair would be required for such buildings within 105 m (345 ft). A blast of this level would rupture ear drums of people within 60 m (197 ft) of the accident site (Figure 4-11). Ignition of a solid rocket motor segment also would produce potentially hazardous air emissions, particularly HCl and $A1_2O_3$, but evaluation of the peak concentrations and duration indicated that little or no health impact from these emissions would result (MSFC 1989).

The actual impacts of an accident resulting in solid rocket motor ignition and fire would depend on where the accident occurred. Direct damage from a solid rocket motor blast wave and burning, plus potential secondary fires or explosions, would be greater in urban or built-up areas.

Rail transportation has been used approximately 300 times to transport fueled Space Shuttle solid rocket motors from Utah to KSC. Each of these has been followed with a return trip, and in about 10 instances, the return trips have carried fueled segments. Each of these shipments was conducted safely with no instances of accidental ignition. These shipments comply with applicable DOT regulations for rail shipment of hazardous materials. As such, minor rail incidents, such as train derailments, have not resulted in ignition of the solid propellant.

On May 2, 2007, a train transporting Space Shuttle solid rocket motors and a passenger car with technicians on board to monitor their transportation derailed near Linden, Alabama when a railroad bridge (trestle) collapsed under the locomotives. Six people were injured when the two locomotives and the passenger car dropped about 3 m (10 ft) and turned on their sides. One of the railcars carrying a solid rocket motor segments also fell on its side and three other railcars and segments experienced a jarring drop. The four other railcars containing segments remained upright and undamaged. As was expected with the safety precautions taken with each shipment, the incident did not result in ignition of the solid propellant (NASA 2007c).




Source: MSFC 1989

**Figure 4-11. Potential Impacts from Transportation Accidents**

### *4.1.2.2 Other Commercial Facilities*

The Constellation Program would be supported by various other commercial facilities throughout the U.S., including facilities that are owned and operated by the Lockheed Martin Corporation and the Boeing Company. Many competitive procurements remain to be awarded and thus many other commercial facilities would be expected to support the Constellation Program. It is expected that the activities engaged in at each commercial facility involved in the Constellation Program would fall within the normal realm of operations at each facility. It is also expected that all such facilities would be in compliance with all applicable Federal, state, and local environmental laws, regulations, and permits. NASA would ensure that this is the case as a matter of contract with all commercial entities selected to support the Constellation Program.

### 4.1.3 Potential Environmental Impacts of Jettisoned Launch Vehicle Components on the Ocean

This section describes the potential impacts of ocean splash down of Ares I and Ares V jettisoned components during the ascent phase for launches from KSC, as well as similar vehicle elements from KSC test launches. Ares I components would include the First Stage, Upper Stage, Spacecraft Adapter, payload shrouds, and the Launch Abort System. The Ares V components would include the SRBs, Core Stage, Earth Departure Stage, Spacecraft Adapter, and payload shrouds. Many aspects of the launch trajectory and element disposition, including downrange splash down and recovery of jettisoned components, and impact and disposal of spent Ares launch vehicle Stages would be similar to Space Shuttle operations.

NASA Range Safety procedures require jettisoned launch vehicle components be considered in demonstrating that the overall approved mission risk limits/safety requirements would be met (NPR 8715.5 [NASA 2005c]). These requirements dictate that the landing areas for the jettisoned components be selected such that the likelihood of impacting structures, ships, or people is very remote. These safety requirements are the same as are currently imposed on the Space Shuttle Program.

#### *4.1.3.1 Normal Launch*

*Ares I Launch*

The Ares I First Stage would deplete its propellant load just over two minutes after launch and would be jettisoned into the Atlantic Ocean for recovery (see Figure 2-8 for the Ares I launch profile). Typically, the First Stage would splash down approximately 80 to 460 km (150 to 250 mi) downrange in a predetermined area of the Atlantic Ocean. Several First Stage components (*e.g.*, the forward section frustum, interstage) would be jettisoned and would not be recovered. The processes for recovery of the First Stage would be similar to those currently used for the Space Shuttle SRB recovery. The Constellation Program is currently studying the option of not recovering the spent First Stage for certain missions.

After Upper Stage ignition, the Launch Abort System would be jettisoned (after it is no longer needed to accomplish a safe abort), land in the Atlantic Ocean, and sink to the ocean bottom. The approximately 2,300 kg (5,200 lb) of solid propellant in the Launch Abort System would be expected to slowly dissolve in the ocean waters. Because of the slow rate of dissolution and the availability of large quantities of ocean water, toxic concentrations are not expected except in the immediate vicinity of the propellant. No mortality of marine biota would be anticipated.

The Service Module shrouds would be jettisoned during the Upper Stage ignition over the Atlantic Ocean and would not be recovered (JSC 2006c).

After burnout, the Ares I Upper Stage containing LOX/LH tanks, nozzles, pyrotechnics from the destruct system, other hardware, and the Orion spacecraft adapter would separate from Orion and would be targeted to land in the Indian Ocean. These components would not be recovered.

*Ares V Launch*

Following a launch profile very similar to the Space Shuttle, the Ares V SRBs would be jettisoned into the Atlantic Ocean (see Figure 2-13 for the Ares V launch profile). The splash down zones and the recovery processes would be similar to those described above for the Ares I First Stage and as currently practiced for the Space Shuttle SRB recovery. The Constellation Program is currently studying the option of not recovering the spent SRBs for certain missions.

The Ares V payload shroud, the Core Stage containing LOX/LH tanks, nozzles, pyrotechnics from the destruct system, and other hardware, and the Earth Departure Stage adapter would be targeted to land in the Indian or Pacific Ocean depending on final trajectory design. These components would not be recovered.

#### 4.1.3.1.1 Environmental Impacts of Ocean Disposal

A residual amount of hydraulic fluid and hypergolic propellants would remain in the launch vehicle stages when they fall into the ocean. If released, the fluid and propellants would be diluted by seawater and would not be expected to affect marine species (USAF 1998).

The introduction of soluble products into an ocean environment from Launch Abort System solid propellant and residual solid propellant from the Ares I First Stage and the Ares V SRBs would be expected to produce short-term, localized impacts (NASA 1996). The potential for solid propellants to dissolve in sea water has been evaluated previously (AFRL 1998, Aerospace 2001, Aerospace 2002). These propellants, as they dissolve, release ammonium perchlorate, which has been shown to be toxic. Studies (TRW 2002) have indicated that the biological effects of perchlorate in seawater principally occur when perchlorate levels are extremely high (1,000 ppm). Because any perchlorate leached from solid propellants used for the Constellation Program would be quickly diluted, toxic concentrations would not likely remain. In addition, because of the limited number of launch events scheduled, the small amount of residual propellants present, and the very large volume of water available for dilution, any adverse impacts from the jettisoned launch vehicle stages would be limited.

Vehicle elements not recovered, possibly including Ares I First Stage and Ares V SRBs for some missions, while not totally inert, would dissolve slowly, dissipate, and become buried in the ocean bottom. Corrosion of stage hardware would contribute various metal ions to the water column; however, due to the slow rate of corrosion in the deep ocean environment and the quantity of water available for dilution, toxic concentrations of metals are not likely to occur (USAF 1998, NASA 2005b, NASA 2006d). Because of the limited number of launch events scheduled and the very large volume of water available for dilution, no adverse impacts would be expected from the nonfuel materials associated with the jettisoned launch vehicle stages (USAF 1998).

It is likely that the density of marine mammals in the splash down zones would be low; therefore, the probability of vehicle elements striking animals is small. These items would likely sink and smother organisms in the immediate area of contact on the ocean bottom (USAF 1998); however, this is expected to have a localized and negligible impact.

For Ares launches, the size and location of the debris fields produced by the jettisoned stages would be specified based on the vehicle's trajectory. NASA would ensure that "Notices to Mariners" and "Notices to Airmen" (NOTAM) would be provided prior to any launch (for the launch area and downrange areas at risk from falling debris or jettisoned stages) to reduce the risk to aircraft and surface vessels.

4.1.3.1.2 Ocean Recovery of the Ares I First Stage and Ares V SRBs

Transit of recovery vessels from KSC to the Ares I First Stage and Ares V SRB splash down zone is expected to be similar to the ongoing operations for the Space Shuttle Program. The recovery team and the ships would be pre-deployed to the planned splash down site in the Atlantic Ocean (JSC 2006c).

During transit, the recovery ships would necessarily carry fuels and potentially other hazardous materials. Requirements of applicable international agreements would be observed as release of potentially hazardous materials at the port or ocean environment could cause environmental impacts. Maritime protocol would be followed to prevent collisions and protect the cargo integrity in the same way as any other seagoing vessel carrying hazardous materials. The overall likelihood of ecological damage and impact from transit should be minimal because the splash down zones would be in the open ocean, which is less biologically rich than upwelling and coastal areas.

After splash down of the Ares I First Stage or Ares V SRBs, the recovery team would ensure that these were safe, and they would be prepared (including parachutes) for return to KSC. The Ares I First Stage and the Ares V SRBs would be dismantled and would be transported to ATK for refurbishment.

The possibility exists that the solid rocket motors may not be retrievable, with a resulting impact to the environment similar to that described previously for Ares I First Stage or Ares V SRBs not planned to be recovered. The environment also could be impacted by a recovery ship accident, or as a result of jettisoned components hitting a ship or aircraft. This possibility would be minimized by the issuance of Notices to Mariners and NOTAMs prior to the launch as described above.

### *4.1.3.2 Launch Accidents*

In the event of an anomalous launch, the point in the launch sequence when the failure occurs determines the impact on the environment. The environmental impacts of accidents that result in vehicle components hitting the ground on or near the launch pad or in the KSC vicinity are discussed in Section 4.1.1.1.12. Accidents that occur at higher altitudes could result in launch vehicle components falling into the ocean or impacting land, depending on when the accident occurs. A discussion of these accidents follows.

*Early-Ascent Aborts/Accidents*

For both early-ascent aborts (*i.e.*, aborts prior to jettisoning any launch vehicle components) and early-ascent accidents, parts of the vehicle would fall back to Earth, with the fragments falling into the Atlantic Ocean. The predominant environmental impact of an early-ascent abort or accident would be from unspent fuel, launch vehicle debris, and unrecoverable stages. The magnitude of the environmental impact would depend on the physical properties of the materials (*e.g.*, size, composition, quantity, solubility) and the local marine biota of the impact region. It is expected that the metal components would slowly corrode. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the large volume of ocean water available for dilution (USAF 1996, NASA 2006d).

During early-ascent aborts, the Crew Module would be separated from the Ares I/Orion Service Module using the Launch Abort System. Once the Launch Abort System motor burns out and sufficient separation from the launch vehicle is obtained, the Crew Module would descend via parachutes to the Atlantic Ocean where the crew (and the Crew Module) would be recovered. With an early-ascent abort, the Ares I disposal would occur via uncontrolled water impact or destruction via the flight termination system. In the event of an Ares V early-ascent anomaly, the vehicle disposal would also occur via uncontrolled water impact or destruction via the flight termination system.

The likelihood that launch vehicle stages or debris would strike a marine mammal is low due to the extent of the open ocean and the relatively low density of marine mammals in the surface waters of open ocean areas (USAF 1998).

Recovery operations following an early-ascent accident would be expected to have a negligible effect on the ocean environment.

*Mid-Ascent Aborts/Accidents*

Ares I mid-ascent aborts are aborts performed after Upper Stage separation from the First Stage and after the Launch Abort System has been jettisoned. Mid-ascent aborts do not result in an attempt to reach a targeted touchdown point, but entail a Crew Module trajectory adjustment to reduce recovery time.

A mid-ascent abort or mid-ascent accident of an Ares I or Ares V could result in impacts of debris along the vehicle flight path. If these objects fall over deep ocean waters, they would momentarily disrupt the environment as the warm objects are cooled and sink, with an extremely remote chance of striking a marine mammal.

*Late-Ascent Aborts/Accidents*

Ares I late-ascent aborts are aborts performed following a premature failure of the Upper Stage when the ascent trajectory has sufficient velocity to allow a Service Module engine burn to get the Crew Module to a suitable landing site or safe orbit. At abort initiation, the Crew Module/Service Module trajectory would be modified with a targeted Service Module engine burn and the Crew Module/Service Module would be maneuvered to an orientation suitable for separation. If landing immediately, the Crew Module and Service Module would separate, with the Crew Module then performing a guided Earth atmospheric entry to a suitable landing site. At the appropriate altitude, the parachutes would be deployed and the Crew Module would descend to a safe landing. If there is an abort to a safe orbit, the mission status would be evaluated and the mission would possibly be allowed to continue. If the decision is made to land, the mission will continue to landing similar to a normal return from the International Space Station. Thus, a late-ascent abort would have the lowest environmental impact of any type of anomalous launch.

At this point in the Constellation Program, landing sites for late-ascent aborts have not been determined, but the Orion spacecraft design would include the potential for an ocean landing of the Crew Module. Abort landing sites for the Crew Module could include Atlantic, Indian, and/or Pacific Ocean sites. Following late ascent aborts, the Crew Module may also be able to reach landing sites within the continental U.S.

In a late-ascent accident, each of the vehicle components would reenter and impact land or water under the flight path. In the event of private property damage, NASA has procedures in place to evaluate such damage and provide for compensation, if warranted. The potential environmental impacts would be very similar to those expected for a normal return of the Orion Crew Module and Service Module. These impacts are presented in more detail in the following sections.

### 4.1.4 Potential Environmental Impacts from Return to Earth of the Orion Crew Module and Service Module

NASA Range Safety procedures require jettisoned entry vehicle components be considered in demonstrating that the overall approved mission risk limits/safety requirements would be met (NPR 8715.5 [NASA 2005c]). These requirements dictate that the landing areas for the jettisoned components be selected such that the likelihood of impacting structures, ships, or people is very remote.

The environmental impacts of return of the Orion spacecraft, including Service Module and the docking mechanism (if from the International Space Station) would be minor, principally associated with sonic booms from Earth atmospheric entry. Other environmental impacts expected would be associated with development of terrestrial landing sites (if terrestrial landing sites are used), landing operations, and recovering the Orion spacecraft. Preliminary analyses of the primary site-independent environmental impacts, *i.e.*, those associated with sonic booms and jettisoned components, are evaluated in this Final PEIS in order to comprehensively understand the potential impacts of the Proposed Action.

The Constellation Program currently requires both terrestrial and water (ocean) landing capabilities for the Orion Crew Module's return to Earth. Any land landings under a normal return would be expected to occur in the western Continental United States. Among the driving considerations for the landing site are the orbital mechanics associated with safely disposing of the Service Module (and the docking mechanism for International Space Station mission return) in the ocean as the Crew Module is en route. As backup, NASA intends to maintain the ability to land the Orion Crew Module in the ocean. When the technical analyses of landing alternatives become more mature, NASA would prepare separate NEPA documentation addressing terrestrial landing sites, as appropriate.

The impacts of jettisoning the Service Module (and the docking mechanism for International Space Station mission return) in the Pacific Ocean, as well as the impacts of an ocean landing of the Orion Crew Module, are addressed in Section 4.1.4.2.

### *4.1.4.1 Impacts of the Orion Spacecraft Landing at a Western U.S. Terrestrial Site*

While the Orion terrestrial landing site(s) have not been selected, the general characteristics important for a site are characterized as generally flat terrain, without marshes, forests, boulders or ravines, and unpopulated. The principal activities at the landing site would be recovery of the Orion Crew Module and crew for transport.

Terrestrial landing site candidates would be chosen within the western portion of the U.S. Therefore, given the possible approach direction of the Orion ranging from the southeast to northeast, the majority of the atmospheric entry trajectories and sonic boom footprints would be over the Pacific Ocean. There are no major land areas within these boundaries; therefore, environmental impacts would be expected to be negligible. However, as the Orion Crew Module passes over land areas, there could be structural and human exposure to sonic booms.

The landing site(s) would most likely be on existing government property. Some support facilities would be needed, which may or may not already be in place, depending on the site(s) selected. For a normal atmospheric entry and terrestrial landing of the Orion Crew Module, the spacecraft would land within a pre-designated restricted landing zone. This area would be cleared of personnel until after the Crew Module and any other items jettisoned during its descent and landing are on the ground. The Crew Module would descend through U.S. National Air Space in near-vertical flight; essentially the Crew Module would remain in a small vertical cylinder that extends from the ground to approximately 15,200 m (50,000 ft) of altitude. This airspace would be controlled with the assistance of the FAA. The confines of the landing location are defined as a 10 km (6.2 mi) diameter circle.

#### 4.1.4.1.1 Potential Sonic Boom Impacts

During atmospheric entry, the Orion Crew Module would travel at supersonic velocities across large areas of land and water in preparation for landing. The velocities created by atmospheric entry would produce pressure waves, or sonic booms. Sonic booms are dependent, among other things, on the atmospheric entry trajectory, and the size, and velocity of the returning object. Atmospheric and meteorological conditions would affect the dispersion of the sonic boom and overpressure. Areas that fall under the atmospheric entry trajectory are subject to sonic booms created by the Orion Crew Module. Since the Orion spacecraft has not been built yet, there are no actual measurements of a sonic boom for Orion atmospheric entry available. The projected sonic boom footprint is discussed in the following sections.

The atmospheric entry of the Space Shuttle has been extensively studied, both with modeling and actual measurements. These activities led to the development of computer modeling tools that have been used to predict the sonic boom footprints for other atmospheric entry vehicles, such as the X-33 Advanced Technology Demonstrator Vehicle.

Sonic booms are measured in terms of pressure above the normal atmospheric pressure at ground level. Overpressures of 0.05 to 0.1 kPa (1 to 2 lbs per square ft [psf]) are produced by supersonic aircraft flying at normal operating altitudes. Some public reaction could be expected if individuals are exposed to sonic boom overpressures between 0.075 and 0.1 kPa (1.5 and 2 psf). The Space Shuttle, on landing approach at 18,000 m (60,000 ft) produces 0.0625 kPa (1.25 psf) at a speed of Mach 1.5 (DFRC 2006). Since they increase surrounding pressure levels, sonic booms are associated with structural damage in some areas. Table 4-27 lists common types of damage and the corresponding overpressure levels. For perspective, the overpressure associated with close lightning strikes may exceed 0.14 kPa (3.0 psf) (MSFC 1997b).

**Table 4-27. Sonic Boom Damage to Structures**

| Sonic Boom Overpressure Nominal kPa (psf) | Type of Damage/ Item Affected | Extent of Damage |
|---|---|---|
| 0.02 - 0.10 kPa (0.4 - 2 psf) Compares to piledriver at construction site | Cracks in plaster | Fine; extension of existing; more in ceilings; over door frames; between some plaster boards. |
| | Cracks in glass | Rarely shattered; either partial or extension of existing. |
| | Damage to roof | Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole. |
| | Damage to outside walls | Existing cracks in stucco extended. |
| | Bric-a-brac | Those carefully balanced or on edges can fall; fine glass (*e.g.,* large goblets) can fall and break. |
| | Other | Dust falls in chimneys. |
| 0.10 - 0.20 kPa (2 – 4 psf) Compares to cap gun or firecracker near ear | Glass, plaster, roofs, ceilings | Failures show, which would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition. |
| 0.20 - 0.50 kPa (4 – 10 psf) Compares to handgun as heard at shooter's ear | Glass | Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses. |
| | Plaster | Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster. |
| | Roofs | High probability rate of failure for tile roofs in nominally good state; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily. |
| | Walls (out) | Old, free standing, in fairly good condition can collapse. |
| | Walls (in) | Inside ("Party") walls known to move at 10 psf. |
| > 0.50 kPa (> 10 psf) Compares to fireworks display from viewing stand | Glass | Some good glass will fail regularly. Glass with existing faults could shatter and fly. Large window frames move. |
| | Plaster | Most plaster affected. |
| | Ceilings | Plaster boards displaced by nail popping. |
| | Roofs | Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end; domestic chimneys dislodged if not in good condition. |
| | Walls | Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage. |
| | Bric-a-brac | Some nominally secure items can fall (*e.g.,* large pictures), especially if fixed to party walls. |

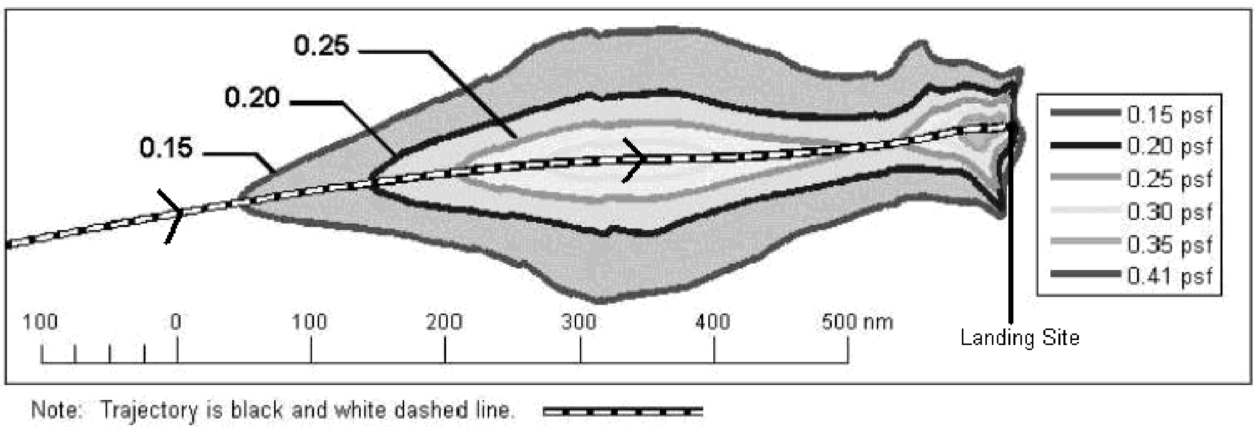
Source: MSFC 1997b

NASA performed extensive sonic boom atmospheric entry modeling for the X-33 reusable launch vehicle program (MSFC 1997b) which addressed the environmental impacts associated with a number of potential western U.S. landing sites. In addition, NASA has performed preliminary sonic boom footprint analysis for the Orion spacecraft (JSC 2007e).

Future NEPA documentation for Orion terrestrial landing site(s) would address sonic boom overpressure levels and their effects in greater detail.

#### 4.1.4.1.2 Preliminary Results for Orion Earth Atmospheric Entry

NASA has performed preliminary evaluations of the potential sonic boom footprints for atmospheric entry of the Crew Module over the western continental U.S. (the returning Service Module would also create a sonic boom footprint, which would occur over the Pacific Ocean, which is discussed in Section 4.1.4.2.1). Preliminary results of the Crew Module analyses indicate peak overpressure values ranging from 0.016 to 0.021 kPa (0.33 to 0.43 psf) occurring approximately 11 to 31 km (7 to 22 mi) from a landing site (JSC 2007e). Figure 4-12 shows the preliminary projected sonic boom footprint for the Crew Module returning from a lunar mission along a representative trajectory.




Note: See conversion table on page xxiii for English and metric units  Source: JSC 2007e

**Figure 4-12. Projected Crew Module Descent Sonic Boom Overpressure Contours**

The contours are the peak ground overpressures due to a sonic boom. The landing site is represented by a small black circle on the far right side of the trajectory line. The outermost contour is 0.007 kPa (0.15 psf) (JSC 2007e). As a comparison, the Space Shuttle mission STS-26 entry in 1988 was measured to have a maximum overpressure value of 0.11 kPa (2.3 psf) (JSC 2007j). The maximum overpressure calculated for each of the Crew Module entry trajectories remained well below the Space Shuttle maximum overpressure and below levels at which minor structural damage or community complaints would be expected. Based on this study, the environmental impacts, including those to marine species, from the Crew Module entry sonic booms would be expected to be negligible.

As a normal part of the Constellation Program design process, recent discussions indicate that the magnitudes of the overpressures could be somewhat higher than what is presented above.

However, the overall conclusion remains unchanged that the overpressures produced by the Crew Module during entry would be lower than those produced by the Space Shuttle. This is an expected result as the Crew Module is a smaller and lighter weight vehicle than the Space Shuttle. Future analyses are planned to refine these estimates.

Earth Atmospheric Entry Accidents

If the Crew Module were to have a catastrophic failure during atmospheric entry, the primary hazard would be that of falling debris. For the Space Shuttle Program, JSC Range Safety uses models developed after the Space Shuttle *Columbia* accident to predict atmospheric entry hazards to the public. These models calculate the risk of casualty resulting from falling debris. The Space Shuttle's trajectory is sometimes modified as the mission nears its completion if the upcoming landing opportunities have a predicted collective public risk of casualty due to falling debris that exceeds acceptable limits. This approach takes into account the probability of a catastrophic failure, the size of the resultant debris field, the resultant amount of debris that would survive to ground impact, the distribution of harmful debris within the debris field, population distribution on the ground, and population sheltering.

For the Constellation Program, preliminary analyses of the risk of potential debris falling on the public while the Orion Crew Module is en route to the landing site have been initiated. The analyses used models developed for and validated by the Space Shuttle Program. The results of these analyses indicate that, regardless of the terrestrial landing sites selected, the Constellation Program is expected to meet NASA's NPR 8715.5 criteria for risk to the public, and would not require in-flight orbital adjustments to meet those criteria. These results were anticipated since, compared to the Space Shuttle, the Crew Module is a smaller and a simpler vehicle that is planned to have a higher overall probability of successful mission completion. In addition, the Crew Module should have far fewer potential debris pieces in the unlikely event of a catastrophic atmospheric entry failure. Furthermore, in the nearly 50-year history of human spaceflight (U.S.: Mercury, Gemini, and Apollo; Russia: Soyuz; and China: Shenzhou), there have been no capsule breakups upon atmospheric entry.

Crew Module failure in the immediate vicinity of the landing site would result in impact of Crew Module debris in the designated landing zone. Therefore, the risk to the public associated with debris would be expected to be negligible.

NASA will coordinate with the FAA regarding atmospheric entry options so that aircraft could be moved from potential debris hazard zones in the event of an anomalous atmospheric entry. NASA will continue to assess whether any other hazards, such as toxic chemical and propellant releases, would be significant should the Crew Module make an uncontrolled impact in the landing zone. If such hazards are found to be significant, NASA would take appropriate risk mitigation measures, *e.g.*, changing the day of landing for weather considerations, movement of personnel, or selection of an alternative landing site.

### *4.1.4.2 Impacts of Service Module and Docking Mechanism Jettison and Crew Module Landing in the Pacific Ocean*

#### 4.1.4.2.1 Ocean Disposal of the Service Module and Docking Mechanism

The Service Module and the docking mechanism (from an International Space Station mission) would be jettisoned from the Orion spacecraft over a predetermined area of the Pacific Ocean just prior to atmospheric entry. See Section 4.1.3.1 for additional information. These objects would not be expected to survive atmospheric entry intact, but would break into many pieces of debris, some of which would survive to ocean impact. In accordance with NPR 8715.6 "NASA Procedural Requirements for Limiting Orbital Debris Generation" (NASA 2007d) and NASA Safety Standard 1740.14 "Guidelines and Assessment Procedures for Limiting Orbital Debris" (NASA 1995c), this disposal would be carried out such that the resulting debris field boundaries are no closer than 370 km (230 mi) from foreign land masses, 46 km (29 mi) from U.S. territories and the Continental United States, and 46 km (29 mi) from the permanent ice pack of Antarctica. Impact of the Service Module (and of the docking mechanism for International Space Station missions) would generate a debris field in a targeted area of the Pacific Ocean. A number of considerations go into the selection of the targeted area. These factors include technical considerations, such as orbital mechanics, and safety, environmental, and geopolitical considerations.

The environmental impacts associated with return of the Service Module include the immediate impacts of the entry sonic booms; the potential for debris striking people, ships, or wildlife; and the potential longer-term impacts of the debris on the ocean environment. The environmental impact of fragments of the Service Module (and the docking mechanism for International Space Station missions) falling into the Pacific Ocean would depend on the physical properties of the materials (*e.g.*, size, composition, quantity, and solubility) and the marine environment of the impact region. Sonic boom footprints for atmospheric entry of large and small pieces of Service Module debris and the associated environmental impacts would be similar to that discussed for the Crew Module.

NASA risk management practices would ensure that the debris impact footprint is selected so that the potential risks to aircraft and shipping from Service Module debris is very small. NASA will know prior to atmospheric entry when and where the debris field will be, and will ensure that NOTAMs and Notices to Mariners are disseminated in a timely manner. NASA will continue to focus on falling debris as the primary hazard and will compute risk estimates based on aircraft and ship traffic given the release of such notices and expected deviation from normal aircraft and shipping routes.

The potential environmental impacts of debris within the expected debris field would be expected to be small. The activities most likely to be affected would be trans-oceanic surface shipping and commercial airline routes. Debris would not be a risk to shipping or the environment whether the debris sinks, floats, or washes ashore. Surviving pieces of debris could be lethal if they strike a living organism on or near the ocean surface. Some surviving pieces could have sufficient kinetic energy to potentially cause damage to ships. Once the pieces travel a few feet below the ocean surface, their velocity would be slowed to the point that the potential for direct impact on sea life would be low. Even if there were a large ship within the impact area, the probability of hitting it with one or more pieces of debris would be small (NASA 1996).

The potential for long-term environmental impact on the debris on the ocean floor is small. The Service Module would be constructed mostly of carbon-based composites and aluminum. Propellant in the Service Module, including hydrazine, would be expected to vent fully prior to debris impact but trace amounts could remain. The propellant tanks would be expected to lose their integrity (*i.e.*, become breached) during atmospheric entry or at impact, ensuring that only residual hydrazine would remain, which would be diluted by seawater and therefore would not be expected to significantly affect marine life.

Based on past analyses of other space components, it is expected that the environmental impact of atmospheric entry debris would be negligible (NASA 1996, USAF 1998, NASA 2005b, NASA 2006d). It is expected that most components would sink and slowly corrode on the ocean floor. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the large volume of ocean water available for dilution (USAF 1996, NASA 2006d).

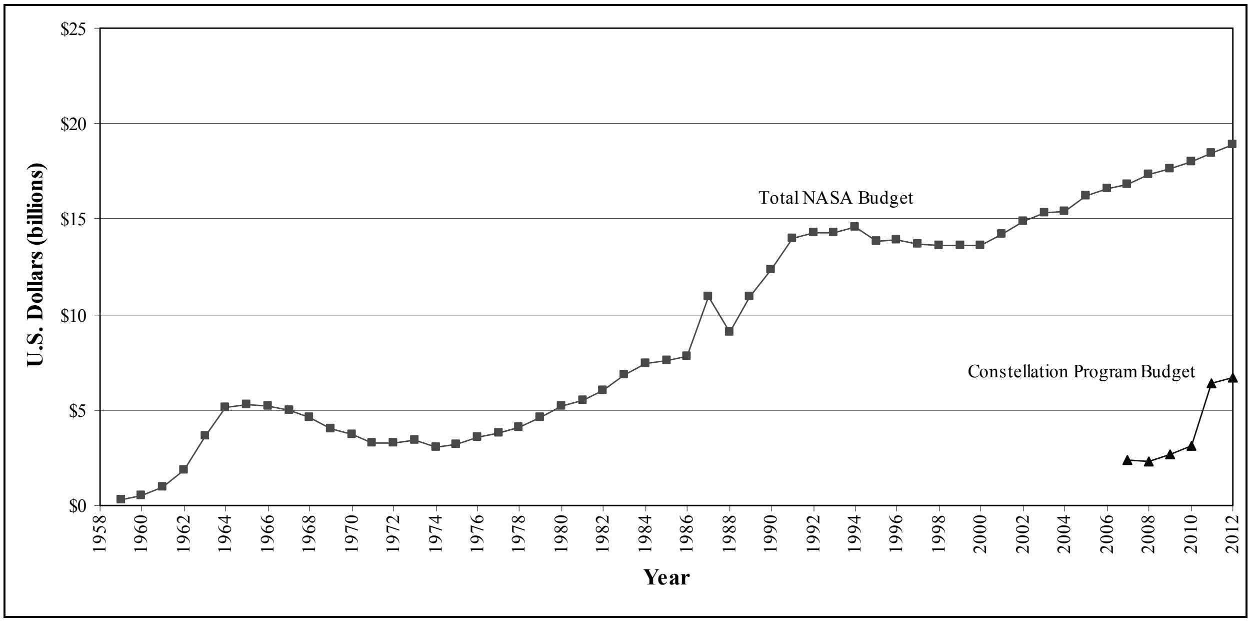
##### 4.1.4.2.2 Ocean landing of the Orion Crew Module

The environmental impacts of the splash down of the Crew Module returning from either the International Space Station or a lunar mission would be expected to be very small. In addition to recovering the crew and the Crew Module, the recovery team would remove materials from the vehicle that need to be transported separately (*e.g.*, returned lunar samples, payloads, and health monitoring devices) from the Crew Module. In addition, residual fuel (methane/oxygen bipropellant) would remain in the Crew Module and would have to be properly managed during recovery operations. The recovery of the Crew Module is expected to have a similar environmental impact to the Pacific Ocean as the recovery of the Ares I First Stage or the Ares V SRBs has to the Atlantic Ocean (see Section 4.1.3.1). The Constellation Program is currently studying the possibility of substituting the methane/oxygen bipropellant with a monopropellant (*e.g.*, hydrazine).

Although NASA would work to ensure that the environmental impacts of an ocean landing of the Crew Module would be low, several aspects of the environmental impacts are still being evaluated. Since potential ocean landing sites would not be selected until much later, the specific environmental impacts at any particular site cannot be determined. Similarly, the detailed environmental impacts of ship operations to recover the Crew Module cannot be estimated without knowledge of the landing site and home port. Although these details are not known, past operations for the Apollo Program and similar operations with the Space Shuttle Program, in the case of Ares I First Stage or the Ares V SRB retrieval, indicate that NASA can manage these activities with minimal environmental impacts. NASA will coordinate with the FAA regarding atmospheric entry options so that aircraft could be moved from potential debris hazard zones in the event of an anomalous atmospheric entry.

### 4.1.5 Potential Socioeconomic Impacts of Implementing the Constellation Program

NASA's past, current, and projected activities have resulted in beneficial impacts to local, regional, and national economies. Over the past 50 years, NASA has expended billions of dollars in support of a wide array of programs across multiple NASA Centers throughout the United States. The economic benefits associated with NASA's continued commitment to the Nation's leadership in space and aeronautics research are expected to continue through 2012 and beyond (reported as nominal U.S. Dollar values, not adjusted for inflation) (see Figure 4-13).



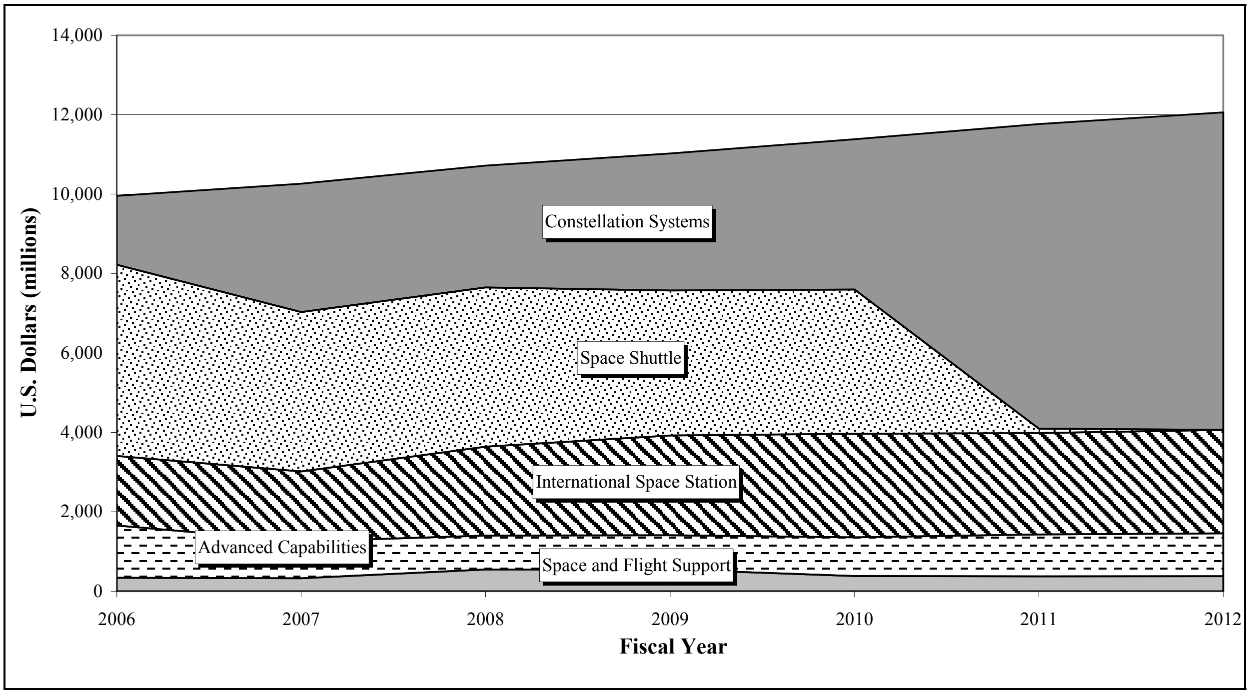

Sources: JSC 2007c, NASA 2006a, and NASA 2005a

**Figure 4-13. Total NASA Budget Fiscal Years 1959-2012 and Constellation Program Budget**

The President's fiscal year 2008 budget request reflects a commitment by NASA to continue the investments begun in prior years.

The distribution of work related to the proposed Constellation Program across NASA's Centers reflects NASA's intention to productively use personnel, facilities, and resources from across the Agency to accomplish NASA's exploration initiative (see Figure 2-2). Assignments align the work to be performed with the capabilities of the individual NASA Centers. The diversity of projects to be performed at each NASA Center would vary considerably; however, it is NASA's intent to retain a major socioeconomic footprint at each Center.

The proposed implementation of the Constellation Program, including the initial investment required and costs of future operations, together with other NASA programs, would be supported within NASA's long-term budget plan (see Figure 4-14). The Constellation Program would not be expected to produce any significant changes in NASA's civil servant workforce at the various NASA Centers. However, detailed analyses of the socioeconomic impacts of implementing the Constellation Program and the consequent significant conclusions are limited by the fact that the Constellation Program is at an early stage of development and would be subject to adjustments and changes as Program requirements become better defined. Detailed meaningful estimates of the specific work allocations at each Center would be available once the prime contracts are awarded for all of the Program's major projects and procurements. Quantification of impacts would require detailed cost information both from the Federal and private sectors and thorough economic analyses of the data, most of which is currently unavailable. The unpredictability of contractor funding and asset allocations at this time limits the projection of effects at each NASA Center.




Source: Adapted from NASA 2007b

**Figure 4-14. NASA Fiscal Year 2008 Budget Request for Exploration Systems and Space Operations**

NASA recognizes that through 2012 the Human Spaceflight Program will be in transition as certain NASA Programs, such as the Space Shuttle Program, are phased out. NASA is currently beginning the process of transitioning the workforce, infrastructure, and equipment from the Space Shuttle Program to the Constellation Program. It is anticipated that many civil servants and support contractors at the various NASA Centers would transition to Constellation Program activities during this transition. NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center.

### 4.1.6 Potential Environmental Impacts to the Global Environment

#### *4.1.6.1 Launch Vehicle Impacts on Stratospheric Ozone*

Exhaust emissions from the Ares I First Stage and the Ares V SRBs would release reactive chlorine compounds (HCl, Cl, $Cl_2$, and ClO) and particulate matter ($Al_2O_3$ and aluminum hydroxychloride) into the stratosphere at high temperatures. Figure 3-25 provides a graphic of the atmospheric layers and their estimated altitudes. Without being consumed, the chlorine compounds break down the stratospheric ozone ($O_3$) and remain in the stratosphere as long as two to three years. The particulate matter also acts as a catalyst for ozone destruction, with high temperatures from the exhaust often accelerating the destruction.

Previous work cites the ozone destruction by liquid propellants and oxides of nitrogen ($NO_x$) produced in aircraft afterburning as insignificant compared to the destruction by chlorine and particulate matter emissions from ignition of solid fuel (TRW 1999). Previous studies have shown that little launch exhaust released in the troposphere actually penetrates into the stratosphere and can be considered negligible compared to that generated in the stratosphere.

The effects of emissions introduced into the stratosphere would depend on the launch profile (*i.e.*, ascent angle) and the rate that propellant is consumed within the stratosphere. Because this Final PEIS is being prepared well in advance of Ares test or mission launches, assumptions were made that the Ares I and Ares V launch profiles would be similar to those for the Space Shuttle. Solid propellant consumption would occur just over two minutes after launch with Ares I First Stage and Ares V SRB separation occurring at an altitude of approximately 58 km (36 mi) and 39 km (24 mi), respectively, depending on launch profile and mission. The Space Shuttle SRB propellants are consumed in approximately two minutes after launch with separation occurring at an altitude of approximately 49 km (30 mi). The Space Shuttle SRB propellant consumption rates as a function of altitude are approximately equal to the expected Ares I and Ares V propellant consumption rates. Therefore, the rate of release of emissions into the stratosphere from the Ares I and Ares V were calculated as the product of the Space Shuttle emission release rate and the ratio of the Ares solid propellant mass consumed per unit time to that calculated for the Space Shuttle.

The Space Shuttle chlorine release rate is estimated as 3.9 mt (4.3 tons) per vertical kilometer, and the Ares I and Ares V vehicles are designed to use 62.5 and 125 percent, respectively, of the solid propellant used by the Space Shuttle. Therefore, the Ares I and Ares V vehicles are estimated to release 2.4 and 4.9 mt (2.7 and 5.4 tons), respectively, of chlorine per vertical kilometer in a single launch. Since a single launch of the Space Shuttle releases 71.6 mt (79 tons) of chlorine to the stratosphere and 102 mt (112 tons) of particulate matter (USAF 2000), each launch of an Ares I and an Ares V would release approximately 45 and 90 mt (50 and 99 tons) of chlorine, respectively and 63.5 and 127 mt (70 and 140 tons) of particulate matter, respectively, to the stratosphere.

Based on the solid rocket engine tests and flights proposed in Table 2-11 for the Constellation Program, seven Ares I test launches are planned over the 2009 to 2014 timeframe, and up to five Ares I mission launches per year are planned between 2015 to 2020, although the actual number of launches could be lower. In addition, five Ares V launches are planned between 2018 and 2020. Estimated total chlorine and particulate matter emissions to the stratosphere from these launches would be no more than 2,200 and 3,000 mt (2,400 and 3,400 tons), respectively, over that period.

During a rocket launch, there are both short-term and long-term cumulative effects on stratospheric ozone. The short-term effect is the creation of a local hole in the ozone layer, but stratospheric mixing has been observed to close the hole within a few hours for Space Shuttle launches. Table 4-28 provides the predicted ozone hole size and depletion time at an altitude of 20 km (12 mi) for various launch vehicles that utilize solid rocket motors during ascent.

However, earlier in situ measurements and modeling studies of a Titan IV launch indicated that local ozone concentrations did not return to pre-launch conditions for as long as 83 minutes (TRW 1999).

**Table 4-28. Ozone Depletion Time and Hole Size**

| Launch Vehicle | Chlorine Release Rate (tons/km)* | Hole Diameter (km) at Altitude of 20 km* | Hole Duration (minutes) |
|---|---|---|---|
| Space Shuttle | 4.3 | 5 | 97 |
| Titan IV | 2.0 | 4 | 25 |
| Atlas V 551/552 | 0.65 | 2 | 3.6 |
| Delta IV M+ (5,4) | 0.36 | 3 | 1.3 |
| Delta IV M+ | 0.42 | 2 | 1.0 |
| Atlas II AS | 0.10 | 0.8 | 0.1 |
| Delta II | 0.30 | 1 | 0.9 |

*See conversion table on page xxiii for English and metric units Source: USAF 2000

Table 4-28 shows that increased chlorine release rates tend to yield larger local holes in the ozone layer that persist for longer times. The relative persistence of the local ozone hole (an indicator of the increased radiation at the Earth's surface) can be approximated by the area of the hole multiplied by the time that the hole persists. The data from Table 4-28 are plotted in Figure 4-15 in terms of the product of hole diameter and hole duration (persistence) and extrapolated, to estimate the impacts from both Ares I and Ares V launch vehicles.

Persistence of the local ozone hole for Ares I would be 35 percent of that from the Space Shuttle, while the local ozone hole for Ares V would have 60 percent greater persistence than for Space Shuttle launches. Because the flight trajectories of launch vehicles are not vertical and wind shears would occur, the ground level ultraviolet radiation increase from loss of stratospheric ozone would be less than would be the case if the ozone depletion occurred in a uniform vertical column. Thus, temporary ozone holes due to rocket exhausts have been judged by experts (Jackman 1998) to have an insignificant impact to global ozone.

Simulations that assumed nine Space Shuttle launches and three Titan IV launches each year for 20 years were conducted previously (Jackman 1998). Assuming stratospheric emissions of 62 and 34 mt (68 and 38 tons) of HCl per Space Shuttle and Titan IV launch, respectively, the calculated total HCl releases over 20 years were 13,154 mt (14,500 tons), equating to a 0.023 percent decrease in annually averaged global total ozone levels as compared to no launches. Similarly, projected stratospheric emissions of 102 and 63 mt (112 and 69 tons) of $Al_2O_3$ per Space Shuttle and Titan IV launch, respectively, totaled to 22,045 mt (24,300 tons) of $Al_2O_3$ releases over 20 years, equating to a 0.010 percent decrease in annually averaged global ozone levels as compared to no launches. The total collective calculated impact from HCl and $Al_2O_3$ releases over 20 years was a 0.033 percent decrease in annually averaged global ozone levels.

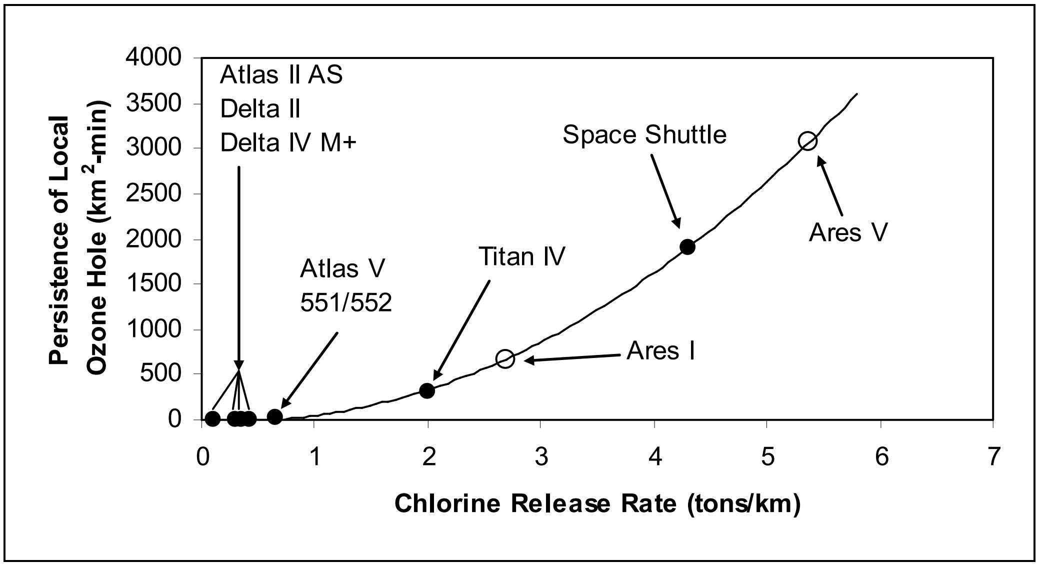



**Figure 4-15. Ozone Hole Persistence for Various Launch Vehicles**

The Constellation Program entails fewer projected launches through the early 2020s than this simulation. Based on the ratio of solid propellant masses between the Ares and Space Shuttle launch vehicles, each launch of an Ares I and an Ares V would release 45 and 90 mt (50 and 99 tons) of chlorine, respectively, and 64 and 130 mt (70 and 140 tons) of particulate matter, respectively, into the stratosphere. This totals to an estimated stratospheric release of 2,200 mt (2,400 tons) of HCl and 3,000 mt (3,400 tons) of $Al_2O_3$ at most through the early 2020s. Assuming a direct relationship between stratospheric releases and annually averaged global ozone level changes, the expected annually averaged global ozone level reductions from Constellation stratospheric HCl and $Al_2O_3$ releases would be no more than 0.0038 percent and 0.0014 percent, respectively, or a total of 0.0051 percent. However, the actual Constellation Program launch rates would most likely be lower than those projected in the simulations; therefore, the impact on the stratosphere from the Constellation Program would be lower.

#### *4.1.6.2 Potential Impacts of the Constellation Program on Global Climate Change*

Greenhouse gases absorb the radiative energy from the Sun and the Earth. Some direct greenhouse gases (*e.g.*, carbon dioxide, chlorofluorocarbons, and water) are emitted from processes described in this Final PEIS, 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.

The following annual greenhouse gas emissions were reported for 2004 in the U.S.: $7.07 \times 10^9$ mt ($7.8 \times 10^9$ tons) of carbon dioxide ($CO_2$) equivalent, $1.71 \times 10^7$ mt ($1.88 \times 10^7$ tons) of $NO_x$, and $8.76 \times 10^7$ mt ($9.66 \times 10^7$ tons) of CO (EPA 2006a). Although water vapor is considered a greenhouse gas, it is not tracked in the EPA inventory.

The principal source of carbon emissions that would be associated with the Constellation Program would be from NASA's energy use in support of the program. From fiscal year 1990 through fiscal year 2005, NASA reduced its total annual primary energy consumption by about

16 percent, from approximately $2.95 \times 10^{16}$ Joules (J) (28,000 billion British Thermal Units [Btu]) to approximately $2.53 \times 10^{16}$ J (24,000 billion Btu) (DOE 2006). NASA consumed energy primarily across four end-use sectors: 1) standard buildings; 2) industrial, laboratory and other energy intensive facilities; 3) exempt facilities and 4) vehicles and equipment, including aircraft operations (see Table 4-29).

**Table 4-29. NASA Energy Use**

| End Use | Fiscal Year 1990 Consumption (Billion Btu)[1] | Fiscal Year 2005 Consumption (Billion Btu)[1] | Percent Change |
|---|---|---|---|
| Standard Buildings | 10,764.0 | 10,793.8 | + 0.3% |
| Energy Intensive Facilities | 10,190.2 | 7,273.4 | - 28.6% |
| Exempt Facilities[2] | 6,050.7 | 4,891.6 | - 19.1% |
| Vehicles & Equipment | 1,736.7 | 1,058.1 | - 39.1% |
| Total Primary Energy | 28,741.6 | 24,016.9 | - 16.4% |

Source: DOE 2006

Notes:

1. See conversion table on page xxiii for metric conversion
2. Predominantly buildings and facilities in which it is technically infeasible to implement energy efficiency measures or where conventional performance measures are rendered meaningless by an overwhelming proportion of process-dedicated energy

The U.S. Department of Energy (DOE) reported that NASA also reduced estimated carbon emissions from facility energy use in standard buildings and energy intensive facilities from about $2.9 \times 10^5$ mt ($3.2 \times 10^5$ tons) in fiscal year 1990 to $2.5 \times 10^5$ mt ($2.8 \times 10^5$ tons) of carbon equivalent in fiscal year 2005, a 14 percent reduction. Although not reported by DOE, NASA's reduced energy usage in exempt facilities, vehicles and equipment would also have resulted in proportional reductions in carbon emissions.

Cumulative global impact from energy use under the Constellation Program would be expected to be similar to that from historical energy use under the Space Shuttle Program. It is NASA's policy to fully comply with the requirements of the National Energy Conservation Policy Act, Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and other statutory and Presidential directives regarding energy efficiency. NASA strives to reduce energy consumption and cost whenever possible in all facility operations. Each NASA Center and Component Facility has an established energy efficiency program directed at reducing facility energy intensity and associated greenhouse gas emissions as well as expanding the use of renewable energy for facilities and operational activities.

Emissions from rocket exhaust would also deposit carbon into the atmosphere. Based on the solid rocket engine tests and flights identified in Table 2-11, over the 2009 to 2020 timeframe roughly 33,900 mt (37,300 tons) of PBAN solid propellant would be expected to be used for engine testing, Launch Abort System testing, and launches. The emissions percentages from these activities, by weight, would be approximately 24 percent CO, 3.5 percent $CO_2$, and 9.5 percent water (MSFC 1989). In addition, the proposed 100 Upper Stage engine tests (at simulated altitude) at SSC would produce about 3,200 mt (3,500 tons) of CO during the development period. The Constellation Program's cumulative contribution to global warming from $CO_2$ and CO rocket exhaust emissions would therefore not be expected to exceed 1,200 mt (1,300 tons) $CO_2$ equivalent and 11,000 mt (12,000 tons) CO equivalent over the 2009 to 2020 timeframe, much smaller than NASA's contribution from energy consumption or than the 2004 national emissions levels.

Under the Proposed Action, NASA has assumed that HCFC 141b would not be used to produce foam insulation for the LH/LOX tanks for the Ares I and Ares V vehicles. To comply with EPA requirements to phase out ODS, and to reduce the long-term supportability risk posed by ODS usage, NASA intends to develop cryoinsulation replacements for the Ares I Upper Stage that do not contain HCFC 141b. NASA might continue to use relatively small amounts of HCFC 141b-blown foam for use in comparative studies. In addition, ATK also uses small quantities of HCFC 141b in foam used to fill test holes in foam insulation on the exterior surface of solid rocket motors. ATK is currently working with NASA to determine the requirements for the Ares I First Stage. The current rate of use is 12 kg/year (26 lb/yr) (ATK 2006). NASA is currently examining possible alternatives to HCFC 141b.

The global warming potentials for many greenhouse gases (expressed in metric tons of $CO_2$ equivalent) have been developed to allow comparisons of heat trapping in the atmosphere. The global warming potentials of HCFC 141b reported by the EPA range from 630 to 713 g (22 to 25 oz) $CO_2$ equivalent per gram of HCFC 141b (EPA 2006d). Therefore, assuming that NASA's annual Constellation Program use of HCFC 141b is less than 100 kg (220 lbs) per year, the maximum annual global warming potential from foam blowing operations is equivalent to less than 100 mt (110 tons) of $CO_2$, a very small fraction of annual U.S. $CO_2$ emissions.

Thus, the total global warming potential from NASA activities is approximately $2.5 \times 10^5$ mt ($2.8 \times 10^5$ tons) carbon-equivalent from energy consumption, less than 100 mt (110 tons) $CO_2$ equivalent annually from foam blowing and, over the 2009 to 2020 timeframe, no more than 1,200 mt (1,300 tons) $CO_2$ from rocket exhaust as well as 11,000 mt (12,000 tons) of CO from rocket exhaust and rocket testing. Collectively, these are less than 0.004 percent of the total global warming potential from all annual U.S. carbon emissions.

## 4.2 ENVIRONMENTAL IMPACTS OF THE NO ACTION ALTERNATIVE

Under the No Action Alternative, the environmental impacts associated with implementing the Proposed Action would not occur. Specifically, no direct impacts associated with launch vehicle engine tests, launches, atmospheric entry, wind tunnel tests, construction of new facilities, modifications of existing facilities, and other direct actions connected with the Constellation Program would occur. This would result in less noise and contamination of air, water, and soil in the near-term. In addition, the secondary impacts associated with the workforce supporting the Proposed Action would not occur. These impacts relate to the support infrastructure (*e.g.*, structures, utilities and roads) and include waste, water impacts, noise and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region. In addition, needed facility maintenance which would be funded by the Constellation Program may not be performed. Therefore, many of these facilities which have historic status could be placed under consideration for demolition; thus, constituting an adverse effect on historic properties.

As this time, a prediction cannot be made as to how the President or Congress would redirect funding and personnel that would otherwise support the proposed Constellation Program. As indicated earlier, the President has directed NASA to terminate the Space Shuttle Program no later than 2010. Without new programs and projects to fill the void left by the close of the Space Shuttle Program, substantial adverse socioeconomic impacts would be experienced by localities that host NASA Centers heavily involved in the Space Shuttle Program.

At each Center or site considered under the Proposed Action, the environmental impacts of the No Action Alternative would vary somewhat. At KSC, the additional rocket launches of the development vehicles, mission launches, and the resulting noise and exhaust clouds from the Ares launches would not occur, along with the direct near-pad impacts from heat, exhaust, and noise on close-in vegetation and wildlife. No sound suppression system water discharges following Ares launches would occur. Planned near-term modifications to the VAB, Mission Control Center and LC-39 Pad B to accommodate Ares I test flights, evaluated under the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f), and the supporting infrastructure necessary to support Ares mission launches would not be necessary.

At SSC, the additional full-scale J-2X engine tests planned to support the Constellation Program would not occur. As a direct result, modifications to the existing facilities and the construction of a new test stand (A-3) evaluated in the *Final Environmental Assessment for the Construction and Operation of the Constellation Program A-3 Test Stand, John C. Stennis Space Center, Hancock County, Mississippi* would not be necessary. In addition, the noise and water vapor exhaust clouds from Constellation Program engine tests would not occur. Cooling water discharges from Program-related engine tests (and the subsequent thermal impacts) would not occur.

At JSC, the impacts associated with modifications of facilities necessary to support the Proposed Action would not occur. There would be no aviation-related training operations for the Constellation Program at the Ellington Field Facility.

At MSFC, the impacts associated with modifications of facilities necessary to support the Proposed Action would not occur. Additional rocket engine tests planned to support the Constellation Program would not be necessary. As a direct result, any modifications to the test facilities to support engine development tests would not occur, nor would noise and water vapor exhaust clouds from Constellation Program engine tests. Cooling water discharges from Constellation Program-related engine tests (and subsequent thermal impacts) would not occur.

At GRC PBS, the impacts of modifications of facilities necessary to support the Proposed Action and impacts from engine testing would not occur.

At LaRC, the impacts associated with modifications and operation of test facilities and wind tunnels necessary to support the Proposed Action would not occur. The NRHP-eligible and NHL historic properties would not undergo modifications, alterations, or additions in support of Constellation Program activities. However, the Impact Dynamics Facility (Gantry) (Building 1297), a National Historic Landmark, was previously considered for possible demolition. If the Proposed Action is not implemented, NASA may have to consult with the Virginia SHPO regarding demolition of the Gantry, which would constitute an adverse effect.

At ARC, the impacts associated with modifications of facilities necessary to support the Proposed Action would not occur.

At WSTF and WSMR, the impacts of construction and modifications of facilities necessary to support the Proposed Action would not occur. The near-term modifications to the launch pad evaluated in the *Final Environmental Assessment for the NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b) would not be necessary. The direct and indirect impacts of engine development test activities, including the Launch Abort System test program at WSTF and the short-term noise and air emissions associated with the rocket launches at the WSMR in support of the Launch Abort System, would not occur.

At ATK, the additional full-scale five-segment solid rocket motor tests planned to support the Constellation Program would not occur. As a direct result, modifications to the test facilities to support this activity would not be necessary. In addition, the noise and exhaust clouds from solid rocket motor tests in support of the Constellation Program would not occur.

There would be no terrestrial or water (ocean) landings of the Orion Crew Module under the No Action Alternative. Therefore, there would be no environmental impacts associated with preparing the terrestrial landing site(s), landing of the Crew Module, or recovery of the Crew Module, Ares I First Stage, and Ares V SRBs. There would be no risks to public from overflight of the Crew Module and no disposal of launch vehicle stages and other vehicle elements in the Atlantic, Pacific, and Indian Oceans.

In addition, no Environmental Justice impacts would be anticipated at any of the facilities proposed for use by the Constellation Program.

## 4.3 CUMULATIVE IMPACTS

This section addresses the cumulative impacts of implementing the Proposed Action coupled with other past, present, or reasonably foreseeable activities that might collectively result in potentially significant environmental impacts. Cumulative impacts are the impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, activities that take place within the same period of time and/or within the same geographical area.

The principal activities associated with the Proposed Action that would result in potential environmental impacts include rocket engine tests, rocket launches, construction of new facilities, modifications of existing facilities, and other direct actions. In addition, there may be secondary impacts associated with the support infrastructure (*e.g.*, structures, utilities, and roads). Such secondary impacts could include wastes, impacts to water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region. The potential socioeconomic impacts of implementing the Constellation Program were discussed previously in Section 4.1.5.

Since the proposed Constellation Program would be largely built upon the ongoing Space Shuttle Program, including the technologies and facilities at each of the potential sites that would have Constellation Program-related activities, the potential environmental impacts would be expected to be very similar to the current impacts associated with the Space Shuttle Program. For sites which would be performing Constellation Program activities but did not or have not in recent years been performing similar activities under the Space Shuttle Program (*e.g.*, GRC), such activities would largely be similar to ongoing operations at those centers and therefore have similar environmental impacts.

For most of the sites, activities that would be undertaken under the Proposed Action would be expected initially to overlap with the Space Shuttle Program until the Space Shuttle is retired. However, the resulting environmental impacts of both the Space Shuttle Program and the Constellation Program would be expected to be small or negligible as the Constellation Program is in its early formulation stages. Actions that could have potential environmental impacts such as construction, engine testing, and test launches are in early planning stages and most construction would begin near the end of this decade, at the time of the planned Space Shuttle retirement. At most sites, the nature of the principal Constellation Program activities (engineering development, testing, research, and launch vehicle/spacecraft assembly) implies that the primary environmental impacts would be directly related to the size of the workforce (*e.g.*, waste, impacts to water, air emissions, and socioeconomic impacts).

Each NASA Center has multiple on-going programs that would be managed concurrently with the Constellation Program. It is reasonable to expect that these programs would conduct testing and evaluation activities and could engage in the construction or modification of buildings as needed. In addition, each NASA Center has funding plans which identify activities such as construction, demolition, or rehabilitation of buildings and test stands. Such activities would be evaluated for environmental impacts by the sponsoring program or affected Center(s) and would be subject to separate NEPA review and documentation, as appropriate. However, these activities may or may not occur within the given timeframe of the funding plan due to many factors (*e.g.*, implemented funding and program direction) and may or may not have any environmental impacts. NASA has identified categories of actions that have demonstrated no impact to the environment when implemented. In general, many on-going activities at NASA Centers fall into these categories of actions. For purposes of the cumulative impacts analysis, those Center activities that have no environmental impact are not discussed further.

### 4.3.1 Cumulative Localized Impacts

At KSC, launches of development vehicles and mission vehicles would release solid propellant combustion products, principally $Al_2O_3$ and HCl, to the atmosphere, and ultimately to the surrounding grounds and waters. While the highest concentrations would be within a few hundred meters of the launch pad, some of the exhaust cloud would ultimately deposit in the KSC/CCAFS region. These deposits would be in addition to similar deposits from past and anticipated future launches from KSC and CCAFS.

Over the period from 2009 to 2020, fewer than 48 five-segment solid rocket motors would be launched from KSC (see Table 2-11). Based on the emission factors developed for the *Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program* (MSFC 1989), the weight percent of emissions from burning PBAN propellant are 30 percent $Al_2O_3$, 24 percent CO, 3.5 percent $CO_2$, 21 percent HCl, 9.5 percent water, nine percent nitrogen, two percent hydrogen, and one percent other materials. Thus, the firing of five-segment solid rocket motors over this timeframe would produce no more than 9,100 mt (10,000 tons) of $Al_2O_3$, 7,300 mt (8,100 tons) of CO, 1,100 mt (1,200 tons) of $CO_2$, 6,400 mt (7,100 tons) of HCl, 2,900 mt (3,200 tons) of water, 2,700 mt (3,000 tons) of nitrogen, 610 mt (670 tons) of hydrogen, and 300 mt (340 tons) of other materials. Approximately two-thirds of the airborne emissions would be initially deposited in the local environment and troposphere, with the remainder deposited in the stratosphere.

These launches would be in addition to the launches from CCAFS. CCAFS launch pads would probably be sufficiently distant from LC-39 at KSC that the exhaust cloud impacts from those launches would only minimally affect the area in the immediate vicinity of LC-39. The possibility exists that exhaust clouds from CCAFS launch pads could reach some of the same far-field areas as Ares exhaust clouds would. This is not expected to be of a magnitude nor of a frequency that would substantially increase exhaust product deposition or result in substantial adverse impacts.

Various monitoring studies (AIAA 1993, CCAFS 1998, KSC 2003) have found that because of the nature of the soil in the area (high calcium carbonate), acid deposits from solid propellant exhaust clouds are quickly neutralized and the long-term effects of the HCl deposits are minimal. While each Ares launch would also have additional impacts very near the launch pad, these effects would be dominated by past and future launches on that pad and not by other nearby CCAFS launches.

Other near-pad launch impacts, including occasional noise impacts on wildlife from Ares launches, would primarily be localized and not compounded by future non-Constellation Program launches.

At SSC, the additional full-scale rocket engine tests planned to support the Constellation Program would result in a continuation of the occasional local impacts of engine tests, primarily short-term noise and water vapor exhaust clouds. The occasional loud noise from past and ongoing engine tests has not had a significant long-term impact on the local and regional area. The buffer area surrounding the site limits the noise impacts on humans and the noise impacts on wildlife in the buffer area are generally limited to startle responses. Furthermore, the proposed Constellation Program activities along with other foreseeable program activities at SSC would not be expected to result in a significant cumulative impact.

At MSFC, rocket engine tests planned to support the Constellation Program would result in a continuation of the occasional local impacts of engine tests, primarily short-term noise and water vapor exhaust clouds. The occasional loud noise from past and ongoing engine tests has not had a significant long-term impact on the local and regional area. MSFC has strategies to mitigate potential adverse impacts such as noise from engine testing (see Chapter 5). Furthermore, the proposed Constellation Program activities along with other foreseeable program activities at MSFC would not be expected to result in a significant cumulative impact.

At WSMR, Launch Abort System test launches would result in the addition of noise and exhaust particulates. The additional noise associated with the test launches would be very short term and would not be expected to adversely impact the surrounding population or wildlife. WSMR occupies a large area of about 1.5 million ha (3.8 million ac) of relatively undeveloped land. When coupled with the ongoing noise generated by routine types of activities such as military aircraft operations and missile tests at WSMR, the additional cumulative effects of Launch Abort System rocket test noise at WSMR would be minimal. The Launch Abort System tests would also generate exhaust products, principally HCl and $Al_2O_3$, which would deposit downrange. The cumulative effects of these deposits when considered along with previous and anticipated future launches would be minimal (WSTF 2007b).

At other NASA Centers, implementation of the Proposed Action would not involve major new construction or new types of activities with the potential for substantial environmental impacts. The proposed activities are similar in nature and magnitude to past and ongoing activities in support of the Apollo Program and the Space Shuttle Program. Therefore, the projected cumulative environmental impacts of implementing of the Proposed Action are principally the secondary impacts associated with the workforce that would support the Proposed Action at each respective facility. This includes the support infrastructure, including structures, utilities, and roads, and the impacts of their use, such as waste, impacts to water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

At ATK's Promontory facility, the full-scale five-segment solid rocket motor tests planned to support the Constellation Program would produce occasional short-term noise and exhaust products, principally $Al_2O_3$ and HCl. These test activities would produce impacts similar in character to past, ongoing, and anticipated future solid rocket motor tests at this remote site. Near-term development tests of the Ares I and Ares V solid rocket motors, and long-term test firings of production motors at ATK would release exhaust products to the immediate environment near the test stand and the local environment around the ATK test site. These releases would increase $Al_2O_3$ and HCl soil concentrations in the immediate vicinity of each test stand. It is expected that future testing activities would be similar in frequency and impacts as past activities. In addition to the Constellation Program actions, ATK also supports other clients who would use the facilities for test firing of rocket motors, resulting in the release of exhaust products in the vicinity of the test stands. The cumulative impact of Constellation Program testing in addition to other past, ongoing, and future solid rocket motor firings would be expected to be minimal.

The principal projected cumulative environmental impacts of implementing of the Proposed Action, coupled with the past, ongoing, and other anticipated activities at ATK, are the accumulation of exhaust deposits in the vicinity of the test stands. The secondary impacts associated with the workforce that would support production of the Constellation Program, including procurement of components, would be comparable to that for the on-going Space Shuttle Program. This includes the support infrastructure, including structures, utilities, and roads, and the impacts of their use, such as waste, water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

### 4.3.2 Cumulative Global Impacts

Implementation of NASA's Constellation Program would result in very small impacts on global warming and stratospheric ozone due to continued energy use and rocket launches.

#### *4.3.2.1 Global Warming*

Cumulative global impact from energy use under the Constellation Program when added to past, ongoing, and anticipated future U.S. actions would be expected to be similar to the historical energy use under the Space Shuttle Program. It is NASA's policy to fully comply with the requirements of the National Energy Conservation Policy Act, Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and other statutory and Presidential directives regarding energy efficiency. NASA strives to reduce energy consumption and cost whenever possible in all facility operations. Each NASA Center and Component Facility has an established energy efficiency program directed at reducing facility energy intensity and associated greenhouse gas emissions as well as expanding the use of renewable energy for facilities and operational activities. See Section 4.1.6.2 for an expanded discussion of NASA energy use.

The total global warming potential from NASA activities is approximately $2.5 \times 10^5$ mt ($2.8 \times 10^5$ tons) carbon-equivalent annually from energy consumption and, over the 2009 to 2020 timeframe for the Constellation Program no more than 1,200 mt (1,300 tons) of $CO_2$ from rocket exhaust as well as 11,000 mt (12,000 tons) of CO equivalent from rocket exhaust and rocket testing. These are collectively less than 0.004 percent of the projected annual U.S. carbon emissions over that period. Therefore, the Proposed Action (combined with NASA's other energy consumption) would add a negligible amount to the U.S. emissions contribution to global warming.

#### *4.3.2.2 Stratospheric Ozone Depletion*

Based on the proposed Constellation Program's 12-year vehicle engine and flight test schedule presented in Table 2-11 (*i.e.*, from 2009 to 2020), implementation of the Proposed Action would potentially result in the deposition of no more than 2,200 mt (2,400 tons) of HCl and 3,000 mt (3,400 tons) of $Al_2O_3$ in the stratosphere.

For the 2000 to 2010 timeframe, the FAA has estimated that about 1,136 worldwide launches would occur. The FAA estimated that approximately 16,209 mt (17,867 tons) of HCl and 29,329 mt (32,329 tons) of $Al_2O_3$ would be deposited in the troposphere, and an equal amount deposited in the stratosphere (FAA 2001). If worldwide launch rates and emissions remain at these levels for the 2009 to 2020 timeframe, about 13 and 10 percent, respectively, of the total HCl and $Al_2O_3$ that would be deposited in the stratosphere would be from Ares launches during that period. This is similar to the amounts that were attributed to the Space Shuttle Program in the *Final Programmatic Environmental Impact Statement for Licensing Launches* (FAA 2001).

Many studies have been conducted on the cumulative environmental effects of launches worldwide. The American Institute for Aeronautics and Astronautics convened a workshop (AIAA 1991) to identify and quantify the key environmental issues that relate to the effects on the atmosphere from launches. The conclusion of the workshop, based on evaluation of scientific studies performed in the U.S., Europe, and Russia, was that the effects of launch vehicle propulsion exhaust emissions on stratospheric ozone depletion, acid rain, toxicity, air quality, and global warming were extremely small compared to other human activities (AIAA 1991, FAA 2001).

## 4.4 ENVIRONMENTAL IMPACTS THAT CANNOT BE AVOIDED

During engine ground testing, liftoff, and ascent, the rocket engines that would be developed for the Constellation Program would produce short-term noise that cannot be avoided. Short-term noise also occurs during liquid engine testing at MSFC, SSC, and perhaps other facilities and solid rocket motor testing at ATK's Promontory facility. Noise would also occur during test flights at WSMR and KSC and liftoff and ascent of Ares I and Ares V launch vehicles at KSC. At each of the sites, past and ongoing rocket engine tests and launches in support of the Space Shuttle and other programs produce similar noise impacts.

Sonic booms over the Atlantic Ocean under the flight path of the Ares I and Ares V launch vehicles, as well as sonic booms during atmospheric entry of the Orion spacecraft over the Pacific Ocean and the western U.S., cannot be avoided. Initial evaluations indicate that the magnitude of these sonic booms are similar to but lower in magnitude than those associated with launch and atmospheric entry of the Space Shuttle. In addition, there would be jettisoned components during launch vehicle ascent and from the returning Orion spacecraft. The potential environmental impacts associated with these components cannot be avoided.

During solid rocket motor ground testing, launches to test the Launch Abort System at WSMR, Ares test flights at KSC, and Ares I and Ares V launches at KSC, solid propellant exhaust is produced, consisting principally of HCl and $Al_2O_3$. These exhaust products and their deposition cannot be avoided. The Launch Abort System test launches at WSMR would collectively emit 65 mt (72 tons) of total suspended particulates, 27 mt (30 tons) of $PM_{10}$, 5.8 mt (6.4 tons) of $NO_x$, and 44 mt (49 tons) of HCl. Each test firing of five-segment solid rocket motors at ATK's Promontory facility would emit approximately 190 mt (210 tons) of $Al_2O_3$, 150 mt (170 tons) of CO, 22 mt (25 tons) of $CO_2$, and 130 mt (150 tons) of HCl. Biota in the immediate vicinity of the test stands could be damaged or killed by the intense heat and HCl deposition from the exhaust cloud. No long-term adverse effects to biota would be anticipated. $Al_2O_3$ particulates from the solid propellant combustion also would be deposited on soils at the test site as the exhaust cloud travels downwind.

At liftoff and during ascent from KSC, the Ares I First Stage and Ares V SRBs would each emit approximately 190 mt (210 tons) of $Al_2O_3$, 150 mt (170 tons) of CO, 22 mt (25 tons) of $CO_2$, 130 mt (150 tons) of HCl, 60 mt (66 tons) of water vapor, 57 mt (63 tons) of nitrogen, 13 mt (14 tons) of hydrogen, and 6 mt (7 tons) of other materials each. In addition, the main engine of the Ares V Core Stage and the Upper Stages of both the Ares I and Ares V vehicles would produce primarily water vapor and water. The exhaust cloud would be concentrated near the launch pad during the first moments of launch. Thereafter, the exhaust cloud would be transported downwind and upward, eventually dissipating to background concentrations. Biota in the immediate vicinity of the launch pads could be damaged or killed by the intense heat and HCl deposition from the exhaust cloud. No long-term adverse effects to biota would be anticipated. $Al_2O_3$ particulates from the ignition of solid fuel also would be deposited on soils and nearby surface waters at the launch site as the exhaust cloud travels downwind.

Although NASA is committed to reducing the use of ozone depleting substances to the extent practicable, the Constellation Program may still use some of these substances, but would utilize them only in limited, tightly controlled quantities.

## 4.5 INCOMPLETE OR UNAVAILABLE INFORMATION

This Final PEIS has been developed during the early design stages of the Constellation Program. It is reasonable to expect that there would be changes to the Constellation Program's plans and designs if the Proposed Action is selected. These changes could result from modification to the launch vehicles and the Orion spacecraft, changes to the locations where various research, development, and testing occurs, and their timing, or a reduction in the number of launches from the planned baseline.

These are not anticipated to substantively affect the environmental evaluations presented in this Final PEIS. However, should substantial change occur in the potential environmental impacts, NASA would evaluate the need for additional environmental analyses and documentation.

Several key aspects of the Constellation Program are not sufficiently defined to be thoroughly evaluated in this Final PEIS. These include:

- Potential building modifications or new construction at MAF, if MAF is chosen as the facility for Ares V Core Stage and/or Earth Departure Stage development
- Configuration of a potential new launch vehicle Vertical Integration Facility at KSC
- A new Launch Complex and new Launch Pad at KSC
- A new Crawlerway from the Vertical Assembly Building to LC-39 and new Crawler-Transport at KSC
- Addition of a new building at KSC to process hazardous materials for the Constellation Program
- Extent to which qualified commercial suppliers would be utilized to provide crew and cargo service to and from the International Space Station
- Potential building modifications at ARC in support of Orion Thermal Protection System tests
- Potential Orion Thermal Protection System flight tests
- Need for and magnitude of continued use of ozone depleting substances now used by the Space Shuttle Program, such as HCFC 141b foam
- Candidate Orion terrestrial landing sites
- Development of Lunar Landers, Lunar Surface Systems, Mar Systems, and other future systems to be implemented beyond 2020.

Detailed analysis of the socioeconomic impacts of implementing the Constellation Program cannot be performed at this time as most of the prime contract procurements are not completed.

Furthermore, complete and accurate socioeconomic information, including budgetary data, workforce projections, and future procurement actions in addition to the prime contract procurements are not available thus limiting the ability to quantify the socioeconomic impact of the Constellation Program.

## 4.6 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

### 4.6.1 Short-Term Uses

Under the Proposed Action, the Ares I and Ares V launch vehicles would be launched from the existing Space Shuttle launch pads at KSC. The short-term affected environment would include the launch complex and surrounding areas. Other nearby activities include commercial, NASA and USAF operations at CCAFS, urban communities, a fish and wildlife refuge, citrus groves, residential communities, and recreational areas. Launch activities for the proposed Constellation Program would be conducted in accordance with past and ongoing NASA and USAF procedures for operations at KSC, CCAFS, the Eastern Range, and in accordance with NASA and U.S. Army procedures at WSMR. Should a launch accident occur under the Proposed Action, short-term uses of HCl-contaminated areas could be curtailed, pending survey and possible mitigation.

Should a ground accident occur, affected environments that could possibly be impacted in the short-term include the immediate vicinity of the test stands at SSC, MSFC, and ATK. Uses of these assets could be curtailed pending survey and possible mitigation.

The proposed Constellation Program would overlap and then continue beyond the close-out of the Space Shuttle Program. At some NASA Centers, many common-use assets would be expected to transition from the Space Shuttle Program to Constellation Program support. No major conflicts between the short-term uses of the facilities have been identified.

### 4.6.2 Long-Term Productivity

No change to land use at any of the facilities proposed for use by the Constellation Program is anticipated. The region would continue to support human habitation and activities, wildlife habitats, citrus groves, grazing and agricultural land, and cultural, historic, and archaeological areas. No long-term effects on these uses are anticipated.

The pursuit of the proposed Constellation Program would benefit the U.S. Space industry, which is important to the economic stability of the country. In addition to the localized economic benefits at each NASA Center and commercial sites, implementing this program has broader socioeconomic benefits. These include technology spin-offs to industry and other space missions, maintaining the unique capability of the U.S. to conduct space missions, and supporting the continued technical development of scientists and engineers. Furthermore, comprehensive formal and informal education programs would be conducted as public outreach efforts, and proactive small business plans would be implemented to provide opportunities for small, small disadvantaged, and woman-owned small businesses, and historically black colleges and universities.

## 4.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irretrievable resource commitment results when a spent resource cannot be replaced within a reasonable period of time. For the Proposed Action, quantities of various resources, including energy, fuels, and other materials, would be irreversibly and irretrievably committed. The use of these resources would be associated with development, vehicle fabrication, launch, and operation of Constellation Program missions.

Fabrication of the launch vehicles and the Orion spacecraft would use electrical and fossil-fuel energy. This constitutes an irretrievable commitment of resources, but would not impose any significant effect on fuel availability. Ground testing, launches, and operation of the Orion spacecraft would consume solid and liquid propellant and related fluids. The solid propellant ingredients for the SRBs would consist of polybutadiene, acrylic acid, and acrylonitrile terpolymer (PBAN). The liquid propellants would include LH and LOX. Typical quantities that would be used are summarized in Chapter 2.

The total quantities of other materials used in the Constellation Program activities that would be irreversibly and irretrievable committed are relatively minor. Typically, these materials include steel, aluminum, titanium, iron, plastic, glass, graphite, nickel, chromium, lead, zinc, and copper. Less common materials used in small quantities may include silver, mercury, gold, rhodium, gallium, germanium, hafnium, niobium, platinum, tantalum, and beryllium.

## 4.8 ENVIRONMENTAL COMPLIANCE

NASA has completed implementation of an Environmental Management System (EMS) at all of its Centers and Component Facilities determined to be “appropriate facilities” based on the facility size, activities, and potential environmental risks. An EMS is a system that (1) incorporates people, procedures, and work practices in a formal structure to ensure that the important environmental impacts of an organization are identified and addressed, (2) promotes continual improvement by periodically evaluating environmental performance, (3) involves all members of the organization as appropriate, and (4) actively involves senior management in support of the environmental management program. The purpose of the NASA EMS is to have a single overall approach to managing environmental activities that allows for efficient, prioritized program execution.

The NASA Centers that would support the Constellation Program are subject to a vast array of Federal, state, and local environmental statutes, regulations, and orders. Each Center has a staff dedicated to complying with these requirements. In addition, NASA has various internal procedural requirements that pertain to environmental management. This section presents an overview of the principal environmental permitting requirements that apply to the various NASA Centers, with identification and brief discussion of additional environmental licenses and permits (if any) that will need to be obtained specifically for implementation of Constellation Program activities.

Since the activities anticipated under the Constellation Program are similar in nature to the activities conducted currently at the various NASA facilities, it is expected that there be minimal, if any, effects on the current environmental permitting status at each facility. All Constellation

Program activities will be conducted in full compliance with all applicable Federal, state, and local regulations, as well as NASA's internal implementing regulations and procedures. Potential impacts of Constellation Program activities on the environmental compliance status at each affected facility are discussed below by environmental media area.

Other government facilities (*e.g.*, the U.S. Army's WSMR site) and commercial facilities that could potentially support the Constellation Program would also be subject to Federal, state, and local environmental statutes, regulations, and orders. These would include but not be limited to the following areas: air, water, floodplains, wetlands, hazardous wastes, hazardous materials, threatened and endangered species, and safety and health.

<u>Air Resources</u>

The Clean Air Act of 1970 and subsequent amendments (42 United States Code [U.S.C.] 7401 *et seq.)* address ambient levels of air pollution and control programs/requirements for sources of air pollution. Air operating permits are required for facilities that emit regulated criteria and hazardous air pollutants from stationary sources. Stationary sources of air pollutants at NASA facilities include combustion sources (*e.g.*, boilers, generators), engine testing, parts cleaning and degreasing, surface coating, abrasive blasting, wood working, fuel storage and dispensing. Permits are not required for mobile sources of air pollutants, including automobiles and trucks, aircraft, and launch vehicles during liftoff and ascent. However, many launch support activities (*e.g.*, vehicle preparation, assembly, propellant loading) are considered stationary sources.

All of the NASA and contractor facilities associated with the Constellation Program and discussed in this Final PEIS have state air operating permits. Regulated air emissions at several of these facilities exceed the "major source" emission thresholds and, therefore, subject these facilities to the CAA's Title V permitting program (40 CFR Part 70). The following facilities have Title V air operating permits: KSC, SSC, JSC, MSFC, GRC Lewis Field, WSMR, and ATK's Promontory facility. In addition, three facilities (MAF, LaRC, and ARC) have accepted certain emission limitations and operate under "synthetic minor" permits. PBS and ATK's CRC facility are minor sources and operate under general state air operating permits.

The various activities that are proposed to occur at each of these NASA facilities under the Constellation Program are consistent with the current activities conducted at these sites under their existing air permits. It is not expected that any Constellation Program activities will change the regulatory permitting status (*i.e.*, major vs. minor) of any facility. Construction permits and operating permit modifications may be required for the addition of stationary sources associated with any new construction and/or modifications to existing buildings/operations (*e.g.*, at SSC or MSFC). As noted previously, launch emissions and other mobile source emissions are not subject to CAA permitting requirements. The possibility exists that some new sources or "major" modifications to existing sources may exceed the permitting thresholds of the EPA's New Source Review (NSR) or Prevention of Significant Deterioration programs. If that is the case, NASA will conduct the necessary analyses and prepare the appropriate permit application(s). In addition, it is expected that facility-specific NEPA documentation would address any air quality and other environmental impacts associated with such larger sources/modifications.

Three NASA Centers (JSC, GRC Lewis Field, and ARC) are located in areas that are not in attainment (*i.e.*, nonattainment areas) for one or more of the NAAQS. JSC is located in an ozone nonattainment area; Lewis Field is in a nonattainment area for $PM_{2.5}$ and ozone (which is also a maintenance area for $PM_{10}$, CO, and $SO_2$); and ARC is located in a nonattainment area for ozone, $PM_{10}$, and $PM_{2.5}$ (which is also a maintenance area for CO). Therefore, activities conducted at these Centers must be consistent with the corresponding State Implementation Plan (SIP) and new actions (*i.e.*, Federal actions) must comply with EPA's General Conformity regulations (40 CFR Parts 51 and 93) established under Section 176(c) of the CAA.

Water Resources

The Clean Water Act of 1977, as amended (33 U.S.C. 1251 *et seq*.), provides regulatory guidelines for water quality and governs the discharge of pollutants into surface waters. The NASA facilities that would support Constellation Program currently generate a variety of sanitary, storm, and industrial wastewaters that must be managed in accordance with the CWA and the implementing EPA and state regulations.

The management of sanitary and industrial wastewaters and stormwaters varies by facility, with some NASA facilities having their own wastewater treatment facilities and others relying on local municipalities, or a combination thereof. In all cases, the treatment and discharge of these wastewaters is permitted by the applicable state and/or local regulatory agencies. Any wastewater is discharged in accordance with the National Pollutant Discharge Elimination System (NPDES) permitting program requirements and a permit issued by either EPA or the state. It is expected that the Constellation Program activities will generate wastewaters of similar composition at volumes within levels currently permitted for at each NASA facility. Therefore, Constellation Program activities will not require substantial modifications to existing permits and no adverse impacts are expected to surface water resources.

Floodplains and Wetlands

Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, as amended 42 U.S.C. 2473(c)(1), mandate that Federal agencies take actions to minimize their impacts on floodplains and wetlands. NASA has promulgated its own regulations for floodplain and wetlands management (14 CFR 1216.2) that require, among others, that each field installation prepare a base floodplain map, incorporate floodplain management and wetlands protection into land use planning activities, and consult with applicable agencies (*e.g.*, the U.S. Army Corps of Engineers [USACE], Federal Emergency Management Agency [FEMA], and USFWS) when proposing to construct a facility in a floodplain/wetland.

Many of the NASA facilities that would be utilized under the Constellation Program have areas that have been identified as floodplains and/or wetlands. However, most of Constellation Program activities are expected, in large part, to utilize existing facilities and, therefore, would have minimal, if any, impacts on floodplains and wetlands. In addition, most new construction activities would likely occur in previously developed areas of the facilities, further minimizing impacts on such resources. NASA will consult with the appropriate Federal and state agencies, as required, if necessary. The construction of the Test Stand A-3 at SSC impacts wetlands. SSC has performed wetlands banking with USACE to mitigate this impact.

Hazardous Material Management

Hazardous materials are regulated under a number of Federal statutes, including the Toxic Substances Control Act (TSCA) of 1986, as amended (15 U.S.C. 2601 *et seq*.); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended (42 U.S.C. 9601 *et seq*.), the Emergency Planning and Community Right-to-Know Act (EPCRA), as amended (42 U.S.C. 11001 *et seq*.), and the Hazardous Material Transportation Act (HMTA) of 1970, as amended (49 U.S.C. 1803 *et seq*.).

Any hazardous materials needed by the Constellation Program would be procured and managed by the NASA facilities and their contractors in accordance with all applicable Federal, state, and local requirements. The types of hazardous materials that would be used by the Constellation Programs are expected to be similar in nature to those currently used by the Space Shuttle Program and other NASA activities.

Hazardous Waste Management

The Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6901 *et seq*.), corresponding state law, and associated Federal and state regulations establish regulatory requirements for managing hazardous wastes. Hazardous wastes must be collected, labeled appropriately, and stored in hazardous waste collection areas prior to treatment and/or disposal.

All of the principal NASA facilities associated with the Constellation Program are currently classified as "large quantity generators" of hazardous waste as they generate 1,000 kg (2,200 lb) or more of hazardous waste or more than 1 kg (2.2 lb) of acute hazardous waste per calendar month. In addition, six installations (KSC, MAF, JSC, WSMR, and ATK's Promontory and CRC facilities) have RCRA permits for treatment, storage, or disposal facilities. Any hazardous wastes generated by the Constellation Program would be managed in accordance with all applicable Federal, state, and local requirements and existing permits. The types and quantities of hazardous wastes that would be generated by the Constellation Program are expected to be similar in nature to those currently generated by the Space Shuttle Program and other NASA activities. It is anticipated that the Constellation Program would not result in substantial changes to the current regulatory status of any facility.

Pollution Prevention

The Pollution Prevention Act of 1990, as amended (42 U.S.C. 13101 *et seq*.) and Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, provide the regulatory framework for Federal installations to implement source reduction, waste minimization, recycling, and reuse programs. NASA Policy Directive NPD 8500.1A, *NASA Environmental Management*, established NASA's policy to prevent or reduce pollution at the source whenever possible. NASA also participates in a partnership with the military services called the Joint Group on Pollution Prevention to reduce or eliminate hazardous material or processes.

All NASA facilities have individual pollution prevention plans, and various pollution prevention initiatives to identify and implement cost-effective waste reduction opportunities. The development and implementation of the Constellation Program is consistent with these initiatives.

Biological Resources

Federal mandates for the conservation and protection of biological resources include, but are not limited to, the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 *et seq*.), the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq*.), and the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703 *et seq*.). NASA has consulted with the NMFS regarding potential impacts to essential fish habitats at KSC from Ares launches. Established standard practices (*e.g.*, complying with the light management plan stipulated in a USFWS/NASA Memorandum of Agreement for nesting sea turtles and hatchlings at KSC) would be observed to minimize impacts to these resources.

Coastal Zone Management

The regulatory framework for coastal zone management is provided by the Federal Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 *et seq*.), which establishes a national policy to preserve, protect, develop, restore, and enhance the resources of the nation's coastal zone. KSC would follow the State of Florida's requirements. No added impacts beyond those normally associated with the Space Shuttle launches would be anticipated. MAF also is located in a coastal zone and has a Coastal Management Plan Permit to cover barge activities. NASA will consult with the appropriate authorities if barge activity necessitates the need to modify the existing permit. LaRC and SSC also would follow all coastal zone management regulations, as appropriate.

Cultural Resources

The National Historic Preservation Act (NHPA), as amended (16 U.S.C. 470 *et seq*.), addresses the protection of historic properties and establishes the National Register of Historic Places (NRHP). NHPA Section 106 outlines the requirements for Federal agencies to consider the effects of an action on properties listed on, or eligible for, the NRHP. The Advisory Council on Historic Preservation (ACHP) Section 106 regulations (36 CFR Section 800), *Protection of Historic and Cultural Properties*, provides the procedures for Federal agencies to meet their obligations under the NHPA, including inventorying resources and consultation with State Historic Preservation Offices (SHPOs) and federally-recognized Native Americans. Other related Federal statutes include the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, and the Archaeological Resources Protection Act, among others.

All of the principal NASA facilities associated with the Constellation Program have one or more historic properties that are either listed on the NRHP or are eligible for NRHP listing. NASA will consult with the appropriate SHPO and with ACHP for concurrence on adverse effect determination and mitigation measures proposed. Approved mitigation plans will be documented in MOAs before major modifications are made to historic resources, as appropriate. NASA will consult with appropriate Native American groups if any Constellation Program activity has the potential to impact archaeological resources or Traditional Cultural Places.

Worker and Public Safety and Health

The Federal Occupational Safety and Health Act of 1970, as amended (29 U.S.C. 661 *et seq*.), authorized the development and enforcement of standards to ensure safe and healthful working conditions. States have promulgated similar statutes and regulations. These regulations are followed on a daily basis by NASA and would be followed in the future under the Constellation Program to ensure the protection of worker and public safety and health from all aspects of the Program, including, among others, excessive noise from rocket engine testing and launches, and exposure to hazardous materials and hazardous wastes.

Additional Permits at NASA Facilities

Each of the NASA facilities which support the Space Shuttle Program and commercial contractors such as ATK have Federal, state, and local permits necessary to support the Space Shuttle Program and would, therefore, be expected to perform most of the activities that would be anticipated to support the Constellation Program with current or extended permits.

At this early stage of the Constellation Program, only a few situations have been identified where either new environmental permits or substantial modifications to existing permits would be required to support the Constellation Program. It is reasonable to expect, however, that if the Proposed Action is selected, additional permits might be needed.

NASA has had an agency-wide effort to eliminate ODS from use, with an exception for mission-critical space applications. Mission-critical uses remain for the Space Shuttle Program (*e.g.*, for use of TCA) and would be transferred to the Constellation Program after the Space Shuttle fleet is retired. NASA is currently in the process of evaluating alternative substances for the materials.

Specific additional permits that might be needed or substantially modified with implementation of the Proposed Action are listed in Table 4-30.

International Agreements

International agreements relating to the use of the global commons are considered in assessing ocean environmental impacts. A broad array of international environmental agreements has been developed over the last century, with most being coordinated in the past few decades under the auspices of the United Nations.

The U.S. is party to the London Dumping Convention of 1972 which is intended to prevent pollution of the oceans by waste dumping or other activities that could cause hazards to humans, living resources and marine life or damage amenities or interfere with other legitimate uses of the ocean. It is commonly agreed that discharges of launch vehicle stages or residual fuel in the jettisoned stages are not covered by the London Dumping Convention or by the 1996 Protocol to that Convention, as they do not fall within the meaning of "dumping" as defined by Article III (FAA 1999).

**Table 4-30. Additional Permits Possibly Required to Support the Proposed Action**

| Facility | Type of Permit Possibly Required for the Proposed Action |
|---|---|
| KSC | May require an additional permit or an amendment to the existing Florida Department of Environmental Protection NPDES permit to discharge water used for noise suppression and wash-down water during an Ares V launch. May require "take" permits from the USFWS for sea turtles. |
| SSC | May require a CAA Title V, PSD permit to discharge air pollutants from the A-3 Test Stand. NPDES permit will require an update to include sound suppression system water and steam condensate discharge from the A-3 Test Stand. Obtained a MDEQ Large Construction Storm Water Permit and a U.S. Army Corps of Engineers wetlands disturbance authorization for A-3 Test Stand construction activities. Also obtained a Department of Marine Resources waiver for constructing a bulkhead and mooring dolphins. Preparing to apply for MDEQ 401 Water Quality Certification and U.S. Army Corps of Engineers 404 Permit for work to be done in the SSC Access Canal. |
| MAF | None Identified |
| JSC | None Identified |
| MSFC | May require a CAA Title V permit to discharge air pollutants from the Main Propulsion Test Article engine testing and to operate the spray-on foam booth for the Ares I Upper Stage. |
| GRC | None Identified |
| LaRC | None Identified |
| ARC | None Identified |
| DRFC/GSFC/JPL | None Identified |
| WSTF/WSMR | None Identified |
| ATK – Promontory and CRC | None Identified |

In addition, the U.S. is a signatory, though not a party to, the United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS has a comprehensive framework governing the use of the ocean and protecting the marine environment. Article 87 expressly provides for freedom of the high seas. Articles 116 through 120 concern living resources on the high seas and Part XII of UNCLOS pertains to protection and preservation of the marine environment. Article 194(1) of UNCLOS requires nations "to prevent, reduce and control pollution of the marine environment…using the best practicable means at their disposal and in accordance with their capabilities…" Article 194(2) requires nations "to take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environments…"

The U.S. is a party to the International Convention for the Prevention of Pollution from Ships (MARPOL) of 1973. MARPOL guidelines are incorporated into ship practices relevant to recovery vessels.

<u>Planetary Protection</u>

The Constellation Program would be required to follow NASA's planetary protection policy. This policy is aimed at protecting Solar Systems bodies from contamination by Earth life and protecting Earth from possible life forms that may be returned from other Solar System bodies.

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# 5. SUMMARY OF MITIGATION MEASURES

Under the Proposed Action (Preferred Alternative), NASA would continue the good environmental practices employed at each of the NASA facilities that would support the Constellation Program. These practices are documented in various Federal, state, and local environmental permits; NASA practices and procedures; and best management practices. Since the proposed Constellation Program is built largely upon the ongoing Space Shuttle Program technologies and support facilities, continuing many of ongoing good environmental practices which support the Space Shuttle Program would mitigate potential environmental impacts associated with Constellation Program activities.

Activities associated with the Proposed Action that are expected to have potential environmental impacts include rocket engine tests, rocket launches and atmospheric entries, wind tunnel tests, and construction of new facilities. These activities, along with modifications of existing facilities, would be expected to utilize site-specific mitigation measures much like those employed for the Space Shuttle Program.

## 5.1 FACILITIES

### 5.1.1 John F. Kennedy Space Center

John F. Kennedy Space Center (KSC) employs an extensive system of mitigation measures to reduce the potential impacts of launches on the environment. All Federal launch complexes, including KSC, Cape Canaveral Air Force Station (CCAFS), and the U.S. Army's White Sands Missile Range (WSMR) have Range Safety processes that: 1) ensure that direct impacts are confined to the range and impacts outside of the range are appropriately managed and mitigated, and 2) ensure that the public is protected, both from direct effects such as falling debris after activation of commanded destruct systems and indirect effects such as exposure to high levels of burning propellant emissions in exhaust clouds.

In mitigation planning for modifications to Launch Complex (LC)-39 Pad B, NASA has considered three categories of potential impacts to biota that could arise from the modifications: 1) nighttime bird and bat strike risks due to tall structures and wires; 2) daytime bird strike risks from low-visibility structures and wires; and 3) sea turtle disorientation risks due to artificial lighting illuminating nesting beaches. NASA's *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* has addressed these concerns and provides mitigation and monitoring measures (KSC 2007f). Examples of these mitigation measures include reduction in the height of the lightning protection towers from that proposed originally; use of minimum number of grounding wires for lightning protection that are of non-coated stainless steel to retain the bright and reflective nature, largest diameter wire possible with markers on the wires for high visibility, and smallest possible angle between the wires and the towers; use of minimum number and intensities of lights requires with longest duration of dark between flashes; and use of low pressure sodium lights that are shielded. This Final Programmatic Environmental Impact Statement (PEIS) incorporates those measures by reference. It is expected that future modifications to LC-39 Pad A would be similar to those to be undertaken for LC-39 Pad B. Therefore, the mitigation and monitoring measures adopted for the modifications to LC-39 Pad A would be expected to be similar to those incorporated for LC-39 Pad B.

### 5.1.2 John C. Stennis Space Center

At John C. Stennis Space Center (SSC), there is a perpetual restrictive easement on 506 square kilometers (195 square miles) (the "Buffer Zone") extends 9.7 kilometers (6 miles) in all directions from the perimeter of the Fee Area to ensure that the noise levels to which the public is exposed from engine tests are reduced (see Figure 3-4). Provisions of the restrictive easement prohibit maintenance or construction of dwellings and other buildings suitable for human habitation. The purpose of the Buffer Zone is to provide an acoustical and safety protection zone for NASA testing operations. Predominant land use in the Buffer Zone includes sand and gravel mining, timber production, and recreational activities. Urban areas interspersed with open space, such as coastal wetlands, adjoin the perimeter of the Buffer Zone.

NASA has addressed the environmental impacts of engine testing at both SSC and at George C. Marshall Space Flight Center (MSFC) in its *Final Environmental Impact Statement of Engine Technology Support for NASA Advanced Space Transportation Program* (MSFC 1997a). NASA committed in the Record of Decision (ROD) (MSFC 1998) for that EIS to take certain positive actions to mitigate the potential offsite noise impacts of testing large engines. The ROD indicated that:

> *NASA would make available, to the public through press releases, test firing schedules for medium, large, and multiple engine tests whose collective thrust level does not exceed that of one large engine. Off site noise levels would be projected using real time meteorological data. If acoustical focusing resulting in overall noise levels of 120 dB or greater is expected offsite, evaluation of potential impact will be made and the results presented to test managers. Engine tests will be delayed if substantial risk of structural damage to private property is determined to exist. However, NASA test management reserves the right to proceed with testing if atmospheric focusing conditions are expected to reasonably diminish as the day advances and meteorological conditions favorably improve. SSC would implement similar noise mitigation for single large engine tests or multiple engines whose thrust level exceed that of one large engine.*
>
> *To verify noise modeling software results, off-site noise monitoring would be conducted at MSFC for approximately six engine tests whose thrust level meets or exceeds that of one medium engine. Similar monitoring would be conducted at SSC for all engine tests whose thrust level equals or exceeds that of one large engine.*

These mitigation measures would be continued for Constellation Program activities at SSC and are incorporated in this Final PEIS by reference.

SSC manages wetlands within the facility in accordance with 14 CFR 1216.205, *Policies for evaluating NASA actions impacting floodplains and wetlands*. In planning mitigation activities addressed in the *Final Environmental Assessment for the Construction and Operation of the*

*Constellation Program A-3 Test Stand* (SSC 2007b), SSC has delineated 47.9 hectares (118.54 acres) wetlands credits (based on the U.S. Army Corps of Engineer's Charleston Method) which would be charged against its "Mitigation Bank." This information, along with an application form for authorization to disturb wetlands, associated maps, and other data were submitted to the U.S. Army Corps of Engineers on March 27, 2007.

### 5.1.3 George C. Marshall Space Flight Center

At MSFC, the physical separation between engine test facilities and public property by the U.S. Army's Redstone Arsenal mitigates or reduces the sound levels under normal atmospheric conditions (see Figure 3-10). As summarized in Section 5.1.2, NASA committed to monitor meteorological conditions prior to testing to determine if sounds waves would result in substantive risk of offsite structural damage (MSFC 1998). These safety procedures would continue to be utilized for Constellation Program testing activities. As with current practice, MSFC would make available test firing schedules for large engine testing via the Public Affairs Office press releases. This Final PEIS incorporates the applicable mitigation measures at MSFC by reference.

### 5.1.4 White Sands Missile Range

Detailed mitigation measures associated with the operation of WSMR are provided in the *White Sands Missile Range Range-Wide Environmental Impact Statement* (WSMR 1998). These measures include actions that would reduce the potential impacts from test launches in support of the Constellation Program. For example, noise impacts are mitigated by excluding the public from areas where they could be exposed to potentially harmful noise levels and by requiring WSMR personnel to use hearing protection devices when needed. In addition, WSMR has a Range Safety program similar to the KSC/CCAFS Range Safety program describe in Section 5.1.1 and elsewhere.

Mitigation measures associated with Constellation Program launch abort testing and construction activities at WSMR are described in the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b). All mitigation actions would be contained within WSMR. Three potential impacts from launch complex modifications are addressed: 1) nighttime migratory bird strike risk due to tall structures; 2) daytime bird strike risk due to low-visibility structures; and 3) the possibility of uncovering historical or archaeological sites during excavations. To address possible bird strikes, the proposed tower would contain the minimum number of lights at the lowest intensity required. Surveys would be conducted during mating season to ensure that no birds are found nesting in the towers; any nest material would be removed prior to egg deposition. There would also be open grates in the floors of the tower to discourage roosting. On-site personnel would be instructed to report dead birds and/or bats as soon as they are discovered. If a cultural site is discovered during excavations, the WSMR Historic Preservation Officer would be notified for action. WSMR also would employ dust control techniques during construction activities, vehicle controls on off-road traffic, soil remediation for hazardous and non-hazardous waste spills, and flight termination systems on launch vehicles to mitigate the impacts of anomalous launch events (WSTF 2007b). This Final PEIS incorporates these measures by reference.

### 5.1.5 Alliant Techsystems-Launch Systems at Promontory

The State of Utah Department of Environmental Quality air permit issues for the test stands at the Alliant Techsystems-Launch Systems Group (ATK) at Promontory, Utah facility imposes meteorological conditions under which test firings are permitted. These conditions ensure that the exhaust cloud from each test is highly diluted, thus reducing the potential for adverse concentrations, far from the test site. Daily limits on the quantities of hydrogen chloride (HCl) from open burning also are imposed by the State of Utah air permit (UDAQ 2006b).

## 5.2 REDUCTION IN USE OF OZONE DEPLETING SUBSTANCES

Since 1990, NASA has reduced overall annual ozone depleting substances (ODS) usage from approximately 1.6 million kilograms (kg) (3.5 million pounds [lb]) to less than 69,000 kg (150,000 lb), a reduction of more than 96 percent. NASA is committed to finding safe and technically acceptable substitutes for remaining ODS uses.

Under the Proposed Action, it is assumed that hydrochlorofluorocarbon (HCFC 141b) would not be used to produce foam insulation for the cryogenic LH/LOX tanks (cryoinsulation) for the Ares I and Ares V launch vehicles. To comply with EPA requirements to phase out ODS, and to reduce the long-term risk that ODS become unavailable for manufacturers, NASA intends to develop cryoinsulation replacements for use on the Ares I Upper Stage that do not contain HCFC 141b. Building on and drawing from work done in support of the Space Shuttle Program, NASA has begun planning a research and development program to identify and qualify substitute cryoinsulation materials that meet Ares I technical requirements and fulfill the non-ODS objective. This test program will require relatively small amounts of HCFC 141b-blown foam for use in comparative studies. These studies are required to ensure that replacement cryoinsulation materials have similar properties and perform at least as well as the current materials in the challenging environments of launch, ascent, and atmospheric entry. The performance profile of the current Space Shuttle Program foam has been designated as the “performance baseline” for materials developed under these renewed research efforts. Successful implementation and operational performance of these materials would enable the Ares I and other space vehicle programs to use non-ozone depleting cryoinsulation.

## 5.3 MEASURES TO REDUCE RISK TO PUBLIC FROM LAUNCH AND ENTRY ACCIDENTS

A NASA Range Safety process has been in effect for over 50 years and parallels similar processes by the U.S. Air Force for CCAFS and the U.S. Army for WSMR. NASA’s Range Safety Policy (NASA 2005c) is designed to protect the public, employees, and high-value property during all phases of flight, including jettisoned Ares I and Ares V components and the Earth atmospheric entry of the Orion spacecraft, and is focused on the understanding and mitigation (as appropriate) of risk. The policy establishes individual and collective risk criteria for the general public (offsite public and onsite visitors) and onsite workforce for the risk of casualty from any means, including blast, debris, or toxics. Range Safety protects people, as well as the range, by understanding the potential impacts of a normal launch and debris as well as launch area and atmospheric entry accidents and establishing protection controls, including not launching when meteorological conditions do not warrant.

Range Safety addresses the measures taken by NASA to protect personnel and property during those portions of a mission (launch, atmospheric entry, and landing) that have the potential to place the general population at risk. The "range" is the land, sea, or airspace within or over which orbital, suborbital, or atmospheric vehicles are tested or flown. Range Safety addresses these areas and the potentially affected areas around the range. NASA's Range Safety policy is specifically defined in NASA Procedural Requirements (NPR) 8715.5 "Range Safety Program."

NASA mitigates and controls the hazards and risks associated with range operations from mission launch and atmospheric entry and applies Range Safety techniques to range operations in the following order of precedence:

1. Preclude hazards, such as uncontrolled vehicles, debris, explosives, or toxics, from reaching the public, workforce, or property in the event of a vehicle failure or other mishap.
2. Apply a risk management process when the hazards associated with range operations cannot be fully contained.

In addition, launches and entries associated with the Constellation Program would be preceded by Notices to Airmen (NOTAM) and Notices to Mariners. These notices would provide information on temporary restrictions along the Ares I and Ares V launch and Orion entry corridors to prevent collisions with surface ships and aircraft.

## 5.4 CULTURAL RESOURCES MITIGATION

If the Proposed Action were implemented, a number of historic resources at various NASA facilities could be adversely affected. For example, the Rotating Service Structure and the Fixed Service Structures at both LC-39 Pads A and B at KSC would be expected to be dismantled as they would not be needed for the proposed new launch vehicles; at John H. Glenn Research Center's Plum Brook Station, modifications to the Spacecraft Propulsion Research Facility (B-2 Facility) (Building 3211) vacuum chamber would be undertaken in support of Ares Upper Stage structural testing; at Langley Research Center, modifications to the Impact Dynamics Facility (Gantry) (Building 1297) would be undertaken in support of Orion drop tests; and at MSFC, modifications to the Structural Dynamics Test Facility (Building 4550) would be undertaken in support of Ares launch stack dynamic testing.

Modifications to historic properties as identified in this Final PEIS (Table 2-10) could affect the character or historic integrity of such properties. NASA has a programmatic agreement with the Department of the Interior, National Park Service to mitigate adverse effects to National Historic Landmarks (NASA 1989). Modifications required for the Constellation Program at NASA facilities would be undertaken in consultation with the respective State Historic Preservation Officer (SHPO). The NASA Historic Preservation Officer at each NASA facility would, in consultation with the SHPO, determine if proposed modifications would be considered "adverse" under the National Historic Preservation Act and other applicable rules and regulations. For such situations, NASA and the SHPO would develop a mitigation strategy to ensure that important historic information is preserved. Such mitigation often includes documenting appropriate aspects of the historic resources before and after modification occur with photographs or drawings, using specific protocols such as the Historic American Buildings Survey/Historic American Engineering Record and other documentation, as determined appropriate by NASA's Historic Preservation Officer and the SHPO.

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| | Jorge McPherson | | | | | √ | | | | | | | √ | |
| | Charlotte Hadley | | √ | | √ | | | | | | | | | |
| | Richard Kalynchuk | | | | √ | √ | | | | | | | | |

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# 7. AGENCIES, ORGANIZATIONS, AND INDIVIDUALS CONSULTED

In preparing this *Final* C*onstellation Programmatic Environmental Statement* (Final PEIS), the National Aeronautics and Space Administration (NASA) has actively solicited and/or received comments from the following list of potentially interested Federal, state, and local agencies; organizations; and individuals:

## FEDERAL AGENCIES

**Executive Office of the President**

*Council on Environmental Quality*
*Office of Management and Budget*
*Office of Science and Technology Policy*

**National Science Foundation**

**U.S. Department of Agriculture**

**U.S. Department of Commerce**

*National Oceanic and Atmospheric Administration*

**U.S. Department of Defense**

*Department of the Air Force*
AFFTC Technical Library
Edwards Air Force Base Library
*Department of the Army*
Fort Irwin (National Training Center-Headquarters) Director of Public Works
*Department of the Navy*

**U.S. Department of Homeland Security**

*Office of the Undersecretary of Management*
*U.S. Coast Guard*

**U.S. Department of the Interior**

*Bureau of Land Management*
*U.S. Fish and Wildlife Service*
*National Park Service*

**U.S. Department of State**

**U.S. Department of Transportation**

*Federal Aviation Administration*

**U.S. Environmental Protection Agency**

*Office of Federal Activities*
*Region 3 Office*
*Region 4 Office*
*Region 5 Office*
*Region 6 Office*
*Region 8 Office*
*Region 9 Office*

## STATE AGENCIES

### State of Alabama

*Alabama Department of Economic and Community Affairs*
*Alabama Department of Environmental Management*
*Alabama Historical Commission*
*State of Alabama, House of Representatives*
*State of Alabama, Office of Governor*
*State of Alabama, Senate*

### State of California

*California Department of Fish and Game*
*California Department of Transportation*
*California State Clearinghouse*
*Native American Heritage Commission*
*State of California, Office of Governor*

### State of Florida

*Florida Department of Environmental Protection*
*Florida State Clearinghouse*
*State of Florida, House of Representatives*
*State of Florida, Office of Governor*
*State of Florida, Senate*

### State of Louisiana

*Louisiana Department of Environmental Quality*
*State of Louisiana, Office of Governor*

### State of Maryland

*Maryland State Clearinghouse for Intergovernmental Assistance*
*Maryland Department of the Environment*
*Maryland Department of Planning*
*State of Maryland, Office of Governor*

### State of Mississippi

*Mississippi Department of Environmental Quality*
*State of Mississippi, Office of Governor*

### State of New Mexico

*New Mexico Department of Cultural Affairs*
*New Mexico Environment Department*
*New Mexico Game and Fish*
*New Mexico State Land Office*
*State of New Mexico, Office of Governor*

### State of Ohio

*Ohio Environmental Protection Agency*
*State of Ohio, Office of Governor*

### State of Texas

*Governor's Office of Budget, Planning, and Policy*
*State of Texas, Office of Governor*

**State of Utah**

*Public Lands and Coordination Office*
*State of Utah, Office of Governor*

**State of Virginia**

*State of Virginia, Office of Governor*
*Virginia Department of Environmental Quality*
*Virginia Department of Historic Resources*

## COUNTY AGENCIES

**State of Alabama**

*Madison County*
County Commissioner

**State of California**

*Inyo County*
Inyo County Free Library, Central Library
Inyo County Free Library, Lone Pine Branch
Inyo County Planning Department
*Kern County*
County Administrative Officer
Department of Planning and Development Services
Kern County Air Pollution Control District
Kern County Library, Beale Memorial Library
Kern County Library, Boron Branch
Kern County Library, California City Branch
Kern County Library, Mojave Branch
Kern County Library, Tehachapi Branch
Kern County Library, Wanda Kirk Branch
*Los Angeles County*
Chief Executive Officer
Los Angeles County Library, Lancaster Branch
Los Angeles County Library, Quartz Hill Branch
Los Angeles County Planning Department
*San Bernardino County*
Land Use Services Department, Planning Division
*Santa Clara County*
County Executive

**State of Florida**

*Brevard County*
County Manager
Development and Environmental Services
Emergency Operations Center
Natural Resources Management Office
Planning and Zoning Office
Public Safety Department
*Lake County*
County Manager

*Orange County*
County Administrator
*Osceola County*
County Manager
*Seminole County*
County Manager
*Volusia County*
County Manager

**State of Louisiana**

*St. Tammany Parish*
Parish President

**State of Maryland**

*Prince George's County*
Office of the County Executive

**State of Mississippi**

*Hancock County*
Board of Supervisors
Port and Harbor Commission
*Pearl River County*
Board of Supervisors

**State of New Mexico**

*Doña Ana County*
County Manager

**State of Ohio**

*Cuyahoga County*
County Administrator
*Erie County*
County Administrator

**State of Texas**

*Harris County*
Office of the Commissioner

**State of Utah**

*Box Elder County*
County Commissioner

**State of Virginia**

*Accomack County*
County Administrator
*York County*
County Administrator

## LOCAL AGENCIES

**State of Alabama**

*City of Huntsville*
Office of the Mayor

*City of Madison*
Office of the Mayor
*City of Triana*
Office of the Mayor

**State of California**

*California City*
Office of the Mayor
*City of Lake Isabella*
Kern River Valley Library
*City of Lancaster*
Antelope Valley Air Pollution Control District
Office of the Mayor
Planning Commission
*City of Los Angeles*
Office of the Mayor
*City of Mountain View*
Office of the Mayor
City Manager's Office
*City of Palmdale*
Office of the Mayor
Palmdale City Library
Planning Department
*City of Pasadena*
Office of the Mayor
*City of Sunnyvale*
Office of the Mayor
*City of Trona*
Trona Library
*City of Victorville*
Lahonton Regional Water Quality Control Board
Mojave Desert Air Quality Management District

**State of Florida**

*City of Cape Canaveral*
Canaveral Port Authority, Chief Executive Officer
Office of the Mayor
*City of Cocoa*
Office of the Mayor
*City of Cocoa Beach*
Office of the Mayor
*City of Melbourne*
Office of the Mayor
*City of New Smyrna Beach*
Office of the Mayor
*City of Orlando*
Office of the Mayor
*City of Rockledge*
Office of the Mayor

*City of Titusville*
Office of the Mayor
Planning Department
*City of West Melbourne*
Office of the Mayor
*Merritt Island*
Commissioner's Office

**State of Louisiana**

*City of New Orleans*
Office of the Mayor
*City of Slidell*
Office of the Mayor

**State of Maryland**

*City of Greenbelt*
Office of the Mayor

**State of Mississippi**

*City of Bay St. Louis*
Office of the Mayor
*City of Waveland*
Office of the Mayor
*City of Picayune*
Office of the Mayor

**State of New Mexico**

*City of Las Cruces*
Bureau of Land Management, Las Cruces District Office
Office of the Mayor
*White Sands Missile Range*
Office of the Garrison Commander

**State of Ohio**

*City of Brook Park*
Brook Park Fire Department
*City of Cleveland*
Cleveland Hopkins International Airport
Department of Public Health, Division of Air Pollution Control
Office of the Mayor
*City of Sandusky*
City Manager

**State of Texas**

*City of Houston*
Office of the Mayor

**State of Utah**

*City of Brigham*
Office of the Mayor

**State of Virginia**

*City of Hampton*
City Manager
Office of the Mayor
*City of Poquoson*
City Manager
*Hampton Roads Planning District Commission*
*Town of Chincoteague*
Office of the Mayor

**ORGANIZATIONS**

Aerospace Industries Association
American Institute of Aeronautics and Astronautics
Diamondhead Property Owners Association
Economic Development Commission of Florida's Space Coast
Environmental Defense
Federation of American Scientists
Florida Coalition for Peace and Justice
Friends of the Earth
Global Network Against Weapons and Nuclear Power in Space
GlobalSecurity.org
Greenpeace International
National Audubon Society
National Congress of American Indians
National Fish and Wildlife Foundation
National Hispanic Environmental Council
National Society of Black Engineers
National Tribal Environmental Council
National Wildlife Federation
Natural Resources Defense Council
Partnership for a Sustainable Future, Inc.
Physicians for Social Responsibility
Sierra Club National Headquarters
Southwest Network for Environmental and Economic Justice
Space Florida
Space Frontier Foundation
The American Association for the Advancement of Science
The Mars Society
The National Space Society
The Nature Conservancy
The Planetary Society
The Space Foundation
The Wilderness Society
Union of Concerned Scientists

**INDIVIDUALS**

Allen, Corinne
Barbero, Gilberto
Beckerman, George
Benjamin, Olga
Bramble, Harriet
Callister, Paul
Cepeda, Joseph
Chambers III, George
Citron, Bob
Cooper, Richard
Daum, Gerhard
DeCarlo, Michelle
DeJaeger, Erik
Drake, Larry
Felsher, Dr. Murray
Gann, E. Ray
Gidlow, Ken
Halvorson, Todd
Hellman, Robert
Hildebrand, James E.
Hockstra, Daniel
Karlen, Rosetta M.
Lavine, Greg
Lear, Robert
Lee, Alex
Lieber Sr., Wilford
Long, David G.
May, Jonathan
McColloch, Craig
McKenney, Brent
Murphy, Carl
Nagrabski, Steve
New, Jeremy
Pawlowski, Vincent
Pieper, John
Sakala, Gregory
Saunders, Michael
Schleifstein, Mark
Shehata, Pete
Showalter, Keith
Simpson Jr., Cecil C.
Skinner, Scott
Smith, Rebecca
Stribley, Todd
Super, Greg
Szewc, Lt. Col. Joseph A.
Vergee
Winn, Oliver
Wittenberg, John W.
Young, Kelly
Young, Sallie
Yanagitani, Brian

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# 9. GLOSSARY OF TERMS

**Abort –** Action taken to terminate an anomalous launch. There are three different abort scenarios: pad abort, mid-ascent abort, and late-ascent abort. With respect to crewed missions, each scenario uses a different method to propel the **Crew Module** free from the launch vehicle and safely return the crew to the Earth.

**Advanced Projects Office –** NASA **Constellation Program** organization responsible for defining the requirements of future systems that would be needed for extended lunar missions and missions to Mars.

**adverse effect –** When used specifically with respect to the effects of an action upon historic properties listed or eligible for listing on the **National Register of Historic Places**. As defined by 36 CFR 800.5 "*Protection of Historic Properties*," an "adverse effect" is evident when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the **National Register** in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the **National Register**. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.

**affected environment –** A description of the existing environment that could be affected by the proposed action or alternatives.

**air emissions –** Gases or particles that are deposited in the atmosphere by various sources (*e.g.*, point sources, mobile sources, and biogenic sources).

**ambient air** – The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures.

**ambient noise –** Noise level measured under normal, everyday conditions.

**anomalous launch** – A rocket launch that deviates from predetermined conditions.

**aquifer(s) –** A geologic formation which contains and/or conducts groundwater.

**Ares I –** The name of the Crew Launch Vehicle (**CLV**), which would have a five-segment reusable solid rocket motor First Stage with a liquid oxygen/liquid hydrogen Upper Stage powered by a J-2X engine.

**Ares V –** The name of the Cargo Launch Vehicle (**CaLV**), which in its current planning configuration would have two five-segment reusable solid rocket boosters, a liquid oxygen/liquid hydrogen **Core Stage** powered by five RS-68 engines, and a liquid oxygen/liquid hydrogen Upper Stage (also called the **Earth Departure Stage**) powered by a J-2X engine.

**artesian pressure –** Pressure exerted on an underground aquifer that forces ground water to flow freely to the surface.

**Atlas –** A family of launch vehicles formerly manufactured by the Lockheed Martin Corporation. Currently, United Launch Alliance, a cooperative venture between Lockheed Martin Corporation and The Boeing Company, has assumed responsibility for providing Atlas rocket services to U.S. government customers.

**atmospheric pollution** – Pollution which is produced by either natural or man-made sources and disperses into the **ambient air**.

**attainment –** An area is designated as being in attainment by the U.S. Environmental Protection Agency if it meets the **National Ambient Air Quality Standards (NAAQS)** for a given **criteria pollutant**. Nonattainment areas are areas in which any one of the **NAAQS** have been exceeded. Areas previously designated nonattainment and subsequently redesignated as attainment are defined as maintenance areas. Areas that cannot be classified on the basis of available information as meeting or not meeting the **NAAQS** for any one criteria pollutant are defined as unclassifiable areas.

**audiometric testing –** Procedure that measures hearing ability. Could be used to mitigate noise effects on workers due to launches or engine ground tests.

**biconic –** a shape which resembles two cones attached together at the base; the cone sizes are not necessarily exact replicas.

**buffer zone –** A neutral zone which serves to separate one area from another, for any of multiple reasons (*e.g.*, environmental effects, greenways, hazardous areas, *etc.*).

**CaLV** – See **Ares V**.

**carbon-fiber composite –** Engineered material made from one or more constituent substances (one of which must be carbon) that exhibit different physical properties when combined, yet retain their individual chemical properties.

**casualty –** An injury requiring overnight hospitalization or worse, including death.

**Categorical Exclusion (Cat-Ex) –** Documents proposed actions or activities that a Federal agency has designated under 14 CFR 1216.305(d) as normally having no significant impact(s) on the human environment, individually or cumulatively.

**CEV –** Crew Exploration Vehicle. Renamed **Orion** following selection of the prime contractor. See **Orion.**

**Clean Air Act –** The national air pollution prevention standards for the United States. This Federal Regulation was originally passed in 1963 and has since been modified and amended several times (most recently with the 1990 Clean Air Act Amendments). Many states and localities have adopted their own air quality regulations which are more stringent than the **Clean Air Act**.

**Clean Water Act –** Similar in scope to the **Clean Air Act**, the **Clean Water Act** is the Federal legislation governing water quality in the United States. Its aim is to reduce toxic releases into water systems as well as to maintain water quality suitable for human sports and recreation.

**CLV** – See **Ares I**.

**Constellation Program** – The NASA program which would provide the vehicles and the infrastructure to support the **International Space Station** and return humans to explore the Moon and eventually Mars and beyond.

**Core Stage** – As used in the **Ares V**, the launch vehicle stage that carries the majority of a vehicle's propulsive capability and LOX/LH propellants to which supplemental propulsive stages can be attached for added thrust.

**crawler transporter** – A tracked vehicle formerly used to move **Saturn V** and currently used to move Space Shuttle vehicles from the Vehicle Assembly Building to the launch pad at KSC. Currently, the **Mobile Launch Platform** is placed on top of the **crawler transporter** and the Space Shuttle is attached to the **Mobile Launch Platform**. The **crawler transporter** then moves both items to the launch pad.

**Crew Module** – Part of the **Orion** spacecraft; a capsule that would provide habitable volume for crew members or cargo room during uncrewed missions. It contains life support, intra-vehicular docking ability, and atmospheric entry and landing ability. There would be several **Orion Crew Module** configurations, which provide for varying crews/cargos configurations.

**criteria pollutants** – The **Clean Air Act** requires the U.S. Environmental Protection Agency to set air quality standards for common and widespread pollutants after preparing criteria documents summarizing scientific knowledge on their health effects. Currently, there are standards in effect for six criteria pollutants: sulfur dioxide ($SO_2$), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter ($PM_{10}$) and particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), nitrogen dioxide ($NO_2$), ozone ($O_3$), and lead (Pb).

**critical habitat** – Areas of habitat, defined under the Endangered Species Act, which are believed to be essential for a threatened or endangered species' conservation.

**cryogens** – In terms of this document, cryogens refers to liquid oxygen/liquid hydrogen (LOX/LH) which are used as propellants.

**cultural resources** – The prehistoric and historic districts, sites, buildings, objects, or any other physical activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

**cumulative impact** – The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes other such actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

**decibel (dB) –** A logarithmic measurement unit that describes a particular sound pressure level compared to a standard reference value. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB. A-weighted decibels (dBA) refer to measured decibels whose frequencies have been adjusted to correspond to the highest sensitivity of human hearing, which is typically in the frequency range of 1,000 to 4,000 Hertz.

**Delta –** A family of launch vehicles formerly manufactured by The Boeing Corporation. Currently, United Launch Alliance, a cooperative venture between Lockheed Martin Corporation and The Boeing Company, has assumed responsibility for providing Delta rocket services to U.S. government customers.

**deluge water –** Water used during the launch of spacecraft to suppress vibrations, fire, and sound from igniting rocket engines and boosters.

**deflagrate –** To burn suddenly and/or violently.

**Design Reference Mission –** Fixed combinations of elements (launch vehicles, capsule sizes, rendezvous locations, number of launches, *etc.*) to deliver crew and/or cargo to a specific destination for a specific duration, used to define the requirements of each mission architecture element during the **ESAS** study.

**Earth Departure Stage –** The Upper Stage of the **Ares V** launch vehicle for lunar missions. It would be used to achieve Earth orbit and subsequently trans-lunar injection once docking with the **Orion** spacecraft is completed (also called Mars Transfer Stage for Mars missions).

**endangered species –** The classification provided under the Endangered Species Act of 1973 to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

**environmental impacts –** Adverse or beneficial effects that the proposed action or alternatives would have on both the human and natural environment. This includes direct, indirect and cumulative impacts.

**essential fish habitat –** Those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity for federally managed fish species. Promulgated under the Magnuson-Stevens Act of 1976 (and subsequent amendments) to protect and conserve domestic fisheries within U.S. territorial waters.

**estuary –** A semi-closed body of water characterized by an open mouth (usually leading to the ocean) and one or more tributaries. Usually, these areas are sites of high biologic activity. They may be known as bays, sounds and/or fjords.

**exhaust cloud –** Emissions from the launch or testing of a rocket.

**exhaust velocity –** The speed of emissions from a rocket engine nozzle.

**Exploration Systems Architecture Study (ESAS) –** A document prepared by NASA, which was used as a starting point for the Constellation Program. It is the result of an Agency-wide team activity to define the requirements for a new space transportation and exploration infrastructure which meets the objectives of President George W. Bush's *Vision for Space Exploration*.

**extravehicular activity(ies) (EVA) –** Actions which include assembly, repair, or exploration outside of the pressurized environment of a space vehicle.

**Extravehicular Activities Project –** The NASA Project under the **Constellation Program** designated for modifying and/or developing new hardware to support **EVAs**.

**Evolved Expendable Launch Vehicle (EELV) Program –** A Department of Defense program to develop and build a family of launch vehicles for long-term military, civil, and commercial use.

**Fairing/Payload Shroud –** An ellipsoid shaped structure which covers cargo being launched into space. Principally designed to protect spacecraft from aerodynamic loads during ascent, it is jettisoned late in the ascent, after those loads diminish.

**Federal Register (FR) –** The official United States Government publication for rules, proposed rules, executive orders and other presidential documents, and notices of Federal agencies and organizations.

**Fee Area –** The area designated within the gated boundary of the John C. Stennis Space Center.

**First Stage –** The launch vehicle stage that provides thrust at liftoff.

**fused silica –** A type of glass containing silicon dioxide in a non-crystalline form. It is currently used in the windows on the Space Shuttle, and would likely be used in the windows on the **Orion Crew Module**.

**General Conformity Rule –** The General Conformity Rule is applicable to nonattainment or maintenance areas (see **attainment**) as designated by the U.S. Environmental Protection Agency (EPA), and ensures that Federal actions conform to each State Implementation Plan for air quality. These plans, approved by the EPA, are each State's individual plan to achieve the **NAAQS** as required by the **Clean Air Act**. The EPA is required to promulgate a Federal Implementation Plan if a State defaults on its implementation plan. A conformity requirement determination for a Federal action is made from influencing factors, including, but not limited to, nonattainment or maintenance status of the area, types of emissions and emission levels resulting from the action, and local impacts on air quality.

**Gimbal –** a mechanical device which allows a nozzle of a rocket engine to be moved in different axes

**Ground Operations Project –** The NASA Project under the **Constellation Program** responsible for ground processing and testing of the integrated launch vehicles, providing launch logistics and services, and post-landing recovery operations of the **Orion Crew Module** as well as the **Ares I First Stage** and the **Ares V solid rocket boosters**.

**ground processing –** Readying the **Orion** spacecraft and the **Ares** launch vehicles for stacking on the mobile launcher and later launch operations. This includes checking battery power, fueling operations, flight and environmental systems checks, loading of any cargo, *etc.* It also refers to actions which involve refurbishing the **Crew Module** and **SRBs** after post-landing and recovery operations.

**ground support equipment –** Any piece of hardware necessary to support launch or recovery operations which is not to be launched itself.

**ground track –** An imaginary pathway on the surface of Earth that corresponds to the location of an in-flight object.

**Halon –** Compounds used as fire extinguishing agents which contain bromine, fluorine, and carbon. Some halon compounds cause ozone depletion and are banned under the *Montreal Protocol on Substances that Deplete the Ozone Layer*. See **Montreal Protocol**.

**hazardous material (Hazmat) –** Generally, a substance or a mixture of substances that has the capability of either causing or significantly contributing to an increase in serious irreversible or incapacitating reversible illness; or posing a substantial present or potential risk to human health or the environment. Use of these materials is regulated by several statutes (*e.g.*, the Resource Conservation Recovery Act).

**Human-rated –** A space system that incorporates those design features, operational procedures, and requirements necessary to transport humans.

**Hypergolic fuel –** Rocket fuel which spontaneously ignites when its two components are combined.

**integrated launch vehicle(s) –** The combination of all components in a launch system.

**International Space Station –** A multi-national research installation which is currently being assembled in Earth orbit.

**in situ –** A Latin phrase meaning *in the place*; under the **Constellation Program**, it refers to the use of prevalent existing resources on lunar missions which will be used to provide fuel, power, *etc.* for sustained human presence.

**Ionosphere –** The Earth's upper atmospheric region where ionization of atmospheric gases occurs

**Launch Abort System –** A propulsive stage of the **Orion** spacecraft which would provide a means of escape for crew members prior to **Ares I** ascent. The Launch Abort System will be similar in design to the Apollo Launch Escape System. It would be mounted on top of the **Crew Module**, and when ignited, would propel the **Crew Module** free of the **Ares I First Stage**.

**launch azimuth –** The initial angle, measured clockwise from North, which a launch vehicle's **ground track** makes as the vehicle begins to ascend.

**lifting body –** An aircraft that obtains lift from the airfoil shape of its fuselage.

**liquefaction –** The process of making or becoming a liquid; in geology, it is the process in which soil is converted into a suspension during events such as earthquakes. A term used to describe potential soil conditions in earthquake-prone regions.

**low Earth orbit –** An orbit generally between 200 to 2000 km (124 to 1,240 mi) above the Earth's surface.

**Lunar Architecture Study –** A NASA study which utilized inputs from government, academic, and private sources to determine a blueprint for a return of human presence on the lunar surface as well as the establishment of a lunar outpost. Robotic precursors to human missions were also integrated into the study.

**Lunar Lander –** The vehicle that would be used to transport crew and cargo from the **Orion** spacecraft in lunar orbit to the lunar surface and back.

**Lunar Lander Project –** The NASA Project under the **Constellation Program** responsible for the design, development, and construction of **Lunar Landers**.

**Mach –** The speed of sound. In general, it is approximately 1,238 km/h (769 mph) at sea level at a temperature of 70°F (21°C).

**Main Propulsion Test Article (MPTA) –** A full-scale, working prototype of an **Ares I** Upper Stage used for multiple ground tests including firing the J-2X engine at MSFC.

**major source –** A pollution source that emits more than a defined threshold level defined by the U.S. Environmental Protection Agency. These sources are required to put in place monitoring plans and obtain applicable state and Federal permits. See **Title V**.

**meteorology –** The scientific study of atmospheric phenomenon.

**mitigation –** A method or action to reduce or eliminate adverse impacts.

**Mission Operations Project –** The NASA Project under the **Constellation Program** that is responsible for astronaut training and planning for, and executing missions. They are also responsible for managing launch and entry Range Safety.

**Mobile Launch Platform –** A two story structure that rides on the **crawler transporter**, and has provided a mobile launch base for both the **Saturn V** and the Space Shuttle vehicles. The structure contains umbilicals which service the obiter as well as attach posts which hold the boosters and orbiter in place, keeping the entire structure upright before launch.

**Montreal Protocol –** Otherwise known as the *Montreal Protocol on Substances that Deplete the Ozone Layer*, this international treaty was originally enacted in 1987, and most recently amended in 1999, to protect the ozone layer through immediately banning some and ultimately phasing-out all ozone depleting substances.

**National Ambient Air Quality Standards (NAAQS) –** Section 109 of the **Clean Air Act** requires the U.S. Environmental Protection Agency to set nationwide standards, the **NAAQS**, for widespread air pollutants. Currently, six pollutants are regulated by primary and secondary **NAAQS** (see **criteria pollutants**).

**National Estuary Program –** A program, directed by Section 320 of the **Clean Water Act,** which is responsible for improving and protecting the quality of estuaries of national importance.

**National Historic Landmark –** A building site, structure, district, or object that is deemed to be of rich historic or cultural value to the United States of America. See **National Historic Preservation Act**.

**National Historic Preservation Act (NHPA) –** Legislation which created the **National Register of Historic Places** and the list of **National Historic Landmarks** in order to preserve historical and archaeological sites in the United States. Section 106 of the NHPA pertains to the "*Protection of Historic Properties*."

**National Register of Historic Places (National Register) –** A register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2(b) of the Historic Sites Act of 1935 and Section 101(a)(1) of the **National Historic Preservation Act** of 1966, as amended.

**Notice of Intent (NOI) –** The first formal step in the environmental impact statement process, consisting of a notice in the ***Federal Register*** with the following information: a description of the proposed Federal action and alternatives; a description of the agency's proposed scoping process, including scoping meetings; and the name and address of the person(s) to contact within the lead agency regarding the environmental impact statement.

**ordnance –** Military materials; explosives, ammunition, or other combat vehicles and equipment.

**Orion –** Formerly the **Crew Exploration Vehicle (CEV)**; refers to the vehicle which would incorporate a **Crew Module**, **Service Module**, **Launch Abort System**, and **spacecraft adapter**. This vehicle would be used (along with the **Ares I** launch vehicle) as a replacement for the Space Shuttle to transport crew and cargo between the Earth and the International Space Station, provide crew transport (along with the **Ares I** and **Ares V** launch vehicles) for lunar and Martian exploration missions, and return crew and cargo to the surface of the Earth. See also **CEV.**

**overall sound pressure level –** A sound level averaged over the entire audio spectrum; used to measure rocket launch noise and engine testing noise propagation from the source.

**oxides of nitrogen ($NO_X$) –** Gases formed primarily by fuel combustion, which contribute to the formation of acid rain. Hydrocarbons and oxides of nitrogen combine in the presence of sunlight to form ground-level ozone, a major constituent of smog.

**oxides of sulfur ($SO_X$) –** A family of gasses which result from the burning of fuels that contain sulfur. These gasses are precursors of sulfuric acid which may precipitate out of the atmosphere in the form of acid rain.

**ozone layer –** A portion of the Earth's **stratosphere** which contains a high concentration of ozone ($O_3$). It is very important in filtering out ultra-violet rays produced by the sun.

**ozone hole(s) –** Areas in the **ozone layer** noted for significant seasonal depletion of stratospheric ozone.

**payload(s) –** The element(s) that a launch vehicle or spacecraft carries over and above what is necessary for its operation. For a launch vehicle, the spacecraft being launched is the payload; for a scientific spacecraft, the suite of science instruments is the payload.

**Phenolic impregnated carbon ablation (PICA) –** A candidate material for use in the heat shield of the **Orion Crew Module**.

**polybutadiene acrylonitrile (PBAN) –**An elastomer used to bind the constituents of solid rocket fuel together; also known as Polybutadiene – Acrylic acid – Acrylonitrile.

**Prevention of Significant Deterioration (PSD) –** A standard that applies to new **major sources** or major modifications at existing sources for pollutants where the source is located in an area defined as in attainment or unclassifiable for the **NAAQS**.

**Project Ares –** The program that is responsible for the development of the **Ares I** and **Ares V** launch vehicles. It is also responsible for the testing of the launch vehicles as well as their delivery to John F. Kennedy Space Center for use in missions.

**Project Orion –** Is responsible for building and delivering the **Orion** spacecraft to the **Ground Operations Project** at John F. Kennedy Space Center. **Project Orion** would lead the development of the **Orion** spacecraft.

**range –** Permanent or temporary area or volume of land, sea, or airspace within or over which orbital, suborbital, or atmospheric vehicles are tested or flown. This includes the operation of launch vehicles from a launch site to the point where orbit is achieved or final landing or impact of suborbital vehicle components. This also includes the atmospheric entry of space vehicles from the point that the commit to de-orbit is initiated to (for normal atmospheric entries) the point of intact vehicle impact, landing, or the impact of all associated debris.

**remediation –** The long term, permanent clean up of CERCLA or other environmentally contaminated sites.

**restrictive easement –** A condition placed on land by its owner or by Federal, state, or local government that in some way limits its use, usually regarding the types of structures which may be built there or what may be done with the ground itself.

**risk –** The combination of (1) the probability (qualitative or quantitative), including associated uncertainty, that a system will experience an undesired event (or sequences of events) such as internal system or component failure and (2) the magnitude of the consequences (to the public , personnel, mission, and vehicle) and associated uncertainties given that the undesired event(s) occur(s).

**rookery –** Colony of breeding birds.

**safing activities –** Refers to venting excessive fuels or disarming ordnance.

**Saturn V –** A member of the Saturn family of rockets designed to launch heavy payloads into space. It was an expendable, liquid-fueled launch vehicle was used to launch the Apollo and Skylab missions.

**seismology –** The study of earthquakes, their sources and after-effects, and the propagation of elastic waves through the Earth.

**Service Module –** A cylindrical structure that would attach to the bottom of the **Crew Module** and provide propulsion and power for the **Orion** spacecraft. The **Service Module** includes radiator panels to dissipate heat, solar arrays to contribute electric power, as well as a platform to attach communications devices such as antennas. It is also used for the final injection burn to get into low Earth orbit, as well as for the deorbit burn during missions to the **International Space Station**.

**Solid Rocket Booster (SRB) –** A rocket that provides additional boost to the main propulsion system used to launch a spacecraft. It consists of a solid rocket motor plus additional assemblies, attach rings, and other electronic avionic systems. It may be expendable (*e.g.*, Atlas and Delta) or reusable (*e.g.*, Space Shuttle).

**Solid Rocket Motor (SRM) –** A rocket motor with a solid propellant consisting of fuel and oxidizer combined in compact grain. The SRM used for the Space Shuttle is a multi-segmented, reusable motor.

**spacecraft adapter –** The connecting structural hardware between the launch vehicle and the **Orion** spacecraft.

**Specific Impulse (Isp) –** describes the efficiency of a rocket engine in terms of the relationship between the change in momentum and the amount of propellant. An engine with a higher specific impulse is considered to be more efficient

**Species of Concern –** Species that are declining or might be in need of conservation actions.

**Superfund site –** Any land in the United States which has been contaminated by hazardous waste and identified by the U.S. Environmental Protection Agency as a candidate for cleanup because it poses a risk to human health and/or the environment.

**stratigraphy –** A branch of geology which studies rock layers and layering.

**stratosphere –** An upper portion of the Earth's atmosphere above the **troposphere**, reaching a maximum height of 50 km (31 mi) above the Earth's surface. The temperature is relatively constant in the lower **stratosphere** and gradually increases with altitude. The stratosphere is the Earth's main ozone producing region.

**superalloy –** A ductile metal alloy able to maintain excellent mechanical strength at extreme temperatures. Superalloys are also able to withstand corrosion and oxidation; typically the base element is nickel, cobalt, or nickel-iron.

**tackifying –** To make sticky. The Ares solid rocket motors would use a solvent to emulsify or partially dissolve the surface of the rubber insulation making it sticky so that layers of rubber can be bonded together.

**Threatened Species –** The classification assigned to an animal or plant likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

**Title V –** Section of the 1990 Clean Air Act Amendments which require permit programs for large sources of air pollution. Permits are regulated under the **Clean Air Act**, but are issued by the state in which a source is located. Permits are available for viewing by all interests (government, general public, and industry).

**topography –** The study of Earth's physical features (natural and man made) as well as the physical features of other planets and moons.

**total maximum daily load (TMDL) –** Calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

**tropopause –** The boundary between the **troposphere** and **stratosphere**, usually characterized by an abrupt change of the relationship between temperature and altitude; the change is in the direction of increased atmospheric stability from regions below to regions above the tropopause; its height varies seasonally, from 15 to 17 km (9 to 11 mi) in the tropics to approximately 10 km (6 mi) in polar regions.

**troposphere –** The portion of the atmosphere next to the Earth's surface in which the temperature rapidly decreases with altitude, clouds form, and convection is active. The **troposphere** begins at ground level and extends to an altitude of 10 to 12 km (6 to 8 mi) above the Earth's surface.

**umbilicals –** Connections that supply necessary support material to a launch vehicle while on the launch pad. They can supply, but are not limited to electricity, air, water and fuels.

**vadose –** Found or located above the water table.

**Warmwater Habitats –** A phrase designated by the Ohio Environmental Protection Agency to describe an aquatic life use categorization.

**wetlands –** Areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil. This classification includes swamps, marshes, bogs, and similar areas.

**Wetland Mitigation Bank –** A site where wetlands and/or other aquatic resources are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources.

**Wild and Scenic Rivers Act –** Legislation enacted in 1968 which created the National Wild and Scenic Rivers System and Nationwide Rivers Inventory. The purpose of the act is to preserve certain rivers which exhibit outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values from damming or other alteration.

**Wildlife Management Area(s) –** Designated areas which allow for a wide range of public use such as hunting, fishing, camping, and other outdoor recreation activities.

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# 10. INDEX

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# APPENDIX A

# EXPLORATION SYSTEMS ARCHITECTURE STUDY DESIGN REFERENCE MISSIONS FOR THE CREW EXPLORATION VEHICLE

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# APPENDIX A

# EXPLORATION SYSTEMS ARCHITECTURE STUDY DESIGN REFERENCE MISSIONS FOR THE CREW EXPLORATION VEHICLE

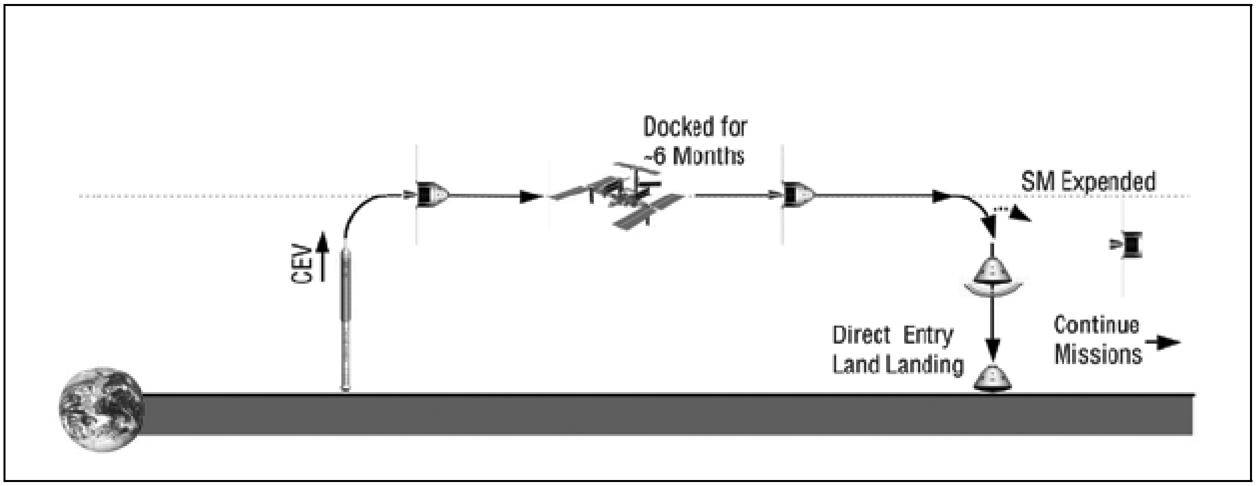
The National Aeronautics and Space Administration (NASA) Exploration Systems Architecture Study (ESAS) Team was established to determine the best exploration architecture and strategy to implement the President's exploration initiative (the *Vision for Space Exploration*) as announced in his January 2004 address (TWH 2004). This initiative encompassed a plan to return humans to the Moon by no later than 2020 in preparation for human exploration of Mars and beyond. As a part of NASA's future human space exploration strategy, the Space Shuttle was to be retired by no later than 2010 and be replaced by a new human-rated spacecraft, the Crew Exploration Vehicle (CEV) (since named Orion). The CEV was to begin operations with first human flights by no later than 2014 (NASA 2004). The ESAS team was required to perform four specific tasks:

- Complete assessment of the top-level CEV requirements and plans to enable the CEV to provide crew transport to the International Space Station and to accelerate the development of the CEV and crew launch system to reduce the gap between Space Shuttle retirement and CEV initial operational capability
- Provide definition of top-level requirements and configurations for crew and cargo launch systems to support the lunar and Mars exploration programs
- Develop a reference lunar exploration architecture concept to support sustained human and robotic lunar exploration operations
- Identify key technologies required to enable and significantly enhance these reference exploration systems and reprioritize near- and far-term technology investments.

The ESAS (NASA 2005) addressed the following four major items: CEV definition, launch vehicle definition, lunar architecture definition, and technology plan definition. Aspects addressed included cost, requirements, ground operations, mission operations, human systems, reliability, and safety. The ESAS team examined multiple combinations of launch elements (*e.g.,* duration, destination, flight sequence, systems, and technologies required to undertake and complete a particular mission) to establish Design Reference Missions that would facilitate the development of the CEV. There are six Design Reference Missions applicable to the Proposed Action, as summarized below (NASA 2005).

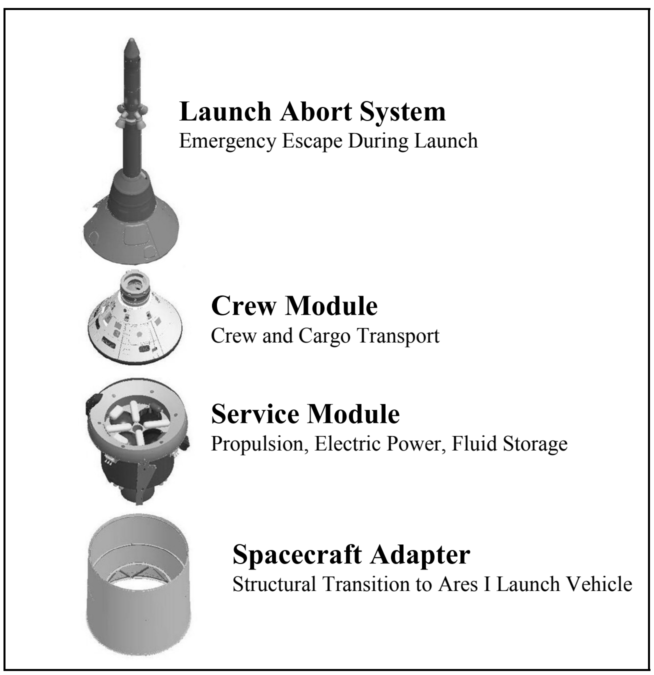
## A.1 CREW TRANSPORT TO THE INTERNATIONAL SPACE STATION

The purpose of this mission would be to transport three International Space Station crew members, and up to three additional temporary crew members, to the International Space Station for a 6-month stay and return them to Earth at any time during the mission (Figure A-1). The CEV, consisting of a Crew Module, Service Module, Launch Abort System, and Spacecraft Adapter (Figure A-2), would be launched by the Crew Launch Vehicle (CLV) (since named Ares I) (Figure A-3) into Earth orbit, where the CEV would perform a series of burns and maneuvers to close on and dock with the International Space Station. Once ingress activities are complete, the CEV would be configured to a quiescent state for the duration of the crew's assignment aboard the International Space Station. Upon completion of their assignment, the crew would return to the CEV and the CEV would undock from the International Space Station. The CEV would depart the vicinity of the International Space Station and would conduct a deorbit burn. After burn completion, the CEV Service Module would be expended, and the CEV Crew Module would be maneuvered to perform a terrestrial (land-based) landing at a designated site.



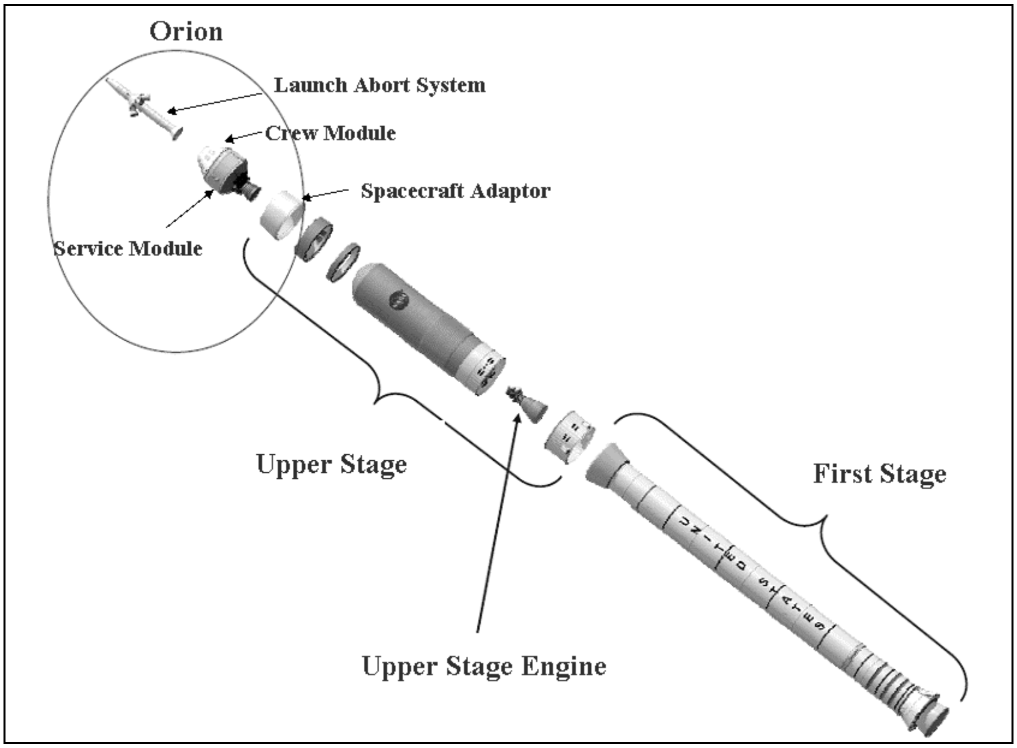

Note: Abbreviations and acronyms are defined on page xx. Source: NASA 2005

**Figure A-1. Normal Crewed Mission to the International Space Station**




Source: JSC 2007

**Figure A-2. Crew Exploration Vehicle Elements**




Source: Adapted from MSFC 2007

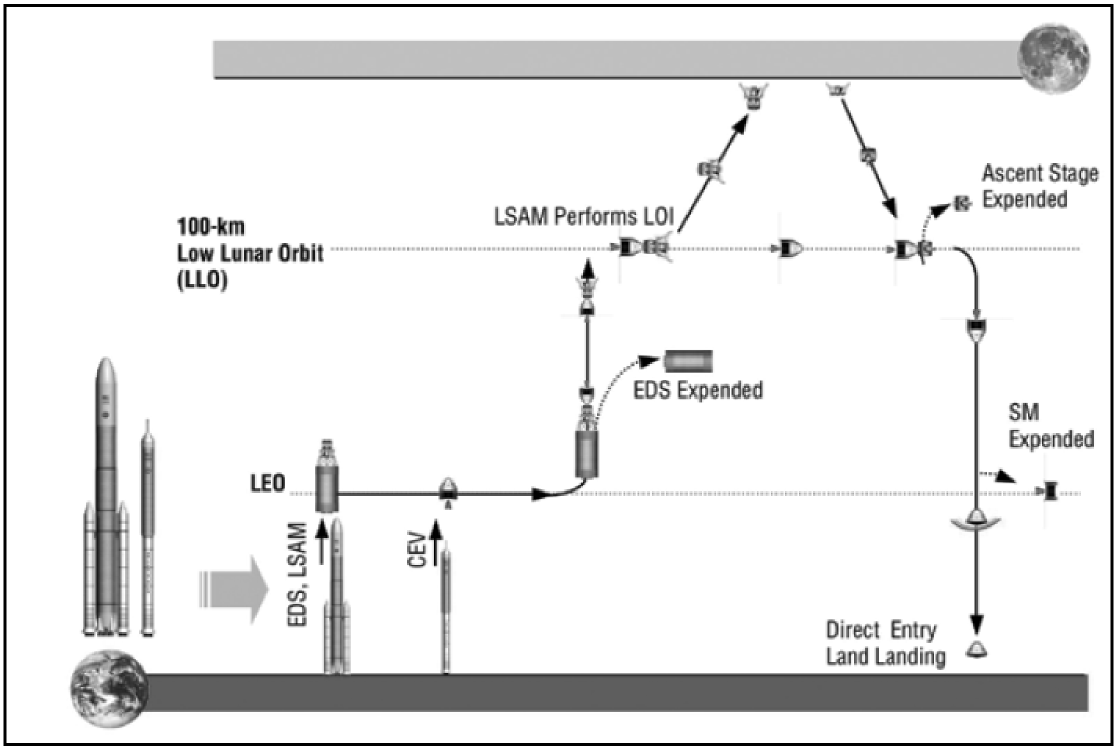
**Figure A-3. Ares I in Launch Configuration**

## A.2 CARGO TRANSPORT TO THE INTERNATIONAL SPACE STATION

The purpose of this mission would be to transport pressurized cargo to the International Space Station and return pressurized cargo to Earth after 90 days. The general mission sequence is similar to that depicted in Figure A-1, except the duration is shorter. A cargo version of the CEV would be launched by the CLV into orbit, filled with up to 3,500 kilograms (kg) (7,700 pounds [lb]) of materiel. The uncrewed CEV would perform a series of burns and maneuvers to close on and dock with the International Space Station. Once ingress activities are complete, the CEV systems would be configured to a quiescent state and the CEV cargo would be offloaded by the International Space Station crew. Upon completion of the docked phase lasting up to 90 days, the International Space Station crew would stow any return items in the CEV pressurized cabin, and Mission Control would command the CEV to undock. The CEV would depart the vicinity of the International Space Station and would conduct a deorbit burn. After burn completion, the CEV Service Module would be expended, and the unoccupied CEV Crew Module would be maneuvered to perform a terrestrial (land-based) landing at a designated site.

## A.3 CREW AND CARGO TRANSPORT TO THE MOON FOR SHORT-TERM MISSIONS

The purpose of this mission would be to transport up to six crew members to any site on the Moon (*i.e.,* global access) for up to 7 days (Figure A-4). This short-term mission would be analogous to the Apollo surface missions. It would demonstrate the capability to land humans on the Moon, operate for a limited period on the surface, and safely return to Earth.



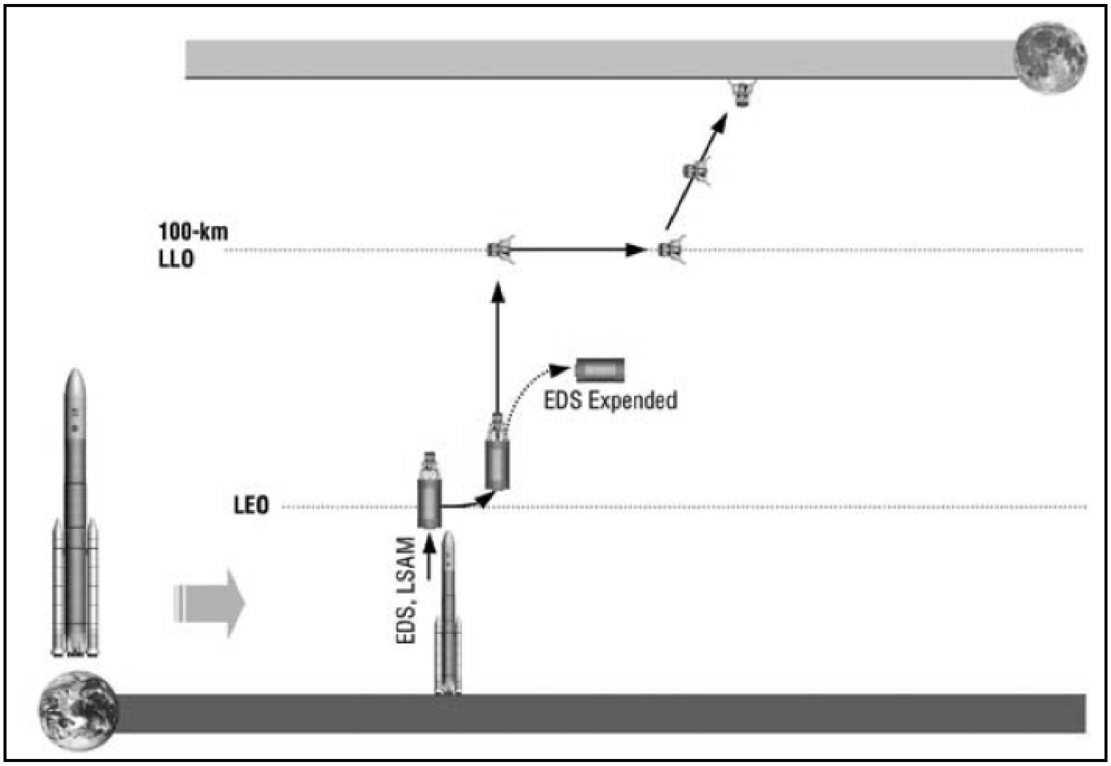

Note: Abbreviations and acronyms are defined on page xx. Source: NASA 2005

**Figure A-4. Normal Crew and Cargo Short-Term Lunar Mission (Sortie)**

The following transportation elements would be required to perform the mission: a CLV, a Cargo Launch Vehicle (CaLV) (since named Ares V), a CEV, a Lunar Surface Access Module (since named Lunar Lander), and an Earth Departure Stage. The mission sequence assumes a combination Earth orbit rendezvous and lunar orbit rendezvous. The Lunar Surface Access Module and Earth Departure Stage would be pre-deployed in a single CaLV launch to low Earth orbit, and the CLV would deliver the CEV and crew to Earth orbit where the Lunar Surface Access Module/Earth Departure Stage and CEV would rendezvous and dock. The Earth Departure Stage would perform a trans-lunar injection burn and would be expended. The Lunar Surface Access Module then would perform the lunar orbit injection for the CEV/Lunar Surface Access Module. The entire crew would transfer to the Lunar Surface Access Module, would undock from the CEV, and would descend to the lunar surface in the Lunar Surface Access Module while the CEV orbits the Moon. After up to 7 days on the lunar surface, the Lunar Surface Access Module would return the crew to lunar orbit where the Lunar Surface Access Module and CEV then would dock. The crew would transfer back to the CEV, and the Lunar Surface Access Module would be expended. The CEV would then return the crew to Earth with a direct entry and land at a designated terrestrial (land-based) landing site.

## A.4 CARGO TRANSPORT TO THE MOON

The purpose of this mission would be to deliver up to 20 metric tons (mt) (22 tons) of cargo to the lunar surface in a single mission using the elements of the human lunar transportation system (Figure A-5). This capability would be used to deliver surface infrastructure needed for lunar outpost buildup (e.g., habitats, power systems, communications, mobility, in situ resource utilization pilot plants) as well as periodic logistics re-supply packages to support a continuous human presence.



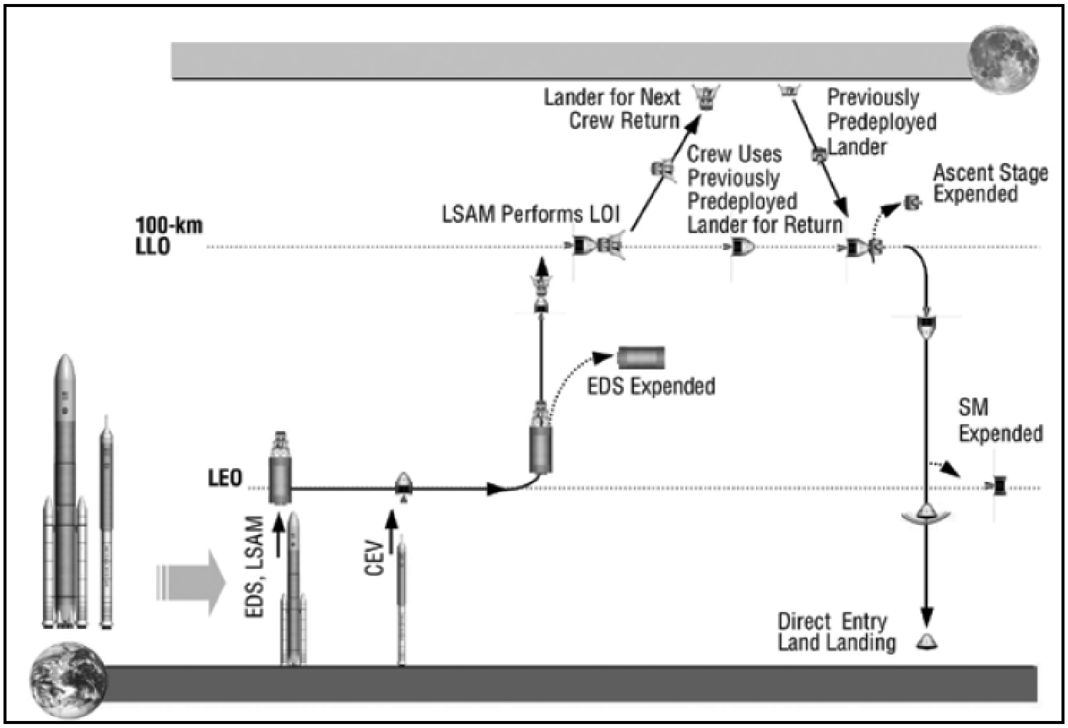

Note: Abbreviations and acronyms are defined on page xx. Source: NASA 2005

**Figure A-5. Normal Lunar Outpost Cargo Delivery Mission**

The following transportation elements would be required to perform the cargo transport mission: the same CaLV and Earth Departure Stage as the short-term lunar mission and a cargo variant of the Lunar Surface Access Module to land the large cargo elements near the lunar outpost site. The cargo variant of the Lunar Surface Access Module would replace the habitation module with a cargo pallet and logistics carriers. The Lunar Surface Access Module and Earth Departure Stage would be launched to low Earth orbit on a single CaLV. The Earth Departure Stage would perform the trans-lunar injection burn and would be expended. The Lunar Surface Access Module would then perform the lunar orbit injection and descend to the lunar surface. The cargo would then be offloaded from the Lunar Surface Access Module autonomously or by the outpost crew.

## A.5 CREW AND CARGO TRANSPORT TO THE MOON FOR LONG-TERM MISSIONS

The purpose of this mission would be to transfer up to six crew members and supplies in a single voyage to a lunar outpost site for an expedition lasting up to 6 months (Figure A-6). Every 6 months, the crew would change. The entire suite of transportation vehicles developed to support a short-term lunar mission also would be required for lunar outpost missions. The mission sequence assumes a similar approach as described for the short-term lunar mission except for duration.




Source: NASA 2005

Note: Abbreviations and acronyms are defined on page xx.

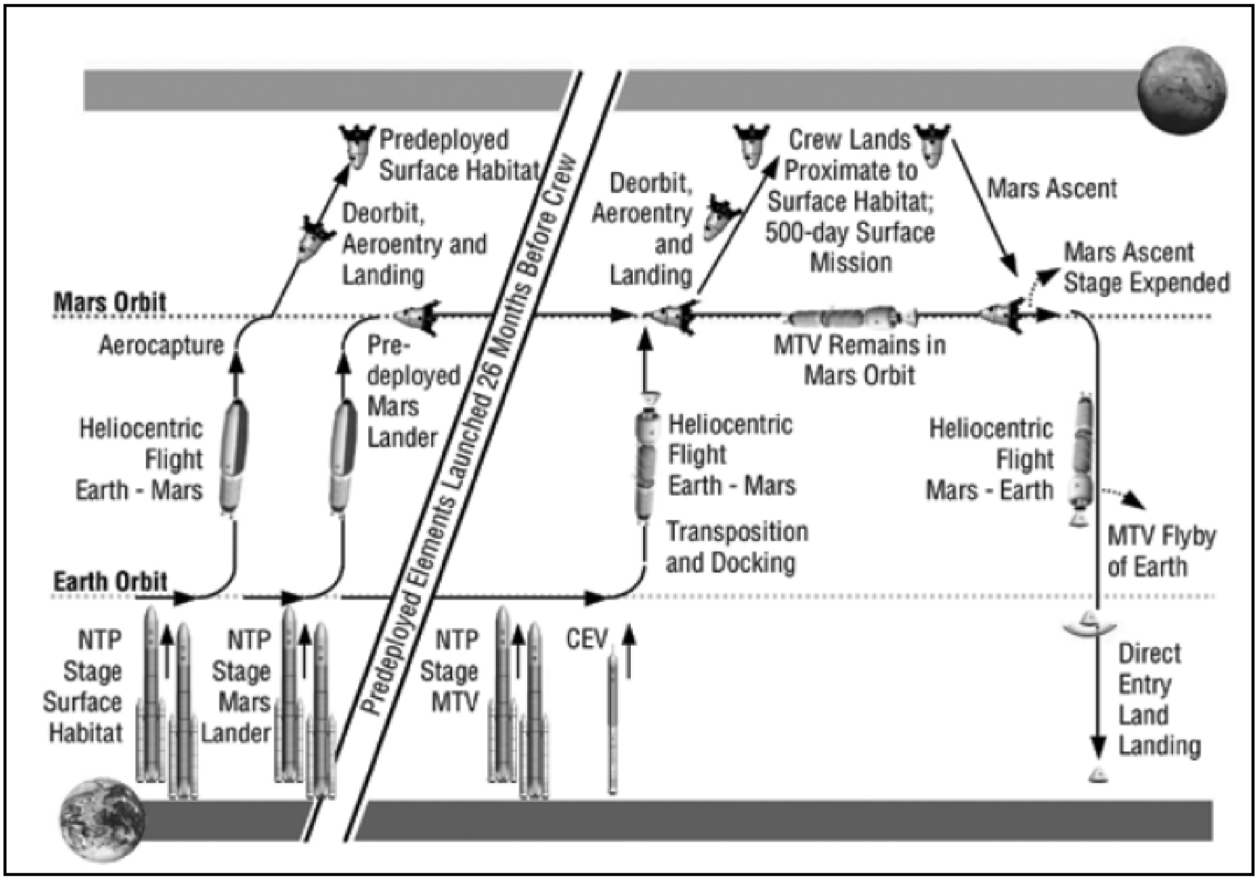
**Figure A-6. Normal Lunar Outpost Crew and Cargo Delivery Mission**

## A.6 CREW AND CARGO TRANSPORT TO MARS

The purpose of this mission would be to establish a continuous human presence on the surface of Mars. The mission sequence would involve a split-mission concept in which cargo would be transported in manageable units to the Mars surface or orbit, and checked out in advance of launching the crew. The split-mission approach would allow the crew to be transported on faster, more energetic trajectories, minimizing their exposure to the deep-space environment, while the vast majority of the materiel sent to Mars would be sent on minimum energy trajectories. Each human mission to Mars would be composed of three vehicle sets: two cargo vehicles and one round-trip piloted (crewed) vehicle (Figure A-7).

The CEV with a crew of up to six would be launched by the CLV into low Earth orbit and would perform a series of burns and maneuvers to close on and dock with the pre-deployed Mars Transfer Vehicle. Once crew and cargo transfer activities are complete, the CEV would be configured to a quiescent state. Periodic systems health checks and monitoring of the CEV would be performed throughout the Mars transfer mission.

As the Mars Transfer Vehicle approaches Earth upon completion of the (up to) 2 ½ year mission, the crew would transfer to the CEV and would undock from the Mars Transfer Vehicle. The CEV would maneuver to the proper entry attitude, and would perform a landing at a designated site.




Source: NASA 2005

Note: Abbreviations and acronyms are defined on page xx; Nuclear Thermal Propulsion (NTP) not within the current planning horizon of the Constellation Program.

**Figure A-7. Normal Mars Exploration Mission**

## A.7 REFERENCES


JSC 2007. National Aeronautics and Space Administration. Personal communication between M. See (NASA JSC) and R. Wickman (NASA HQ) regarding updated CEV 606 configuration graphics. April 29, 2007.

MSFC 2007. National Aeronautics and Space Administration. *Expanded Views of Ares I and Ares V*. Available at: http://www.nasa.gov/pdf/146764main_CLV_CaLV_Description.pdf. Accessed on May 7, 2007.

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TWH 2004. The White House. *A Renewed Spirit of Discovery. The President's Vision for U.S. Space Exploration*. Available at: http://www.whitehouse.gov/space/renewed_spirit.html. January 2004.

# APPENDIX B

# RESPONSES TO DRAFT PEIS PUBLIC REVIEW COMMENTS

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# APPENDIX B

# RESPONSES TO DRAFT PEIS PUBLIC REVIEW COMMENTS

The Notice of Availability of the *Draft Constellation Programmatic Environmental Impact Statement* (Draft PEIS) was published in the *Federal Register* on August 17, 2007 (72 *FR* 46218). The National Aeronautics and Space Administration (NASA) mailed over 300 hard copies and/or compact disks (CDs) of the Draft PEIS to potentially interested Federal, state, and local agencies; organizations; and individuals. In addition, the Draft PEIS was made publicly available in electronic format on NASA's web site at http://www.nasa.gov/mission_pages/constellation/main/peis.html. NASA also sent electronic mail (e-mail) notifications to potentially interested individuals who had submitted scoping comments via e-mail but who had not provided a mailing address.

The public review and comment period for the Draft PEIS closed on September 30, 2007. NASA received a total of 21 submissions (letters and e-mails) from Federal, state, and local agencies; organizations; and an individual, of which, 14 submissions contained comments regarding the Constellation Program. Seven submissions only requested to be added to the mailing list to receive a copy of the Final PEIS. Comments were received from the following Federal, state, and local agencies; organizations; and individual:

Federal Agencies

U.S. Environmental Protection Agency, Office of Federal Activities
U.S. Department of the Interior
*National Park Service*
*U.S. Fish and Wildlife Service*

State Agencies

New Mexico Department of Cultural Affairs, Historic Preservation Division
New Mexico Environment Department, Office of the Secretary
Maryland Department of the Environment, Science Services Administration
Maryland Department of Planning
Virginia Department of Environmental Quality, Office of Environmental Impact Review

Local Agencies

Brevard County Natural Resources Management Office, Florida
City of Madison, Alabama, Office of the Mayor
State of Ohio, Office of the Governor

Organizations

National Society of Black Engineers
The Space Frontier Foundation

Individual
Rosetta M. Karlen

The comment submissions included concerns regarding:

- Establishing a light management plan at John F. Kennedy Space Center (KSC) in Florida
- Establishing a monitoring program for bird strikes at KSC
- Water quality, air quality, and hazardous wastes at the U.S. Army's White Sands Missile Range (WSMR) in New Mexico
- Performing a coastal zone consistency determination for Langley Research Center in Virginia
- Raising awareness of metals in the environment
- Environmental impacts in outer space, including impacts on the Moon.

This appendix provides copies of the 14 comment submissions along with NASA's responses. The names of the individuals who only requested a copy of the Final PEIS are included in Chapter 7 of this Final PEIS. No alternatives to the Proposed Action (Preferred Alternative) were raised during the public review of the Draft PEIS.

## Comments from the U.S. Environmental Protection Agency:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

OCT - 1 2007

ZA/Environmental Manager
Constellation Program
NASA Lyndon B. Johnson Space Center
Houston, Texas 77058

Dear Sir/Madam:

In accordance with National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the Environmental Protection Agency (EPA) has reviewed the National Aeronautics and Space Administration's (NASA) draft programmatic environmental impact statement (EIS) for the Constellation Program.

The purpose of the Constellation Program is to develop the flight systems and Earth-based ground infrastructure required to enable continued access to space and to enable future crewed missions to the international Space Station, the Moon, Mars, and beyond.

EPA believes that this programmatic EIS provides an adequate discussion of the potential environmental impacts of the proposed program. Therefore, EPA has no objection to the proposed action discussed in this draft programmatic EIS.

We appreciate the opportunity to review this draft programmatic EIS. The staff contact for this review is Ken Mittelholtz (202-564-7156).

Sincerely,

Anne Norton Miller
Director
Office of Federal Activities

Internet Address (URL) • http://www.epa.gov
Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Postconsumer, Process Chlorine Free Recycled Paper

## Response to comments from the U.S. Environmental Protection Agency:

Thank you for your comments.

## Comments from the National Park Service:

From: John_Stiner@nps.gov [mailto:John_Stiner@nps.gov]
Sent: Tuesday, September 25, 2007 9:03 AM
To: Busacca, Mario (KSC)
Cc: Rosemary_Williams@nps.gov
Subject: Comments on draft Constellation Programmatic EIS

Mario:

Thank you for the opportunity to review the draft Constellation Programmatic Environmental Impact Statement. The vast majority of the proposed actions would not result in new impacts to Canaveral National Seashore and require no further comment. As per mitigation measures, we were pleased to note that :

Any modifications to historic resources will be undertaken in consultation with the State Historic Preservation Officer.

The KSC lighting plan will be adhered to to protect nesting sea turtles. Several measures will be taken to reduce the number of bird and bat strikes at LC Pads 39 A and B. We suggest establishing a monitoring program to record bird strikes during major avian migration periods.

John Stiner

## Response to comments from the National Park Service:

Thank you for your comments.

The John F. Kennedy Space Center (KSC) has an active, on-going monitoring program for all biological resources on the Center. As part of this program, KSC plans to add specific monitoring efforts to address potential bird strikes for all new tall structures constructed for the Constellation Program. This commitment has been previously documented in the Finding of No Significant Impact for the *Final Environmental Assessment for the Construction, Modification and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida.*

## Comments from the U.S. Fish and Wildlife Service:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive, South
Suite 310
Jacksonville, Florida 32216-0912

IN REPLY REFER TO:

**FWS Log No. 41910-07-TA-0632**

September 5, 2007

ZA/ Constellation Program Environmental Manager
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058

FWS Log Number: 41910-2007-TA-0632

Dear Dr. Rhatigan:

The U.S. Fish and Wildlife Service (Service) has reviewed your letter dated August 6, 2007, and its accompanying August 2007 Draft Constellation Programmatic Environmental Impact Statement. The National Aeronautics and Space Administration (NASA) proposes to implement the Constellation Program, a coordinated effort to provide necessary flight systems and Earth-based ground infrastructure at Kennedy Space Center (KSC) in Brevard County, Florida. We provide the following comments in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Your August 6, 2007, letter requesting comments was received on August 21, 2007. We provide NASA our comments on the effects of the proposed project on the nesting and hatchling loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), and leatherback (*Dermochelys coriacea*) sea turtles.

Our concern with the Constellation Program is the effect the lighting associated with this program may have on nesting and hatching sea turtles at KSC. Artificial lighting can be detrimental to sea turtles in several ways. Field observations have shown a correlation between lighted beaches and reduced sea turtle nesting. Adult females rely on visual brightness cues to find their way back to the ocean after nesting, those turtles that nest on lighted beaches may be disoriented by artificial lights and have difficulty finding their way back to the ocean.

Under natural conditions, hatchling sea turtles, which typically emerge from nests at night, move toward the brightest, most open horizon, which is over the ocean. However, when bright light sources are visible on the beach, they become the brightest spot on the horizon and attract hatchlings in the wrong direction, making them more vulnerable to predators, desiccation, entrapment in debris or vegetation, and exhaustion, and often luring them onto roadways and parking lots where they are run over. Artificial lights can also disorient hatchlings once they reach the water.

## Comments from the U.S. Fish and Wildlife Service (cont.):

The Service has been working with KSC to finalize a Biological Opinion (BO) for the lights that affect nesting and hatching sea turtles at KSC. Currently KSC has no authorized 'incidental take' for the lights that are affecting nesting and hatching sea turtles.

The Service has determined that the following conditions are necessary to minimize the effects of the Constellation Program on the above federally listed species:

1. A 'Light Management Plan' is implemented for the Constellation Program using the best available sea turtle 'friendly' lighting technology. The Light Management Plan shall be reviewed and approved by the Service.
2. The Service's BO for KSC's facility-wide lighting affects on sea turtles, authorizing incidental take of nesting and hatching sea turtles is completed.

The Service appreciates the cooperation of NASA. We like forward to working with you and your staff regarding the Constellation program. For further coordination please contact Ann Marie Lauritsen at (904) 525-0661.

Sincerely,

John F. Milio
FOR
David L. Hankla
Field Supervisor

Cc: Sandy MacPherson- JAX FO
Ron Hight- MINWR
Stephanie Nash- Regional Office- Atlanta

**Response to comments from the U.S. Fish and Wildlife Service:**

Thank you for your comments.

The U.S. Fish and Wildlife Service (USFWS) indicated that the John F. Kennedy Space Center (KSC) needs to have an approved Light Management Plan and completed Biological Opinion from the USFWS for endangered nesting and hatchling sea turtles. The USFWS has issued NASA an interim Biological Opinion, which takes into consideration NASA's operations at the Center, including Space Shuttle launches, and makes a determination as to the "incidental take" that may occur due to those operations.

Per the Endangered Species Act of 1973, anything that negatively impacts the survival of an endangered species is considered a "take." A "take" includes a disorientation/misorientation or death due to human-caused impacts such as artificial lights. Disorientation may not necessarily cause death, but it does jeopardize the turtle's ability to successfully make it to the ocean and significantly reduces its survivability due to exhaustion and starvation and increased predation. A "take" does not include natural impacts such as storm events and depredation. "Incidental" means happening just by chance due to human operations. These chance events could include storm events, predation, and other natural conditions that may have influenced the take numbers other than just artificial light.

KSC is currently in consultation with the USFWS to finalize this Biological Opinion based on the results of the 2007 nesting season. KSC has conferred with the Jacksonville Office of the Fish and Wildlife Service, Florida and has verbally agreed that there should be a separate Biological Opinion developed for the Constellation Program once the Space Shuttle Program is closed-out. That Biological Opinion will address a specific Light Management Plan for KSC.

## Comment from the New Mexico Department of Cultural Affairs:

National Aeronautics and
Space Administration
**Lyndon B. Johnson Space Center**
2101 NASA Parkway
Houston, Texas 77058-3696

082140

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AUG 2 2 2007
LMM
HISTORIC PRESERVATION DIVISION

August 6, 2007

Reply to Attn of: ZA-07-014

TO: Federal, State and Local Agencies, and Other Interested Parties

FROM: ZA/Constellation Program Environmental Manager

SUBJECT: Notice of Availability of the Draft Constellation Programmatic Environmental Impact Statement

In compliance with the NASA policy and procedures (14 CFR Part 1216, subpart 1216.3) for implementing the National Environmental Policy Act, as amended (42 U.S.C. 4321 *et seq.*), the Draft Constellation Programmatic Environmental Impact Statement is being distributed to Federal, State, and local agencies; interested persons, and organizations, as well as selected repositories. The Draft Constellation Programmatic Environmental Impact Statement is also available in Acrobat® format at: http://www.nasa.gov/mission_pages/constellation/main/eis.html

Any comments on environmental issues related to this Draft Constellation Programmatic Environmental Impact Statement must be submitted by September 30, 2007. Comments may be submitted via e-mail to nasa-cxeis@mail.nasa.gov; by telephone at 1-866-662-7243; or submitted in writing to the following mailing address:

ZA/Constellation Program Environmental Manager
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058

NO COMMENT
NMSHPO

Jennifer L. Rhatigan

Jennifer L. Rhatigan, Ph.D., P.E.

Enclosure

## Response to comment from the New Mexico Department of Cultural Affairs:

Thank you for your comment.

# Comments from the New Mexico Environment Department:

*State of New Mexico*
*ENVIRONMENT DEPARTMENT*
*Office of the Secretary*
*Harold Runnels Building*
*1190 St. Francis Drive, P.O. Box 26110*
*Santa Fe, New Mexico 87502-6110*
*Telephone (505) 827-2855*

**BILL RICHARDSON**
*GOVERNOR*

**RON CURRY**
*SECRETARY*

**CINDY PADILLA**
*DEPUTY SECRETARY*

September 19, 2007

Jennifer L. Rhatigan, Ph.D., P.E.
ZA/Constellation Program Environmental Manager
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058

Dear Dr. Rhatigan:

**RE: DRAFT CONSTELLATION PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT ( AUGUST 2007)**

This transmits New Mexico Environment Department (NMED) comments concerning the above- referenced Draft Programmatic Environmental Impact Statement (DPEIS).

*SURFACE WATER QUALITY*

These comments apply only to White Sands Missile Range (WSMR)/Johnson Space Center White Sands Test Facility (WSTF) facilities located in New Mexico.

The U.S. Environmental Protection Agency (USEPA) requires National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) coverage for storm water discharges from construction projects (common plans of development) that will result in the disturbance (or re-disturbance) of one or more acres, including expansions, of total land area. It is unclear in the EIS whether construction activities will be part of this proposed action. If construction of one, or a combination of several discrete facilities, exceed one acre (including staging areas, etc.), these construction activities will require appropriate NPDES permit coverage prior to beginning construction (small, one - five acre, construction projects may be able to qualify for a waiver in lieu of permit coverage - see Appendix D).

Among other things, this permit requires that a Storm Water Pollution Prevention Plan (SWPPP) be prepared for the site and that appropriate Best Management Practices (BMPs) be installed and maintained both during and after construction to prevent, to the extent practicable, pollutants (primarily sediment, oil & grease and construction materials

## Comments from the New Mexico Environment Department (cont.):

Jennifer L. Rhatigan
September 19, 2007
Page 2

from construction sites) in storm water runoff from entering waters of the U.S. This permit also requires that permanent stabilization measures (revegetation, paving, etc.), and permanent storm water management measures (storm water detention/retention structures, velocity dissipation devices, etc.) be implemented post construction to minimize, in the long term, pollutants in storm water runoff from entering these waters. In addition, permittees must ensure that there is no increase in sediment yield and flow velocity from the construction site (both during and after construction) compared to pre-construction, undisturbed conditions (see Subpart 9.C.1)

You should also be aware that EPA requires that all "operators" (see Appendix A) obtain NPDES permit coverage for construction projects. Generally, this means that at least two parties will require permit coverage. The owner/developer of this construction project who has operational control over project specifications (probably WSMR in this case), the general contractor(s) who has day-to-day operational control of those activities at the site, which are necessary to ensure compliance with the storm water pollution plan and other permit conditions, and possibly other "operators" will require appropriate NPDES permit coverage for this project.

The CGP was re-issued effective July 1, 2003 (see **Federal Register/Vol. 68, No. 126/Tuesday, July 1, 2003** pg. 39087). The CGP, Notice of Intent (NOI), Fact Sheet, and Federal Register notice can be downloaded at: http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

In addition, operation of these types of facilities may require Storm Water Multi-sector General Permit (see **Federal Register/Vol. 65, No. 210/Monday, October 30, 2000)** coverage. Impact areas, fueling and material handling areas, soil remediation activities, equipment manufacturing, etc. likely qualify as potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges from activities that meet the USEPA definition of "industrial activities," under several possible sectors. This permit also requires preparation of a SWPPP, and installation of appropriate storm water runoff control practices (per the SWPPP).

An industrial SWPPP should include such things as:

- **A description of potential pollutant sources** - includes such things as a site map, an identification of the types of pollutants that are likely to be present in storm water discharges, an inventory of the types of materials handled at the site that potentially may be exposed to precipitation, a list of significant spills and leaks of toxic or hazardous pollutants, sampling data, a narrative description of the potential pollutant sources from specific activities at the facility, and identification of specific potential pollutants; and

- **A description of appropriate measures and controls** - includes the type and location of existing and proposed non-structural and structural best management practices (BMPs) selected for each of the areas where industrial materials or activities are exposed to storm water. Non-structural and structural BMPs to be described and implemented include such things as good housekeeping, preventive maintenance, spill prevention and response procedures, periodic inspections, employee training, record keeping, non-storm water evaluations and certifications,

## Comments from the New Mexico Environment Department (cont.):

Jennifer L. Rhatigan
September 19, 2007
Page 3

sediment and erosion control, as well as implementation/maintenance of traditional storm water management practices where appropriate, and a reclamation plan.

WSMR already has NPDES Storm Water Multi-sector General Permit coverage (NMR05A057) for various other industrial activities at this facility. The permittee should amend the existing Storm Water Pollution Prevention Plan to incorporate any additional activities and pollutant controls dictated by this proposed action.

*AIR QUALITY*

Aluminum oxide ($Al_2O_3$) is listed under 20.2.72.502 NMAC – Toxic Air Pollutants and Emissions, Table A-Noncarcinogens. To ensure compliance with the State of New Mexico's air quality regulations, modeling may need to be conducted to show that the eight-hour average ambient concentration of the toxic air pollutant $Al_2O_3$ does not exceed one-one hundredth of the occupational exposure limit (OEL) and that the required air toxics emission limits listed under Section 502, Table A are not exceeded. If the OEL and/or the emissions limits exceed what is listed under Section 502, Table A, then an air quality permit must be obtained from the Department's Air Quality Bureau (AQB). For more information on the permitting and modeling requirements for toxic air pollutants, please refer to 20.2.72.400 NMAC.

White Sands Missile Range (WSMR) extends into parts of several New Mexico counties, including Doña Ana County. The White Sands Test Facility (WSTF), which is within the boundaries of WSMR, is located entirely in Doña Ana County. All of the counties are considered in attainment with New Mexico and National Ambient Air Quality Standards; however, the AQB has recorded exceedances of the standard for particulate matter (PM10) in Doña Ana County. In response to the recorded exceedances of the standard for PM10, a Natural Events Action Plan (NEAP) has been developed for wind blown dust in Doña Ana County. As part of the NEAP, White Sands Missile Range signed a memorandum of agreement (MOA) with the New Mexico Environment Department in support of the NEAP. This MOA needs to be referenced in the PEIS for this project if any portion of the project area is located in Doña Ana County. The NEAP may be downloaded from our web page at http://www.nmenv.state.nm.us/aqb/NEAP/index.html. Doña Ana County has adopted an ordinance for dust control (Doña Ana County Ordinance No. 194-2000, Erosion Control Regulations). Compliance with this ordinance may be required.

Areas disturbed by project activities, within and adjacent to the project area, should be reclaimed to avoid long-term problems with erosion and fugitive dust. During the construction activities, dust control measures should be taken to minimize the release of particulates. Long-term dust control can be achieved by paving, revegetating, or using dust suppressants on disturbed areas following construction.

All asphalt, concrete, quarrying, crushing, and screening facilities contracted in conjunction with the proposed project must have current and proper air quality permits. For more information on air quality permitting and modeling requirements, please refer to 20.2.72 NMAC.

## Comments from the New Mexico Environment Department (cont.):

Jennifer L. Rhatigan
September 19, 2007
Page 4

The project as proposed should have no long-term significant impacts to ambient air quality.

*HAZARDOUS WASTE*

We would like to emphasize a number of items concerning hazardous waste relative to this project::

- If test articles impact on-site, WSMR is exempt from the Resource Conservation and Recovery Act (RCRA). However, if WSMR manages the crash sites and contaminated soil, as required by their Stewardship program, then WSMR's remediation and recovery efforts may be subject to RCRA Subtitle C and/or D. Management of contaminated media and newly created waste associated with crash debris and contaminated soil is potentially subject to RCRA.

- NASA states in Section 4.1.1.9.1 (Land Resources) that in all cases, the test articles would land within WSMR. If a test weapon crashes off-site, then WSMR is subject to the Military Munitions Rule (see Subpart M to 40 CFR 266). This scenario is not addressed in the EIS.

- NASA states in Section 3.1.9.9 (Hazardous Materials and Waste) of the EIS that White Sands Missile Range (WSMR) is regulated both for generation and for treatment and storage of hazardous wastes, for which it holds a RCRA Part B Permit. WSMR's 1989 and future (currently in draft) RCRA operating permits are for storage only; therefore, treatment of hazardous waste is prohibited.

- NASA must ensure that all off-specification, unused and unburned fuels, propellants, and oxidizers are properly managed.

We appreciate the opportunity to comment on this document. Please let us know if you have any questions.

Sincerely,

Ron Curry
Secretary

NMED File No. 2523ER

**Response to comments from the New Mexico Environment Department:**

Thank you for your comments.

**NASA General Response:** The NASA Launch Abort System (LAS) testing proposed for the U.S. Army's White Sands Missile Range (WSMR) has also been evaluated separately from the *Draft Constellation Programmatic Environmental Impact Statement* (Draft PEIS). This separate evaluation included preparation of an Environmental Assessment (EA), entitled the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico*. This separate EA was required due to schedule constraints relating to completing facility design activities in a timely manner to meet important test program milestones and allow construction activities to commence. This EA discusses many of the issues in the New Mexico Environmental Department (NMED) comments provided to NASA by letter dated September 19, 2007. This EA was completed in late July 2007 and was issued for a 30-day public comment period on August 5, 2007. The public comment period closed on September 5, 2007. There were no comments received and a Finding of No Significant Impact (FONSI) was prepared. A copy of the EA on a compact disk (CD) was sent to the NMED point of contact for NASA activities on August 3, 2007. A copy of the EA can be obtained by contacting Tim Davis at NASA's Johnson Space Center White Sands Test Facility (WSTF) via telephone at (575) 524-5024 or electronic mail (e-mail) at timothy.j.davis@nasa.gov. The EA is also available in electronic format at: www.nasa.gov/mission_pages/constellation/main/wsmr_las_ea.html.

**Specific Responses to Surface Water and Storm Water Comments**

**NMED Comment:** It is unclear in the EIS whether construction activities will be part of this proposed action. If construction of one, or a combination of several discrete facilities, exceed one acre (including staging areas, etc.), these construction activities will require appropriate NPDES permit coverage prior to beginning construction (small, one-five acre, construction projects may be able to qualify for a waiver in lieu of permit coverage – see Appendix D).

**NASA Response**: The Proposed Action will include numerous construction activities. As described in the LAS EA, Sections 1.4.2.1 through 1.4.2.8, this project will include a final integration and test facility, storage areas, launch facilities, a launch pad area, a launch gantry, an umbilical tower, a launch services pad with blast barrier, and possibly some relatively minor additional road work. Based on standard WSMR environmental compliance procedures and normal construction practices for contractors at a Federal facility, all appropriate National Pollutant Discharge Elimination System (NPDES) permit coverage, including storm water for small construction activities, will be evaluated and obtained as required by regulations.

**NMED Comment**: WSMR already has NPDES Storm Water Multi-sector General Permit coverage (NMR05A057) for various other industrial activities at this facility. The permittee should amend the existing Storm Water Pollution Prevention Plan to incorporate any additional activities and pollutant controls dictated by this proposed action.

**Response to the Comment Letter from the New Mexico Environment Department (cont.):**

**NASA Response**: NPDES evaluation of new and proposed projects at WSMR is a routine activity performed by the WSMR Environmental Directorate. As dictated by standard WSMR environmental compliance procedures, the current NPDES Storm Water Multi-Sector General Permit coverage will be amended as applicable for additional activities and pollutant controls.

**Specific Responses to Air Quality Comments**

**NMED Comment**: To ensure compliance with the State of New Mexico's air quality regulations, modeling may need to be conducted to show that the eight-hour average ambient concentration of the toxic air pollutant $Al_2O_3$ does not exceed one-one hundredth of the occupational exposure limit (OEL) and that the required air toxics emission limits listed under Section 502, Table A are not exceeded. If the OEL and/or the emissions limits exceed what is listed under Section 502, Table A, then an air quality permit must be obtained from the Department's Air Quality Bureau (AQB).

**NASA Response**: The LAS EA discusses the various propellants and potential air emissions in Sections 1.3.2, 1.4.2.9, 3.2.5, and 4.2.5. As specified by both WSMR and NASA standard environmental compliance procedures, evaluations of propellants and emissions will ensure compliance with regulatory requirements including air toxic permitting requirements for aluminum oxide, if necessary. Any modeling and permit preparation tasks required by this project will be performed by personnel with the WSMR Environmental Directorate.

**NMED Comment**: In response to the recorded exceedances of the standard for PM10, a Natural Events Action Plan (NEAP) has been developed for wind blown dust in Dona Ana County. As part of the NEAP, White Sands Missile Range signed a Memorandum of agreement (MOA) with the New Mexico Environment Department in support of the NEAP. This MOA needs to be referenced in the PEIS for this project if any portion of the project area is located in Dona Ana County. The NEAP may be downloaded from our web page at http://www.nmenv.state.nm.us/aqb/NEAP/index.html. Dona Ana County has adopted an ordinance for dust control (Dona Ana County Ordinance No. 194-2000, Erosion Control Regulations). Compliance with this ordinance may be required.

**NASA Response**: The proposed construction site at Launch Complex (LC)-32 is located within Doña Ana County. The MOA with NMED has been referenced in the Final PEIS. In the LAS EA, air quality issues are also discussed in Sections 3.2.5 and 4.2.5. Mitigation measures including dust suppression activities such as utilization of water tankers are briefly discussed in the EA in Section 5.2. Section 3.1.9.2.2 of the Final PEIS has been modified by adding the following sentence at the end of the second paragraph: "…exceedances of $PM_{10}$ due to wind-blown dust have been recorded in Doña Ana County. In response to these exceedances, a Natural Events Action Plan has been developed for wind blown dust in Doña Ana County. As part of the Natural Events Action Plan, WSMR signed a Memorandum of Agreement with the New Mexico Environment Department in support of the Natural Events Action Plan."

**Response to the comment from the New Mexico Environment Department (cont.):**

**NMED Comment**: Areas disturbed by project activities, within and adjacent to the project area, should be reclaimed to avoid long-term problems with erosion and fugitive dust. During the construction activities, dust control measures should be taken to minimize the release of particulates. Long-term dust control can be achieved by paving, revegetating, or using dust suppressants on disturbed area following construction.

**NASA Response**: The LAS EA discusses air quality issues including dust control in Sections 3.2.5, 4.2.5, and 5.2. Additionally, revegetation is briefly discussed in Section 4.3.1. In summary, the EA discusses mitigation measures for dust control including dust suppressants such as using water tanks and minimizing ground disturbance when possible. In the event that up-range landing zones require mitigation measures, Sections 4.2.4 and 4.2.6 in the LAS EA discuss the evaluation of corrective measures in cooperation with the regulatory agencies. For example, Contingency Plans will be developed to address any up-range issues due to landing zones or launch accidents and follow-up Work Plans will be generated with input, and approval, from the appropriate regulatory agencies.

**NMED Comme**nt: All asphalt, concrete, quarrying, crushing, and screening facilities contracted in conjunction with the proposed project must have current and proper air quality permits.

**NASA Response**: Based on standard WSMR and NASA operational procedures and environmental compliance requirements, including procurement regulations for obtaining contractor services at a Federal facility, any asphalt, concrete, quarrying, crushing, and screening facilities will have current and proper air quality permits.

**NMED Comment**: The project should have no long-term significant impacts to ambient air quality.

**NASA Response**: NASA concurs with this NMED comment. The project will not have any long-term significant impacts to ambient air quality. The LAS EA documentation describes air quality issues at Sections 3.2.5 and 4.2.5. Additionally, mitigation measures for dust suppression are briefly discussed in Section 5.2.

**Specific Responses to Hazardous Waste Comments**

**NMED Comment**: If test articles impact on-site, WSMR is exempt from the Resource Conservation and Recovery Act (RCRA). However, if WSMR manages the crash sites and contaminated soil, as required by their Stewardship program, then WSMR's remediation and recovery efforts may be subject to RCRA Subtitle C and/or D. Management of contaminated media and newly created waste associated with crash debris and contaminated soil is potentially subject to RCRA.

**NASA Response**: WSMR will comply with all applicable rules and regulations, including the RCRA Subtitle C and/or D programs where applicable. In the LAS EA, the potential for managing crash sites and contaminated soils is briefly described in Sections 4.2.4 and 4.2.6. To summarize the LAS EA, a Contingency Plan will be developed that documents standard procedures for emergency response and spill response due to a launch accident. This Contingency Plan will delineate specific actions for immediate response procedures to minimize

**Response to comments from the New Mexico Environment Department (cont.):**

contamination, notify regulatory agencies, and develop final corrective action strategies with associated Agency-approved documentation (*e.g.,* Work Plans). All corrective action activities will be performed in compliance with all state and Federal regulatory requirements.

**NMED Comment**: NASA states in Section 4.1.1.9.1 (Land Resources) that in all cases, the test articles would land within WSMR. If a test weapon crashes off-site, then WSMR is subject to the Military Munitions Rule (see Subpart M to 40 CFR 266). This scenario is not addressed in the EIS.

**NASA Response**: This scenario is not discussed in the PEIS, or the LAS EA, because an off-range launch accident from the LAS test activities is not considered a scenario that is reasonably expected to occur. As such, it is not discussed in any of the NEPA documentation. However, the EA discusses human health and safety in Sections 3.9 and 4.9. These discussions of human health and safety provisions include the possibility of utilizing flight termination procedures to preclude an offsite launch accident (Section 5.6 of the EA discussing mitigation measures). In the extremely unlikely event that a test article goes severely off-target and lands off-range, the LAS Test Program would comply with all applicable NASA and WSMR procedures as well as all state and Federal rules and regulations.

**NMED Comment**: NASA states in Section 3.1.9.9 (Hazardous Materials and Waste) of the EIS that White Sands Missile Range (WSMR) is regulated both for generation and for treatment and storage of hazardous wastes, for which it holds a RCRA Part B Permit. WSMR's 1989 and future (currently in draft) RCRA operating permits are for storage only; therefore, treatment of hazardous waste is prohibited.

**NASA Response**: The LAS testing activities at WSMR will not require any treatment of hazardous waste. It is expected that the project will generate only relatively small quantities of hazardous waste which will require accumulation in satellite areas and eventual storage of hazardous waste in a RCRA permitted storage area prior to shipment for off-site disposal. All generation and storage procedures will meet the current, and future, requirements of the RCRA Part B permit. WSMR has historically been called a RCRA Treatment, Storage, and Disposal Facility (TSDF). This is standard RCRA terminology, even though facilities may not have permits for certain portions of possible RCRA regulated activities. For example, WSMR is a permitted storage facility, not a permitted disposal or treatment facility and the White Sands Test Facility (WSTF) is a permitted treatment and storage facility, but not a disposal facility. However, both WSMR and WSTF are routinely described by the regulatory agencies as a TSDF and it is likely that this terminology is where the Draft PEIS language discussing potential treatment was obtained. Regardless, the project does not anticipate any hazardous waste treatment requirements and will not require any hazardous waste operations that are not allowed by the current, and future, RCRA Part B permit. The language regarding treatment of hazardous waste in the Draft PEIS has been removed to preclude any need for clarification on the RCRA provisions. Section 3.1.9.9 of the Final PEIS currently states, "WSMR is regulated both for generation and storage of hazardous wastes, for which it holds a RCRA Part B permit."

**Response to comments from the New Mexico Environment Department (cont.):**

**NMED Comment**: NASA must ensure that all off-specification, unused and unburned fuels, propellants, and oxidizers are properly managed.

**NASA Response**: NASA addressed these issues in several areas in the EA. The management of hazardous waste, hazardous materials, and solid waste is discussed in Sections 1.4.2.9, 3.8, and 4.8 of the EA. Additionally, a brief discussion of mitigation activities is also discussed in Section 5.5 of the EA. To summarize the EA, hazardous waste will be managed using standard WSMR Procedures. These procedures provides guidelines for the handling and management of hazardous waste and facilitates compliance with all Federal, state, and local laws regulating the generation, handling, treatment, storage, and disposal of hazardous waste. For hazardous materials, the EA states that unused materials will be recovered, transported, properly managed, and stored in accordance with WSMR procedures and all state and Federal regulations. For solid waste, the EA states that an offsite contractor will collect the waste and transport for disposal at the local landfill.

## Comment from the Maryland Department of the Environment:

MDE

**MARYLAND DEPARTMENT OF THE ENVIRONMENT**
1800 Washington Boulevard • Baltimore, Maryland 21230
410-537-3000 • 1-800-633-6101 • http://www.mde.state.md.us

Martin O'Malley
Governor

Anthony G. Brown
Lieutenant Governor

Shari T. Wilson
Secretary

Robert M. Summers, Ph.D.
Deputy Secretary

September 24, 2007

Ms. Jennifer L. Rhatigan
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, TX 77058

RE: State Application Identifier: MD20070821-0904
Project: Draft Constellation Programmatic Environmental Impact Statement

Dear Ms. Rhatigan:

Thank you for providing the Maryland Department of the Environment (MDE) with the opportunity to comment on the above-referenced project. Copies of the documents were circulated throughout MDE for review, and it has been determined that this project is consistent with MDE's plans, programs and objectives.

Again, thank you for giving MDE the opportunity to review this project. If you have any questions or need additional information, please feel free to call me at (410) 537-4120.

Sincerely,

Joane D. Mueller

Joane D. Mueller
MDE Clearinghouse Coordinator
Science Services Administration

cc: Bob Rosenbush, State Clearinghouse

## Response to comment from the Maryland Department of the Environment:

Thank you for your comment.

## Comment from the Maryland Department of Planning:

MDP
Maryland Department of Planning

Martin O'Malley
Governor
Anthony G. Brown
Lt. Governor

Richard Eberhart Hall
Secretary
Matthew J. Power
Deputy Secretary

August 23, 2007

Ms. Jennifer L. Rhatigan, Ph.D.
ZA/Constellation Program Environmental Manager
National Aeronautics and Space Administration
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, TX 77058

**STATE CLEARINGHOUSE REVIEW PROCESS**
**State Application Identifier: MD20070821-0904**
**Reviewer Comments Due By:** September 27, 2007
**Project Description:** Draft Constellation Programmic Environment Impact Statement: develop flight systems and Earth-based ground infrastructure for access to space and assistance for future crewed missions
**Project Location:** States of Alabama, California, Florida, Louisiana, Mississippi, New Mexico, Ohio, Texas, Utah and Virginia; Prince George's County
**Clearinghouse Contact:** Bob Rosenbush

Dear Ms. Rhatigan:

Thank you for submitting your project for intergovernmental review. Participation in the Maryland Intergovernmental Review and Coordination (MIRC) process helps ensure project consistency with plans, programs, and objectives of State agencies and local governments. MIRC enhances opportunities for approval and/or funding and minimizes delays by resolving issues before project implementation.

The following agencies and/or jurisdictions have been forwarded a copy of your project for their review: the Maryland Departments of Natural Resources, the Environment, Transportation; the County of Prince George's; and the Maryland Department of Planning; including the Maryland Historical Trust. They have been requested to contact your agency directly by **September 27, 2007** with any comments or concerns and to provide a copy of those comments to the State Clearinghouse for Intergovernmental Assistance. Please be assured that after **September 27, 2007** all MIRC requirements will have been met in accordance with Code of Maryland Regulations (COMAR 14.24.04). The project has been assigned a unique State Application Identifier that should be used on all documents and correspondence.

If you need assistance or have questions, contact the State Clearinghouse staff noted above at 410-767-4490 or through e-mail at brosenbush@mdp.state.md.us. Thank you for your cooperation with the MIRC process.

Sincerely,

Linda C. Janey

Linda C. Janey, J.D., Assistant Secretary
for Clearinghouse and Communications

LCJ:BR
Enclosures
cc: Beth Cole – MHT*
Steve Allan – MDPL*
Ray Dintaman – DNR*
Joane Mueller – MDE*
Cindy Johnson – MDOT*
Beverly Warfield – PGEO*

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## Response to comment from the Maryland Department of Planning:

Thank you.

## Comments from the Virginia Office of Environmental Impact Review:

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

L. Preston Bryant, Jr.
Secretary of Natural Resources

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David K. Paylor
Director

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September 25, 2007

ZA/Constellation Program Environmental Manager
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058

RE: Draft Constellation Programmatic Environmental Impact Statement, Langley Research Center, City of Hampton, Virginia (DEQ 07-143F).

Dear ZA/Constellation Program Environmental Manager:

The Commonwealth of Virginia has completed its review of the August 6, 2007 Draft Environmental Impact Statement (DEIS) (received August 20, 2007) for the above referenced project. The Department of Environmental Quality is responsible for coordinating Virginia's review of federal environmental documents and responding to appropriate federal officials on behalf of the Commonwealth. The following agencies and planning district commission participated in the review of this proposal:

Department of Environmental Quality
Hampton Roads Planning District Commission

The Department of Historic Resources and the City of Hampton were also invited to comment.

**Project Description**

The National Aeronautics and Space Administration (NASA) has submitted a Draft Programmatic Environmental Impact Statement (DPEIS) for the Constellation Program. NASA proposes to implement the Constellation Program to develop a new class of exploration vehicles and the infrastructure necessary to support their development and use in space exploration. The purpose of NASA's Proposed Action is to undertake the activities necessary to develop the flight systems and ground infrastructure required to enable continued access to space and to enable future crewed missions to the International Space Station, the Moon, Mars, and beyond. The Constellation Program consists of six projects:

## Comments from the Virginia Office of Environmental Impact Review (cont.):

Page 2

1. Project Orion (develop and test the Orion spacecraft);
2. Project Ares (develop and test the Aries I and Ares V launch vehicles);
3. Ground Operations Project (logistics and launch services);
4. Mission Operations Project (crew, flight controllers, and support staff training);
5. Lunar Lander Project (develop and test lunar lander); and
6. Extravehicular Activities (EVA) Project (provide space suits and tools).

In Virginia, NASA proposes to utilize the Langley Research Center (LARC) in the City of Hampton to manage the Orion Launch Abort System development, the Orion landing system development and testing, and Ares ascent development flight test vehicle integration. According to the DPEIS, most of the reasonably foreseeable activities would be similar to ongoing activities conducted in support of NASA programs. Most of the modifications anticipated would be relatively minor such as internal upgrades to test equipment and components. Except for modifications of existing buildings, no new construction or building expansion is proposed at LaRC.

**Environmental Program Guidance**

According to the DPEIS anticipated activities proposed for the NASA Langley Research Center in Hampton would be minor internal upgrades to equipment and not involve the construction of new facilities or the expansion of existing facilities. Therefore, the Virginia natural resource agencies that reviewed the document do not anticipate significant project impacts to programs under their jurisdiction. However, should the proposed action change and significant impacts are identified, compliance with one or more programs may be required. The following is provided as guidance on environmental programs that could be impacted by future unforeseen actions related to the Constellation Program.

**1. Water Quality & Wetlands**. In Virginia, water quality and wetland impacts are regulated through Federal and State government programs. Point source pollution control is administered by DEQ pursuant to Virginia Code 62.1-44.15, and is accomplished through the implementation of:

- The National Pollutant Discharge Elimination System (NPDES) permit program established pursuant to Section 402 of the federal Clean Water Act and administered in Virginia as the Virginia Pollutant Discharge Elimination System (VPDES) permit program.
- The Virginia Water Protection Permit (VWPP) program administered by DEQ (Virginia Code §62.1-44.15:5) and Water Quality Certification pursuant to Section 401 of the Clean Water Act.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

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Wetlands management is accomplished through:

- The tidal wetlands program is administered by the Virginia Marine Resources Commission (VMRC) (Virginia Code 28.2-1301 through 28.2-1320).
- The Virginia Water Protection Permit (VWPP) program administered by DEQ, which includes protection of both tidal and non-tidal wetlands (Virginia Code §62.1-44.15:5), and Water Quality Certification pursuant to Section 401 of the Clean Water Act.

Please note that the Commonwealth does not support the filling of wetlands, particularly when alternative sites have been identified. It is the policy of the Commonwealth of Virginia to first avoid impacts to wetlands before considering other mitigation measures such as minimization and compensation. The Virginia Water Protection Permit regulations state that "mitigation means sequentially avoiding and minimizing impacts to the extent practicable, and then compensating for remaining unavoidable impacts of a proposed action" (9 VAC 25-210-10). According to State Water Control Law § 62.1-44.15:5D, "…except in compliance with an individual or general Virginia Water Protection Permit issued in accordance with this subsection, it shall also be unlawful to conduct the following activities in a wetland: (i) new activities to cause draining that significantly alters or degrades existing wetland acreage or functions, (ii) filling or dumping, (iii) permanent flooding or impounding, or (iv) new activities that cause significant alteration or degradation of existing wetland acreage or functions. Permits shall address avoidance and minimization of wetland impacts to the maximum extent practicable. A permit shall be issued only if the Board finds that the effect of the impact, together with other existing or proposed impacts to wetlands, will not cause or contribute to a significant impairment of state waters or fish and wildlife resources."

Furthermore, Federal wetlands mitigation policy is guided by a Memorandum of Agreement between the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency that clarify a three-step approach to avoiding, minimizing, and compensating for unavoidable impacts (see Clean Water Act Section 404 (b)(1) *Guidelines Mitigation Memorandum of Agreement*, February 1990). The Corps first makes a determination that potential impacts have been avoided to the maximum extent practicable; remaining unavoidable impacts will then be mitigated to the extent appropriate and practicable by requiring steps to minimize impacts and, finally, compensate for aquatic resource values. This sequence is considered satisfied where the proposed mitigation is in accordance with specific provisions of a Corps and EPA approved comprehensive plan that ensures compliance with the compensation requirements of the 404(b)(1) Guidelines (examples of such comprehensive plans may include Special Area Management Plans, Advance Identification areas (Section 230.80), and State Coastal Zone Management Plans).

In general, DEQ recommends that the amount of stream and wetland impacts be avoided to the maximum extent practicable. For unavoidable impacts, DEQ

## Comments from the Virginia Office of Environmental Impact Review (cont.):



encourages the following practices to minimize the impacts to wetlands and waterways:

- operation of machinery and construction vehicles outside of stream-beds and wetlands;
- use of synthetic mats when in-stream work is unavoidable;
- stockpiling of material excavated from the trench for replacement if directional drilling is not feasible; and
- preservation of the top 12 inches of trench material removed from wetlands for use as wetland seed and root stock in the excavated area.

For any future development related to the proposed project with potential water quality or wetland impacts, contact VMRC at (757) 247-2200 for a JPA.

**2. Subaqueous Lands Impacts**. The Virginia Marine Resources Commission (VMRC), pursuant to Chapter 12 of Title 28.2 of the Code of Virginia, is responsible for issuing permits for encroachments in, on, or over State-owned submerged lands throughout the Commonwealth. Accordingly, if any portion of future development projects involves any encroachments channelward of ordinary high water along natural rivers and streams, a permit may be required from VMRC.

The Virginia Marine Resources Commission serves as the clearinghouse for the Joint Permit Application (JPA) used by the:

- U.S. Army Corps of Engineers (Corps) for issuing permits pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act;
- DEQ for issuance of a Virginia Water Protection Permit;
- VMRC for encroachments on or over state-owned subaqueous beds as well as tidal wetlands; and
- local wetlands board for impacts to wetlands.

For any future development related to the proposed project with potential impacts to subaqueous lands, water quality, or wetland impacts, contact VMRC at (757) 247-2200 for a JPA. VMRC will distribute the application to the appropriate agencies. Each agency will conduct its review and respond.

**3. Erosion and Sediment Control and Stormwater Management.** According to available guidance from the Department of Conservation and Recreation's (DCR's) Division of Soil and Water Conservation (DSWC), federal agencies and their authorized agents conducting regulated land disturbing activities on private and public lands in the state must comply with the Virginia Erosion and Sediment Control Law and Regulations (VESCL&R), Virginia Stormwater Management Law and Regulations (VSWML&R), and other applicable federal nonpoint source pollution mandates (e.g. Clean Water Act Section 313, Federal Consistency under the Coastal Zone Management Act). Clearing

## Comments from the Virginia Office of Environmental Impact Review (cont.):



and grading activities, installation of staging areas, parking lots, roads, buildings, utilities, or other structures, soil/dredge spoil areas, or related land conversion activities that disturb 2,500 square feet or more in Chesapeake Bay Preservation Areas would be regulated by VESCL&R and those that disturb one acre or greater would be covered by VSWML&R. Accordingly, NASA should prepare and implement erosion and sediment control (ESC) and stormwater management (SWM) plans to ensure compliance with state law. NASA is ultimately responsible for achieving project compliance through oversight of on-site contractors, regular field inspection, prompt action against non-compliant sites, and/or other mechanisms, consistent with agency policy.

Furthermore, DCR is responsible for the issuance, denial, revocation, termination and enforcement of Virginia Pollutant Discharge Elimination System (VPDES) permits for the control of stormwater discharges from municipal separate storm sewer systems (MS4s) and land disturbing activities under the Virginia Stormwater Management Program. Therefore, for projects involving land disturbing activities of 2,500 square feet or more, the property owner/authorized agent is required to apply for registration coverage under the General Permit for Discharges of Stormwater from Construction Activities. General information and registration forms for the General Permit are available on DCR's website at: http://www.dcr.virginia.gov/sw/vsmp.htm#geninfo.

**4. Chesapeake Bay Preservation Areas.** According to available guidance from DCR's Division of Chesapeake Bay Local Assistance (DCBLA), while Chesapeake Bay Preservation Areas are not locally designated on federal lands, NASA must ensure any future development is consistent with the provisions of the *Chesapeake Bay Preservation Area Designation and Management Regulations*, (Regulations) § 9 VAC 10-20-10 et seq., as one of the enforceable policies of Virginia's Coastal Resources Management Program (VCP). In accordance with the Federal consistency requirements of the Coastal Zone Management Act (CZMA), Federal actions on installations located within Tidewater Virginia are required to be consistent with the performance criteria of the Regulations on lands analogous to locally designated Chesapeake Bay Preservation Areas.

The Chesapeake Bay Preservation Act along with the Chesapeake Bay Preservation Area Designation and Management Regulations (Regulations) (§9 VAC 10-20-110), as locally implemented by the City of Hampton, strictly controls land disturbance in:

- tidal wetlands;
- non-tidal wetlands connected by surface flow and contiguous to tidal wetlands or perennial water bodies:
- tidal shores;
- highly erodible soils; and
- within a 100-foot vegetated buffer area located adjacent to and landward of the aforementioned features and along both sides of any water body with perennial flow that are within the Chesapeake Bay watershed (i.e. Resource Protection Areas or RPAs).

## Comments from the Virginia Office of Environmental Impact Review (cont.):

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The area 100 feet landward of RPAs (i.e. Resource Management Areas or RMAs) is subject to the City of Hampton's less stringent performance criteria. The performance criteria for RMAs include:

- minimizing land disturbance;
- preserving indigenous vegetation;
- minimizing impervious surfaces;
- controlling stormwater runoff quality; and
- developing erosion and sediment control plans for land disturbances greater than 2,500 square feet.

Prior to construction of any future projects, an individual site plan, description and consistency analysis for each project must be submitted to DEQ for consistency review under the federal Coastal Zone Management Act (CZMA). A consistency determination must be conducted for each project. For further information, contact Alice Baird, DCR-DCBLA at (804) 225-2307.

**5. Air Pollution Control.** Please note that the LaRC is located in the Hampton Roads ozone ($O_3$) maintenance area and an emission control area for the contributors to ozone pollution, which are volatile organic compounds (VOCs) and oxides of nitrogen ($NO_x$). This has two practical consequences for any future development or expansion of the facility. One is that the NASA should take all reasonable precautions to limit emissions of VOCs and $NO_x$, principally by controlling or limiting the burning of fossil fuels. A second precaution, stemming from 9 VAC 5-40-5490 in the Regulations for the Control and Abatement of Air Pollution, is that there are some limitations on the use of "cut-back" (liquefied asphalt cement, blended with petroleum solvents) that may apply in the construction of roads and parking areas associated with the project. The asphalt must be "emulsified" (predominantly cement and water with a small amount of emulsifying agent) except when specified circumstances apply. Moreover, there are time-of-year restrictions on its use during the months of April through October in VOC emission control areas.

During construction, fugitive dust must be kept to a minimum by using control methods outlined in 9 VAC 5-50-60 et seq. of the Regulations for the Control and Abatement of Air Pollution. These precautions include, but are not limited to, the following:

- Use, where possible, of water or chemicals for dust control;
- Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials;
- Covering of open equipment for conveying materials; and
- Prompt removal of spilled or tracked dirt or other materials from paved streets and removal of dried sediments resulting from soil erosion.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

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If project activities include the burning of construction or demolition material, this activity must meet the requirements under 9 VAC 5-40-5600 et seq. of the Regulations for open burning, and it may require a permit. The Regulations provide for, but do not require, the local adoption of a model ordinance concerning open burning. NASA should contact the City of Hampton officials to determine what local requirements, if any, exist.

**6. Solid and Hazardous Wastes and Hazardous Materials.** Any soil that is suspected of contamination or wastes that are generated for any future development must be tested and disposed of in accordance with applicable Federal, State, and local laws and regulations. Some of the applicable State laws and regulations are:

- Virginia Waste Management Act (Code of Virginia Section 10.1-1400 et seq.);
- Virginia Hazardous Waste Management Regulations (VHWMR) (9VAC 20-60);
- Virginia Solid Waste Management Regulations (VSWMR) (9VAC 20-80); and
- Virginia Regulations for the Transportation of Hazardous Materials (9VAC 20-110).

Some of the applicable Federal laws and regulations are:

- the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. Section 6901 et seq. and the applicable regulations contained in Title 40 of the Code of Federal Regulations); and
- the U.S. Department of Transportation Rules for Transportation of Hazardous materials (49 CFR Part 107).

Also, any structures that are to be demolished, renovated, or removed should be checked for asbestos-containing materials (ACM) and lead-based paint prior to demolition. If ACM or LBP are found, in addition to the federal waste-related regulations mentioned above, State regulations 9VAC 20-80-640 for ACM and 9VAC 20-60-261 for LBP must be followed.

- *Asbestos Materials*. It is the responsibility of the owner or operator of a renovation or demolition activity, prior to the commencement of the renovation or demolition, to thoroughly inspect the affected part of the facility where the operation will occur for the presence of asbestos, including Category I and Category II nonfriable asbestos containing material (ACM). Upon classification as friable or non-friable, all waste ACM shall be disposed of in accordance with the Virginia Solid Waste Management Regulations (9 VAC 20-80-640), and transported in accordance with the Virginia regulations governing Transportation of Hazardous Materials (9 VAC 20-110-10 et seq.). Contact the DEQ Waste Management Program for additional information, (804) 698-4021, and the Department of Labor and Industry, Ronald L. Graham at (804) 371-0444.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

Page 8

- *Lead-Based Paint.* If applicable, the proposed project must comply with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations, and with the Virginia Lead-Based Paint Activities Rules and Regulations. For additional information regarding these requirements contact the Department of Professional and Occupational Regulation, David Dick at (804) 367-8588.

Please note that DEQ encourages all construction projects and facilities to implement pollution prevention principles, including the reduction, reuse, and recycling of all solid wastes generated. All generation of hazardous wastes should be minimized and handled appropriately. For more information contact Paul Kohler, DEQ Waste Division, at (804) 698-4208.

**7. Petroleum Storage Tanks**. The NASA Langley Research Center (CEDS Facility # 5001411) currently operates 5 regulated underground storage tanks (USTs) and 9 regulated aboveground storage tanks (ASTs) for the storage and dispensing of various petroleum products including gasoline, diesel fuel, heating oil, etc. It is not clear from the DPEIS whether any regulated USTs or ASTs would be impacted by the re-use of some facilities at NASA Langley. It is advised that the removal or disturbance of any regulated UST or AST currently in use be reported to the DEQ Tidewater Regional Office.

There have been 6 petroleum releases reported at the west area of LaRC, all of which are closed cases. The east area of LaRC is located on Langley Air Force Base (LaAFB). There have been 3 petroleum releases reported at LaAFB which are adjacent to the east area of LaRC. These closed cases include PC#s 1990-1239, 1993-0927, and 1998-2368.

If evidence of a petroleum release is discovered during any future construction that may occur at LaRC, it must be reported to DEQ. Contact Rebecca Gehring, DEQ-TRO at (757) 518-2190 or Gene Siudyla, DEQ-TRO at (757) 518-2117. Petroleum contaminated soils and ground water must be characterized and disposed of properly.

For any future construction that includes the use of portable AST storage (>660 gallons) for equipment fuel, the tank(s) must be registered with DEQ using AST Registration form 7540-AST. Any questions concerning UST or AST registration may be directed to Tom Madigan, DEQ-TRO (757) 518-2115 or temadigan@deq.virginia.gov.

**8. Pesticides.** DEQ recommends that the use of herbicides or pesticides for construction or landscape maintenance should be in accordance with the principles of integrated pest management. The least toxic pesticides that are effective in controlling the target species should be used. Please contact the Department of Agriculture and Consumer Services at (804) 786-3501 for more information.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

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**9. Natural Heritage Resources.** The Department of Conservation and Recreation's Division of Natural Heritage (DNH) can search its Biotics Data System (BDS) for occurrences of natural heritage resources in the area of any future construction related to this proposal. Natural heritage resources are defined as the habitat of rare, threatened, or endangered animal and plant species, unique or exemplary natural communities, and significant geologic communities.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the Department of Conservation and Recreation (DCR), DCR has the authority to report for VDACS on state-listed plant and insect species. We recommend that the DNH be contacted at (804) 786-7951, to secure updated information on natural heritage resources, prior to construction, should any construction or expansion occur in the future as a result of program activities.

**10. Wildlife Resources.** The Department of Game and Inland Fisheries (DGIF), as the Commonwealth's wildlife and freshwater fish management agency, exercises enforcement and regulatory jurisdiction over wildlife and freshwater fish, including state or federally listed endangered or threatened species, but excluding listed insects (*Virginia Code* Title 29.1). DGIF is a consulting agency under the U.S. Fish and Wildlife Coordination Act (16 U.S.C. sections 661 et seq.), and provides environmental analysis of projects or permit applications coordinated through DEQ and several other state and federal agencies. DGIF determines likely impacts upon fish and wildlife resources and habitat, and recommends appropriate measures to avoid, reduce, or compensate for those impacts.

DGIF maintains an online database, the Virginia Fish and Wildlife Information Service (VAFWIS), that contains up-to-date information on fish and wildlife resources, including threatened and endangered species. Basic access to this database is available via DGIF's website (http://vafwis.org/WIS/ASP/default.asp). DGIF recommends use of VAFWIS during the initial environmental review of any project. A greater level of access to the VAFWIS is available with a subscription. Alternatively, applicants can request a formal review by VAFWIS staff. For more information on this service, contact Shirl Dressler at (804) 367-6913. For additional information and coordination, contact Amy Ewing, DGIF, at (804) 367-2211.

**11. Forest Resources.** In order to protect trees not slated for removal from the effects of any future program construction, NASA should mark and fence them at least to the dripline or the end of the root system, whichever extends farther from the tree stem. Marking should be done with highly visible ribbon so that equipment operators see the protected areas easily. The parking, stacking, and moving of heavy equipment and construction materials near trees can damage root systems by compacting the soil. Soil compaction, from weight or vibration, affects root growth, water and nutrient uptake, and gas exchange. If parking and stacking are unavoidable, NASA should use

## Comments from the Virginia Office of Environmental Impact Review (cont.):

Page 10

temporary crossing bridges or mats to minimize soil compaction and mechanical injury to plants.

Any stockpiling of soil should take place away from trees. Piling soil at a tree stem can kill the root system of the tree. Soil stockpiles should be covered, as well, to prevent soil erosion and fugitive dust. Questions on tree protection may be directed to the Department of Forestry, Todd Groh, at (434) 220-9044.

**12. Historic Structures and Archaeological Resources.** NASA, as a federal agency, must consider the effects of its actions on historic properties listed in or eligible for the National Register of Historic Places and provide the Advisory Council on Historic Preservation the opportunity to comment in accordance with Sections 106 of the National Historic Preservation Act, as amended, and its implementing regulation 36 CFR 800. The Section 106 review process begins when NASA provides a description of the undertaking and its Area of Potential Effect (APE) to the State Historic Preservation Officer (SHPO), which in Virginia is DHR. NASA must consult directly with DHR on this undertaking.

For any future submissions 36 CFR 800.8 allows federal agencies to coordinate Section 106 compliance during the National Environmental Policy Act (NEPA) review process. However, NASA must inform the SHPO (DHR) early in the process that it intends to do so. NASA must also ensure that the environmental documentation prepared under NEPA presents information about historic properties and potential effects to such resources at a level of detail that allows the SHPO and other consulting parties to comment. For additional information and coordination, contact Ethel Eaton, DHR, at (804) 367-2323, Ext. 112.

**Federal Consistency under the Coastal Zone Management Act**

Pursuant to the Coastal Zone Management Act of 1972, as amended, prior to initiating activities, NASA LaRC is required to determine the consistency of its activities affecting Virginia's coastal resources or coastal uses with the Virginia Coastal Resources Management Program (see section 307(c)(1) of the Act and 15 CFR Part 930, sub-part C, section 930.34). This involves an analysis of the activities in light of the Enforceable Policies of the VCP (see attached), and submission of a consistency determination reflecting that analysis and committing NASA LaRC's actions to be consistent with the Enforceable Policies. We encourage NASA to consider the Advisory Policies of the VCP as well (Attachment 2).

The DPEIS did not contain a consistency determination for the project. This determination may be provided as part of the final PEIS concluding the NEPA process, or independently, depending on your agency's preference. A consistency determination for each proposed project must be submitted to DEQ for coordinated review prior to construction. Section 930.39 gives content requirements for the consistency

## Comments from the Virginia Office of Environmental Impact Review (cont.):

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determination, or you may visit the DEQ Website at, http://www.deq.state.va.us/eir/federal.html.

Thank you for the opportunity to review the Draft Constellation Programmatic Environmental Impact Statement. Detailed comments of reviewing agencies are attached for your review. Please contact me at (804) 698-4325 or John Fisher at (804) 698-4339 for clarification of these comments.

Sincerely,

Ellie Irons

Ellie Irons, Manager
Office of Environmental Impact Review

Enclosures

cc: Paul Kohler, DEQ-ORP
Michelle Hollis, DEQ-TRO
Tony Watkinson, VMRC
Amy Ewing, DGIF
Robbie Rhur, DCR
Keith R. Tignor, VDACS
Todd Groh, DOF
Matt Heller, DMME
Ethel Eaton, DHR
Mary Stanley, VDOT
Brian Ballard, City of Hampton
Arthur Collins, Hampton Roads PDC

## Comments from the Virginia Office of Environmental Impact Review (cont.):

COMMONWEALTH *of* VIRGINIA

L. Preston Bryant, Jr.
Secretary of Natural Resources

*DEPARTMENT OF ENVIRONMENTAL QUALITY*
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Director

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Attachment 1

**Enforceable Regulatory Programs comprising Virginia's Coastal Resources Management Program (VCP)**

a. Fisheries Management - The program stresses the conservation and enhancement of finfish and shellfish resources and the promotion of commercial and recreational fisheries to maximize food production and recreational opportunities. This program is administered by the Marine Resources Commission (VMRC); Virginia Code 28.2-200 to 28.2-713 and the Department of Game and Inland Fisheries (DGIF); Virginia Code 29.1-100 to 29.1-570.

The State Tributyltin (TBT) Regulatory Program has been added to the Fisheries Management program. The General Assembly amended the Virginia Pesticide Use and Application Act as it related to the possession, sale, or use of marine antifoulant paints containing TBT. The use of TBT in boat paint constitutes a serious threat to important marine animal species. The TBT program monitors boating activities and boat painting activities to ensure compliance with TBT regulations promulgated pursuant to the amendment. The VMRC, DGIF, and Virginia Department of Agriculture Consumer Services (VDACS) share enforcement responsibilities; Virginia Code 3.1-249.59 to 3.1-249.62.

b. Subaqueous Lands Management - The management program for subaqueous lands establishes conditions for granting or denying permits to use state-owned bottomlands based on considerations of potential effects on marine and fisheries resources, tidal wetlands, adjacent or nearby properties, anticipated public and private benefits, and water quality standards established by the Department of Environmental Quality (DEQ). The program is administered by the Marine Resources Commission; Virginia Code 28.2-1200 to 28.2-1213.

c. Wetlands Management - The purpose of the wetlands management program is to preserve wetlands, prevent their despoliation, and accommodate economic development in a manner consistent with wetlands preservation.

(1) The tidal wetlands program is administered by the Marine Resources Commission; Virginia Code 28.2-1301 through 28.2-1320.

(2) The Virginia Water Protection Permit program administered by DEQ includes protection of wetlands --both tidal and non-tidal; Virginia Code §62.1-44.15:5 and Water Quality Certification pursuant to Section 401 of the Clean Water Act.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

Attachment 1 continued

Page 2

d. Dunes Management - Dune protection is carried out pursuant to The Coastal Primary Sand Dune Protection Act and is intended to prevent destruction or alteration of primary dunes. This program is administered by the Marine Resources Commission; Virginia Code 28.2-1400 through 28.2-1420.

e. Non-point Source Pollution Control – (1) Virginia's Erosion and Sediment Control Law requires soil-disturbing projects to be designed to reduce soil erosion and to decrease inputs of chemical nutrients and sediments to the Chesapeake Bay, its tributaries, and other rivers and waters of the Commonwealth. This program is administered by the Department of Conservation and Recreation; Virginia Code 10.1-560 et.seq.).

(2) Coastal Lands Management is a state-local cooperative program administered by the DCR's Division of Chesapeake Bay Local Assistance and 84 localities in Tidewater (see i) Virginia; Virginia Code §10.1-2100 –10.1-2114 and 9 VAC10-20 et seq.

f. Point Source Pollution Control - The point source program is administered by the State Water Control Board (DEQ) pursuant to Virginia Code 62.1-44.15. Point source pollution control is accomplished through the implementation of:

(1) the National Pollutant Discharge Elimination System (NPDES) permit program established pursuant to Section 402 of the federal Clean Water Act and administered in Virginia as the Virginia Pollutant Discharge Elimination System (VPDES) permit program.

(2) The Virginia Water Protection Permit (VWPP) program administered by DEQ; Virginia Code §62.1-44.15:5 and Water Quality Certification pursuant to Section 401 of the Clean Water Act.

g. Shoreline Sanitation - The purpose of this program is to regulate the installation of septic tanks, set standards concerning soil types suitable for septic tanks, and specify minimum distances that tanks must be placed away from streams, rivers, and other waters of the Commonwealth. This program is administered by the Department of Health (Virginia Code 32.1-164 through 32.1-165).

h. Air Pollution Control - The program implements the federal Clean Air Act to provide a legally enforceable State Implementation Plan for the attainment and maintenance of the National Ambient Air Quality Standards. This program is administered by the State Air Pollution Control Board (Virginia Code 10-1.1300 through §10.1-1320).

(i) Coastal Lands Management is a state-local cooperative program administered by the DCR's Division of Chesapeake Bay Local Assistance and 84 localities in Tidewater, Virginia established pursuant to the Chesapeake Bay Preservation Act; Virginia Code §10.1-2100 –10.1-2114 and Chesapeake Bay Preservation Area Designation and Management Regulations; Virginia Administrative Code 9 VAC10-20 et seq.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

Attachment 2

**Advisory Policies for Geographic Areas of Particular Concern**

a. Coastal Natural Resource Areas - These areas are vital to estuarine and marine ecosystems and/or are of great importance to areas immediately inland of the shoreline. Such areas receive special attention from the Commonwealth because of their conservation, recreational, ecological, and aesthetic values. These areas are worthy of special consideration in any planning or resources management process and include the following resources:

a) Wetlands
b) Aquatic Spawning, Nursery, and Feeding Grounds
c) Coastal Primary Sand Dunes
d) Barrier Islands
e) Significant Wildlife Habitat Areas
f) Public Recreation Areas
g) Sand and Gravel Resources
h) Underwater Historic Sites.

b. Coastal Natural Hazard Areas - This policy covers areas vulnerable to continuing and severe erosion and areas susceptible to potential damage from wind, tidal, and storm related events including flooding. New buildings and other structures should be designed and sited to minimize the potential for property damage due to storms or shoreline erosion. The areas of concern are as follows:

i) Highly Erodible Areas
ii) Coastal High Hazard Areas, including flood plains.

c. Waterfront Development Areas - These areas are vital to the Commonwealth because of the limited number of areas suitable for waterfront activities. The areas of concern are as follows:

i) Commercial Ports
ii) Commercial Fishing Piers
iii) Community Waterfronts

Although the management of such areas is the responsibility of local government and some regional authorities, designation of these areas as Waterfront Development Areas of Particular Concern (APC) under the VCRMP is encouraged. Designation will allow the use of federal CZMA funds to be used to assist planning for such areas and the implementation of such plans. The VCRMP recognizes two broad classes of priority uses for waterfront development APC:

i) water access dependent activities;
ii) activities significantly enhanced by the waterfront location and complementary to other existing and/or planned activities in a given waterfront area.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

**Advisory Policies for Shorefront Access Planning and Protection**

a. Virginia Public Beaches - Approximately 25 miles of public beaches are located in the cities, counties, and towns of Virginia exclusive of public beaches on state and federal land. These public shoreline areas will be maintained to allow public access to recreational resources.

b. Virginia Outdoors Plan - Planning for coastal access is provided by the Department of Conservation and Recreation in cooperation with other state and local government agencies. The Virginia Outdoors Plan (VOP), which is published by the Department, identifies recreational facilities in the Commonwealth that provide recreational access. The VOP also serves to identify future needs of the Commonwealth in relation to the provision of recreational opportunities and shoreline access. Prior to initiating any project, consideration should be given to the proximity of the project site to recreational resources identified in the VOP.

c. Parks, Natural Areas, and Wildlife Management Areas - Parks, Wildlife Management Areas, and Natural Areas are provided for the recreational pleasure of the citizens of the Commonwealth and the nation by local, state, and federal agencies. The recreational values of these areas should be protected and maintained.

d. Waterfront Recreational Land Acquisition - It is the policy of the Commonwealth to protect areas, properties, lands, or any estate or interest therein, of scenic beauty, recreational utility, historical interest, or unusual features which may be acquired, preserved, and maintained for the citizens of the Commonwealth.

e. Waterfront Recreational Facilities - This policy applies to the provision of boat ramps, public landings, and bridges which provide water access to the citizens of the Commonwealth. These facilities shall be designed, constructed, and maintained to provide points of water access when and where practicable.

f. Waterfront Historic Properties - The Commonwealth has a long history of settlement and development, and much of that history has involved both shorelines and near-shore areas. The protection and preservation of historic shorefront properties is primarily the responsibility of the Department of Historic Resources. Buildings, structures, and sites of historical, architectural, and/or archaeological interest are significant resources for the citizens of the Commonwealth. It is the policy of the Commonwealth and the VCRMP to enhance the protection of buildings, structures, and sites of historical, architectural, and archaeological significance from damage or destruction when practicable.

# Comments from the Virginia Office of Environmental Impact Review (cont.):

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
**TIDEWATER REGIONAL OFFICE**
**ENVIRONMENTAL IMPACT REVIEW COMMENTS**

**September 11, 2007**

**PROJECT NUMBER:** **07-143F**

**PROJECT TITLE:** Constellation

As Requested, TRO staff has reviewed the supplied information and has the following comments:

**Petroleum Storage Tank Cleanups:**
This proposed project will include use of existing facilities located at both the west and east areas of NASA Langley Research Center (LaRC). The draft EIS did not provide any details of proposed construction at the existing facilities. There have been 6 petroleum releases reported at the west area of LaRC, all of which are closed cases (see Figure 3-16). The east area of LaRC is located on Langley Air Force Base (LaAFB) (see Figure 3-17). There have been 3 petroleum releases reported at LaAFB which are adjacent to the east area of LaRC. These closed cases include PC#s 1990-1239, 1993-0927, and 1998-2368. If evidence of a petroleum release is discovered during construction of this project, it must be reported to DEQ. Contact Ms. Rebecca Gehring at (757) 518-2190 or Mr. Gene Siudyla at (757) 518-2117. Petroleum contaminated soils and ground water generated during construction of this project must be properly characterized and disposed of properly.

**Petroleum Storage Tank Compliance/Inspections:**
The proposed Constellation facility in the Tidewater Region, NASA Langley Research Center, (CEDS Facility # 5001411) currently operates 5 regulated underground storage tanks (USTs) and 9 regulated aboveground storage tanks (ASTs) for the storage and dispensing of various petroleum products including gasoline, diesel fuel, heating oil, etc. It is not clear from the EIS whether any regulated USTs or ASTs would be impacted by the re-use of some facilities at NASA Langley. It is advised that the removal or disturbance of any regulated UST or AST currently in use be reported to the DEQ Tidewater Regional Office (see contact information below)

In addition to the above, if the construction of this project will include the use of portable AST storage (>660 gallons) for equipment fuel, the tank or tanks must be registered with DEQ using AST Registration form 7540-AST. This form is available at the **DEQ web site (deq.virginia.gov)** under "petroleum programs, download library, AST registration forms". Once the registration form is completed, it should be mailed to the DEQ address on the form along with the appropriate registration fee (also listed on the form). **Any questions concerning UST or AST registration should be directed to "Tom Madigan" at the Tidewater Regional Office 5636 Southern Boulevard, Virginia Beach, VA 23462, (757) 518-2115 or by e-mail at temadigan@deq.virginia.gov**

**Virginia Water Protection Permit Program (VWPP):**
No comments

**Air Permit Program :**
No comments.

1 of 2

## Comments from the Virginia Office of Environmental Impact Review (cont.):

DEPARTMENT OF ENVIRONMENTAL QUALITY
TIDEWATER REGIONAL OFFICE
ENVIRONMENTAL IMPACT REVIEW COMMENTS

September 11, 2007

**PROJECT NUMBER:** 07-143F

**PROJECT TITLE:** Constellation

**Water Permit Program :**
Comment on this document is limited to the NASA Langley facility only. No permits under the jurisdiction of the DEQ/TRO Water Permit Section are required for the activities described in this document.

**Waste Permit Program :**
Comment on this document is limited to the NASA Langley facility only. The document recognizes the need to manage waste in accordance with the Virginia Hazardous Waste Management Program and the Virginia Solid Waste Management Program. Based on the management program presented it appears no waste management permits are required.

The staff from the Tidewater Regional Office thanks you for the opportunity to provide comments.

Sincerely,

Michelle R. Hollis
Environmental Specialist
5636 Southern Blvd.
VA Beach, VA 23462
(757) 518-2146
(757) 518-2009 Fax
mrhollis@deq.virginia.gov

2 of 2

## Comments from the Virginia Office of Environmental Impact Review (cont.):

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
**DIVISION OF AIR PROGRAM COORDINATION**

**ENVIRONMENTAL REVIEW COMMENTS APPLICABLE TO AIR QUALITY**

**TO: John E. Fisher** **DEQ - OEIA PROJECT NUMBER: 07 – 143F**

**PROJECT TYPE:** ☐ STATE EA / EIR **X FEDERAL EA / EIS** ☐ SCC

☐ CONSISTENCY DETERMINATION/CERTIFICATION

RECEIVED
AUG 3 1 2007
DEQ-Office of Environmental Impact Review

**PROJECT TITLE: CONSTELLATION**

**PROJECT SPONSOR: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

**PROJECT LOCATION: X OZONE MAINTENANCE AREA**

**REGULATORY REQUIREMENTSMAY BE APPLICABLE TO:** **X CONSTRUCTION**
**X OPERATION**

**STATE AIR POLLUTION CONTROL BOARD REGULATIONS THAT MAY APPLY:**

1. ☐ 9 VAC 5-40-5200 C & 9 VAC 5-40-5220 E – STAGE I
2. ☐ 9 VAC 5-40-5200 C & 9 VAC 5-40-5220 F – STAGE II Vapor Recovery
3. ☐ 9 VAC 5-40-5490 et seq. – Asphalt Paving operations
4. **X 9 VAC 5-40-5600 et seq. – Open Burning**
5. **X 9 VAC 5-50-60 et seq. Fugitive Dust Emissions**
6. ☐ 9 VAC 5-50-130 et seq. - Odorous Emissions; Applicable to____________________
7. ☐ 9 VAC 5-50-160 et seq. – Standards of Performance for Toxic Pollutants
8. ☐ 9 VAC 5-50-400 Subpart_____, Standards of Performance for New Stationary Sources, designates standards of performance for the____________________________
9. ☐ 9 VAC 5-80-10 et seq. of the regulations – Permits for Stationary Sources
10. ☐ 9 VAC 5-80-1700 et seq. Of the regulations – Major or Modified Sources located in PSD areas. This rule may be applicable to the ____________________________
11. ☐ 9 VAC 5-80-2000 et seq. of the regulations – New and modified sources located in non-attainment areas
12. ☐ 9 VAC 5-80-800 et seq. Of the regulations – Operating Permits and exemptions. This rule may be applicable to ______________________________________________

**COMMENTS SPECIFIC TO THE PROJECT:**

**Being in an ozone maintenance area, all precautions are necessary to restrict the emissions of volatile organic compounds (VOC) and oxides of nitrogen ($NO_X$) during the proposed activities at Langley Research Center.**

K.S. Narasimhan

**(Kotur S. Narasimhan)**
**Office of Air Data Analysis**

**DATE: August 31, 2007**

## Comments from the Virginia Office of Environmental Impact Review (cont.):

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

RECEIVED
SEP 18 2007
DEQ-Office of Environmental Impact Review

**MEMORANDUM**

**TO:** John Fisher, Environmental Program Planner

PWK

**FROM:** Paul Kohler, Waste Division Environmental Review Coordinator

**DATE:** September 18, 2007

**COPIES:** Sanjay Thirunagari, Waste Division Environmental Review Manager; file

**SUBJECT:** Environmental Impact Report; Constellation; DEQ Project Code 07-143F

The Waste Division has completed its review of the Consistency Determination report for the Constellation project in Hampton, Virginia. We have the following comments concerning the waste issues associated with this project:

This is a multi-state project and the scope is extensive. For each area in Virginia where any work is to take place, the applicant needs to conduct an environmental investigation on and near the property to identify any solid or hazardous waste sites or issues before work can commence. This investigation should include a search of waste-related databases. Please see the attached page regarding this database search. A GPS database search was conducted but did not reveal any waste sites that would impact or be impacted by the subject site. Paul Herman of DEQ's Federal Facility program was consulted for his comments and he will respond in a separate memo if he has additional comments.

Any soil that is suspected of contamination or wastes that are generated must be tested and disposed of in accordance with applicable Federal, State, and local laws and regulations. Some of the applicable state laws and regulations are: Virginia Waste Management Act, Code of Virginia Section 10.1-1400 *et seq.*; Virginia Hazardous Waste Management Regulations (VHWMR) (9VAC 20-60); Virginia Solid Waste Management Regulations (VSWMR) (9VAC 20-80); Virginia Regulations for the Transportation of Hazardous Materials (9VAC 20-110). Some of the applicable Federal laws and regulations are: the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Section 6901 *et seq.*, and the applicable regulations contained in Title 40 of the Code of Federal Regulations; and the U.S. Department of Transportation Rules for Transportation of Hazardous materials, 49 CFR Part 107.

Also, structures to be demolished should be checked for asbestos-containing materials (ACM) and lead-based paint (LBP) prior to demolition. If ACM or LBP are found, in addition to the federal waste-related regulations mentioned above, State regulations 9VAC 20-80-640 for ACM and 9VAC 20-60-261 for LBP must be followed.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

Please note that DEQ encourages all construction projects and facilities to implement pollution prevention principles, including the reduction, reuse, and recycling of all solid wastes generated. All generation of hazardous wastes should be minimized and handled appropriately.

If you have any questions or need further information, please contact Paul Kohler at (804) 698-4208.

Attachment: Waste Information

# Comments from the Virginia Office of Environmental Impact Review (cont.):

## Waste Information

There are four Waste Division databases that are to be used to complete this review. These are the Solid Waste Database, CERCLA Facilities, Voluntary Remediation Program, and Hazardous Waste Facilities databases.

**The Solid Waste Database**
A list of active solid waste facilities in Virginia.

**CERCLA Facilities Database**
A list of active and archived CERCLA (EPA Superfund Program) sites.

**Hazardous Waste Facilities Database**
A list of hazardous waste generators, hazardous waste transporters, and hazardous waste storage and disposal facilities. Data for the CERCLA Facilities and Hazardous Waste Facilities databases are periodically downloaded by the Waste Division from U.S. EPA's website.

**Accessing the DEQ Databases:**
The report author should access this information on the DEQ website at http://www.deq.state.va.us/waste/waste.html . Scroll down to the databases which are listed under Real Estate Search Information heading.

The ***solid waste information*** can be accessed by clicking on the Solid Waste Database tab and opening the file. Type the county or city name and the word County or City, and click the Preview tab. All active solid waste facilities in that locality will be listed.

The ***Superfund information*** will be listed by clicking on the Search EPA's CERCLIS database tab and opening the file. Click on the locality box, click on sort, then click on Datasheet View. Scroll to the locality of interest.

The ***hazardous waste*** information can be accessed by clicking on the Hazardous Waste Facility tab. Go to the Geography Search section and fill in the name of the city or county and VA in the state block, and hit enter. The hazardous waste facilities in the locality will be listed.

The ***Voluntary Remediation Program*** GPS database can be accessed by clicking on "Voluntary Remediation," then "What's in my backyard" in the center shaded area, and then under "Mapping Applications," click on "What's in my backyard" again.

This database search will include most waste-related site information for each locality. In many cases, especially when the project is located in an urban area, the database output for that locality will be extensive.

## Comments from the Virginia Office of Environmental Impact Review (cont.):

09/25/2007 14:43 FAX 001/001

HAMPTON ROADS
PLANNING DISTRICT COMMISSION



September 13, 2007

Mr. John E. Fisher
Department of Environmental Quality
Office of Environmental Impact Review
629 East Main Street, Sixth Floor
Richmond, Virginia 23219

Re: Constellation DEQ 07-143F (ENV:GEN)

Dear Mr. Fisher:

Pursuant to your request of August 22, 2007, the staff of the Hampton Roads Planning District Commission has reviewed the Draft Environmental Impact Statement for the proposed Constellation program at the National Aeronautics and Space Administration We have contacted the City of Hampton regarding the project.

Based on this review, the project is generally consistent with local and regional plans and policies. In addition, the City of Hampton notes that the project may help to bring new research activity to NASA Langley.

We appreciate the opportunity to review this project. If you have any questions, please do not hesitate to call.

Sincerely,

Arthur L. Collins

Arthur L. Collins
Executive Director/Secretary

MLJ/fh

Copies: Mr. James Freas, HA

MAILED
SEP 18 2007
HRPDC

HEADQUARTERS • THE REGIONAL BUILDING • 723 WOODLAKE DRIVE • CHESAPEAKE, VIRGINIA 23320 • (757) 420-8300
PENINSULA OFFICE • 2101 EXECUTIVE DRIVE • SUITE C • HAMPTON, VIRGINIA 23666 • (757) 262-0094

**Response to comments from the Virginia Office of Environmental Impact Review:**

Thank you for your comments.

In response to the comment, "The DPEIS did not contain a consistency determination for the project. This determination may be provided as part of the final PEIS concluding the NEPA process…", the following paragraph has been added to Section 3.1.7.1 in the Final PEIS:

"LaRC is located within the "coastal zone" as defined under the Virginia Department of Environmental Quality Virginia Coastal Zone Management Program. Under the Virginia Coastal Resources Management Program a network of state agencies and local governments administer enforceable laws, regulations, and policies in the following areas: tidal and nontidal wetlands, fisheries, subaqueous lands, dunes and beaches, point source air pollution, point source water pollution, nonpoint source water pollution, shoreline sanitation, and coastal lands. All Federal actions and programs that directly affect Virginia's coastal zone must be carried out in a manner that is consistent with the enforceable policies comprising Virginia's Coastal Resources Management Program. Virginia Department of Environmental Quality Office of Environmental Impact Review may review Federal projects for consistency with enforceable policies during the NEPA process. Not all of these enforceable programs are applicable to the Proposed Action."

In addition, the following paragraph has been added in Section 4.1.1.7.1:

"LaRC is located within the "coastal zone" as defined under the Virginia Department of Environmental Quality's Virginia Coastal Resources Management Program. Therefore, the proposed activities under the Constellation Program must be consistent with the Virginia Coastal Resources Management Program's enforceable policies regarding coastal resources. Given the location and nature of activities to be conducted at LaRC under the Proposed Action, the following enforceable policies would not be applicable: fisheries, subaqueous land, wetlands, dunes and beaches, and shoreline sanitation. Pollution control (point and non-point source) and air pollution would be in accordance with existing Virginia Department of Environmental Quality permits as further detailed in Sections 4.1.1.7.2 and 4.1.1.7.3, respectively. LaRC has determined that these activities can be implemented within the existing framework of environmental regulations and would be consistent with the enforceable programs and advisory policies of the Virginia Coastal Resources Management Program."

**Comment from the Brevard County Natural Resources Management Office:**

**From:** Coles, Deborah S [Debbie.Coles@brevardcounty.us] **Sent:** Fri 9/28/2007 5:05 PM
**To:** NASA-Cx-Environmental-Impact-System
**Subject:** Constellation Programmatic EIS

The Brevard County Natural Resources Management Office has reviewed impacts associated with the Constellation Program at the John F. Kennedy Space Center. It is our understanding that the impacts associated with the proposed Ares launches will be similar to those associated with current and historic launch activities. This office has no specific comments at this time.

Regards,

Debbie Coles
Special Projects Coordinator IV
Brevard County Natural Resources Management Office
2725 Judge Fran Jamieson Way
Viera, Florida 32940
(321) 633-2016
Fax (321) 633-2029
mailto:debbie.coles@brevardcounty.us

**Response to comment from the Brevard County Natural Resources Management Office:**

Thank you for your comment.

## Comment from the City of Madison, Office of the Mayor, Alabama:

OFFICE OF THE MAYOR

ARTHUR S. "SANDY" KIRKINDALL
MAYOR

100 HUGHES ROAD
MADISON, ALABAMA 35758

(256) 772-5602/5603
FAX (256) 772-3828

CITY OF MADISON

August 23, 2007

Dr. Jennifer L. Rhatigan
ZA/Constellation Program Environmental Manager
Attn: ZA-07-014
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058

Dr. Rhatigan:

The City of Madison has received and reviewed the Draft Constellation Programmatic Environmental Impact Statement.

After an examination of the material contained within the statement, the City of Madison has no comment regarding the environmental impact of this project.

We thank you for taking the time to send us this statement, and wish you well in your work.

Sincerely,

Arthur S. "Sandy" Kirkindall
Mayor

WWW.MADISONAL.GOV

## Response to comment from the City of Madison, Office of the Mayor, Alabama:

Thank you for your comment.

## Comment from the Governor of Ohio:

OFFICE OF THE GOVERNOR · STATE OF OHIO

TED STRICKLAND
GOVERNOR
STATE OF OHIO

August 21, 2007

Dr. Jennifer L. Rhatigan
NASA Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, TX 77058-3696

Dear Dr. Rhatigan:

Thank you for your recent correspondence regarding the Draft Constellation Programmatic Environmental Impact Statement. I appreciate you taking the time to contact me about this matter.

I have forwarded your letter to my policy staff and have asked them to take into consideration the information presented.

I look forward to working with you to turn around Ohio. Thank you again for taking the time to write, and please feel free to contact my office in the future.

Sincerely,

Ted Strickland

Ted Strickland
Governor

TS/tjb

77 South High Street, 30th Floor, Columbus, Ohio 43215-6117
614-466-3555 Fax: 614-728-9522

## Response to comment from the Governor of Ohio:

Thank you.

## Comments from the National Society of Black Engineers:

**RESPONSE TO**

**NASA'S**
**Constellation Programmatic Environmental Impact Statement**
**(PEIS)**

**Author:** Joy Singfield
Director, Environmental Engineering Special Interest Group
National Society of Black Engineers

**Dated:** Friday, September 28, 2007

**Response Subject Matter:** Metallic Oppositions in Environmental Impact Initiatives

**Abstract:** NASA's Draft Constellation Programmatic Environmental Impact Statement (PEIS) addresses the environmental impacts associated With the Proposed Action and the No Action alternative.
NASA's PEIS creates flight systems and Earth-based ground infrastructure required to enable continued access to space and enable future missions. This response is developed to raise awareness of the effects of metals on the environment, and to offer solutions and alternatives to testing, verifying environmental safety with metal testing, and developing metal waste options.

# Comments from the National Society of Black Engineers (cont.):

**Section Responses to:**
**Metals debris and waste options**

**Using Metals and Testing the effects of Metals.**

The use of metals in launching vehicles brings about debris, which results in environmental effects on land, water, and air. These elements are compromised when vehicles launch, and leave the environment vulnerable to the debris of metal. As mentioned in the Launch Range safety section, it was stated for the probability of metallic toxins to be low. A possible question that may pose as a concern is, how can we be sure the level of accuracy this assumption holds? An alternative testing method would be to conduct a test on the climate, and elements of the Earth, such as land, air, and water prior to the launch, to define the current state of the environment to launching. Once the launch has taken place, a test to determine the condition of the environment after launch, would give an accuracy of the effects the launch has on the environment, by testing and analyzing changes that may have taken place during the transition. More accurate water levels, land quality, and in air purity can be defined by recording the before and after states of the environment. For example, an air purification test measuring the level of purity of air prior to, and after a launch, can determine effects the vehicles have on the environment. This will allow accurate assumptions of the environmental quality after a launch, by measuring the levels and analyzing environmental changes before and after a launch.

One possibility to measure effectiveness would be a test using simulation, or virtual prototype of an actual launch, simulating reactions, to calculate possible preventions and rehabilitation features. This method may increase accurate results, and factor in more precise time limits for environmental recovery from hazardous materials, or toxins that compromise the safety of the environment. This controlled simulation environment, creates a variety of scenarios, and poses possible solutions to make formulations more accurate and effective, to develop changes to produce higher land quality, and concrete measurements that effect and alter environmental possibilities. Utilizing this feature can create limitless launch possibility options, without having to physically launch vehicles, resulting in the strain on the environment. This system will test and measure possible developments, that may cause new design, or mechanical options, that may improve launches more accurately. This simulation tests will preserve the environment, and develop proactive solutions and measurements that can be taken in order to predict, and launch vehicles.

Another option is to test the use of environmentally friendly metals. By setting up to develop new processes for metal coatings, new benefits can be offered to the aerospace component manufacturing.

In order to stop the release of highly toxic metals, their buildup must be prevented during the building process of these vehicles. Carbon based tool coatings may be a possible approach for environmentally friendly forming processes. For example, using the “Molyseal”, which does not

# Comments from the National Society of Black Engineers (cont.):

contain chemicals or materials that are hazardous or toxic or give rise to safety or environmental concerns.

This metal finishing tool can be applied using dipping, painting, or spraying techniques, with short treatment times at low temperature, and is compatible with existing cleaning and pretreatment procedures . The usefulness of this application is, of course, limited to metal debris that is expected to remain intact. Any metals that are pulverized, shattered, or otherwise non-intact will expose untreated interior surface to the environment.

**Metallic Waste Options**

In addition to testing to measure the affects on the environment before, and after testing, a possible asset may be to develop ways to rehabilitate and recover the environment when waste has left its mark on the environment.

Testing the dissolve of metals, gives an idea to the time frame of actual dissolve, and measure against the effects on the environment by determining the time it takes from when metal waste arrives to when it has dissolved. This testing can be done to aid in determining if the time it takes to dissolve the metals has an impact on the environment.

Testing the dissolve of vehicle elements not recovered will make it possible to identify and measure the true effectiveness of the land quality, and accuracy of physical metal dissolve. Determining and implementing material types that result in quick dissolve may prove as an effective possibility in determining environmentally responsible solutions for metallic waste management.

**Response to comments from the National Society of Black Engineers:**

Thank you for your comments.

NASA has considered the potential impact on the environment from both routine launches and accidents of the proposed launch vehicles and spacecraft that would support the Proposed Action. This includes the potential impacts of hazardous materials, propellants, and structural materials that might be used in these vehicles. To a large extent, the proposed launch vehicles are very similar to those currently used by NASA and the U.S. Air Force. Extensive environmental monitoring and assessment programs have led to a good understanding of the scope and magnitude of launch environmental effects.

NASA does not consider the release of metallic toxics from ocean disposal of flight hardware to have substantial environmental impacts. Tables 2-3, 2-4, 2-5, 2-7 and 2-8 list the primary material constituents that are currently being proposed for the Ares I, Ares V, and Orion. The majority of these materials, especially the metals, are not considered "highly toxic." The metals cited, primarily aluminum, aluminum-lithium alloy, steel, titanium, and nickel-chromium alloy, are commonly used in many other commercial and military applications such as shipping, aircraft, and offshore structures.

NASA has been implementing environmentally preferable solutions over the years for space flight operations and will continue to do so. NASA is continuing to identify alternative technologies and materials that can reduce public or worker risk. NASA's policy is to use environmentally friendly materials whenever practical. This has resulted in changes to the Space Shuttle over the years and is likely to continue for the Constellation Program.

Each NASA Center works towards reducing the amount of hazardous substance, pollutant, or contaminant entering the waste stream or otherwise released to the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reducing the hazards to public health and the environment associated with the release of such substances. Each NASA Center has a Pollution Prevention Plan and is required to be compliant with environmental laws and regulations, Presidential Executive Orders, and NASA's environmental policy and associated directives, as well as each Centers' own environmental policies and programs.

## Comments from the Space Frontier Foundation:

SPACE FRONTIER FOUNDATION
Advancing NewSpace

16 First Avenue
Nyack, NY 10960

September 30, 2007

ZA/Environmental Manager
Constellation Program
NASA Johnson Space Center
2101 NASA Parkway
Houston, TX 77058
PH: 866.662.7243
EM: nasa-cxeis@mail.nasa.gov

RE: Public Comment on the Draft Constellation Programmatic Environmental Impact Statement (PEIS)

Dear Environmental Manager:

We believe there is a potentially grave oversight in the Draft Constellation PEIS with respect to lunar surface systems and future human presence on the Moon. It is critical to not only examine the impact of the Constellation program on the Earth but also how those missions might impact the long-term human settlement of the Moon.*

The PEIS implicitly takes the position that the National Environmental Policy Act of 1969 (NEPA) was not meant to be extrapolated to apply outside the Earth's atmosphere, and therefore does not in and of itself require an extraterrestrial impact analysis. We agree with that position. However it is important that all space activities treat NEPA compliance in a consistent way. To date, the U.S. government has not taken a clear stance on whether NEPA governs extraterrestrial activities. Therefore, if NASA is taking the position that activities outside the Earth's atmosphere are beyond NEPA jurisdiction, it is vital that this position be made explicit.

Regardless of the applicability of NEPA, we assert that the public policy of the United States should include protecting those space-based resources necessary to sustain and expand human presence and economic activity beyond the Earth. NASA, as an agency of the American government, must take a pro-active environmental stewardship approach to the exploration and development of the Moon. Beyond acting on behalf of an American public consensus on environmental stewardship, the United States Government, including NASA, is legally bound by the Outer Space Treaty to adopt appropriate measures on the Moon so as to avoid harmful contamination.

Article IX of the Outer Space Treaty (1967), states (emphasis added):

> *"Parties to the Treaty shall…conduct exploration of [outer space and celestial bodies (including the Moon)] so as to **avoid their harmful contamination** and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter **and, where necessary, shall adopt appropriate measures** for this purpose."*

The Treaty further states:

> *"If a State Party to the Treaty **has reason to believe** that an **activity** or experiment planned **by it or its nationals in outer space, including the Moon**, and other celestial bodies, would cause potentially harmful interference with activities of other States' Parties in the peaceful exploration and use of outer space, including the Moon…**it shall undertake appropriate consultations before proceeding** with such activity or experiment."*

Although environmental impacts on the Moon are currently left outside the scope of the PEIS, the lunar activities discussed within the PEIS do raise significant environmental impact issues and concerns. As

* It has been verbally reported to us that, during the Apollo era, studies on environmental impacts and contamination of the Moon were conducted. Unfortunately, these studies, conducted in 1969/early 1970s, are not electronically archived and we have been unable to locate them.

www.spacefrontierfoundation.org

## Comments from the Space Frontier Foundation (cont.):

SPACE FRONTIER FOUNDATION
Advancing NewSpace

16 First Avenue
Nyack, NY 10960

just one illustration, NASA is currently in the process of making technical decisions between using toxic and non-toxic propellants in the lunar lander propulsion system. Since this architecture element will repeatedly transport humans and cargo to and from the lunar surface, the use of toxic propellants could have a significant negative impact.

Since NASA uses toxic propellants in many other propulsion systems, and these technologies could be used in a lunar lander, this is a major concern for us. Toxic propellants could contaminate potential sources of water at the lunar poles, or seep into human living environments. Protecting potential sources of water at the lunar poles, and the general environment surrounding future communities, is critical to human settlement of the Moon.

However, while the PEIS indicates that NASA is leaning towards non-toxic propulsion, there is:

- no commitment made by NASA to use non-toxics on the lunar surface, and
- no commitment that NASA will consider this environmental impact in its technical choices about lunar lander propulsion, and
- no indication that NASA even understands the problem exists — that use of toxic propellants in this way could have a significant negative lunar environmental impact on future human communities on the Moon.

As this example shows, it is imperative that lunar environmental impact issues and concerns be considered and addressed immediately in all technical decisions, even if not required by the NEPA.

The Space Frontier Foundation is dedicated to opening the space frontier to human settlement. Therefore, speaking in the interest of future settlers, we strongly urge that environmental stewardship of solar system resources be made a key architectural and technical requirement of NASA's implementation of the Vision for Space Exploration, including Constellation and all other programs.

Sincerely,

Mr. Bob Werb
Chairman of the Board
Space Frontier Foundation

www.spacefrontierfoundation.org

## Response to comments from the Space Frontier Foundation:

Thank you for your comments.

As stated in your comment letter, NASA takes the position that potential environmental impacts in outer space, including the Moon, are beyond the scope of NEPA analysis.

Your comments and concerns that NASA should consider environmental impacts on the lunar surface as a part of the design process have been referred to the appropriate NASA offices for Constellation Program requirements definition.

## Comment from Rosetta M. Karlen:

September 28, 2007

ZA/Environmental Manager
Constellation Program
NASA Johnson Space Center
2101 NASA Parkway
Houston, TX 77058

RE: Constellation PEIS Mailing List

Dear Manager:

Enjoying NASA's website today, I found I can receive information on the PEIS. Please place me on your mailing list for this information, and if it cannot be snet both by printed copy and CD, I would prefer a printed copy.

Being a great fan of the Shuttle program (my 1986 Honda's license plate from 1988 is RTN2SPC), I am happy for the opportunity to receive information regarding the next generation of spacecraft, although nothing will look quite as amazing as a Shuttle launch and landing.

Best wishes on your program.

Sincerely,

Rosetta Karlen

Rosetta M. Karlen
[redacted]

## Response to comment from Rosetta M. Karlen:

Thank you for your comment.