NASA LANGLEY RESEARCH CENTER

Environmental Resource Document

2020 Update

June 2020

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LIST OF ACRONYMS

ACBM	Asbestos-Containing Building Materials
ACHP	Advisory Council on Historic Preservation
AICUZ	Air Installations Compatible Use Zone
ALDF	Aircraft Landing Dynamics Facility
ALS	Advanced Life-Support Qualified
AMRL	Applied Marine Research Laboratory
AQCR	Air Quality Control Region
AQS	Air Quality System
AST	Aboveground Storage Tank
AWQC	Ambient Water Quality Criteria
BMP	Best Management Practice
BTU	British Thermal Unit
C	Centigrade or Celsius
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CASI	Climate Adaptation Science Investigators
CBM	Condition Based Monitoring
CBPA	Chesapeake Bay Preservation Area
CDL	Construction Debris Landfill
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFCs	Chlorofluorocarbons
cm	Centimeter
CMA	Coastal Management Area
CMTS	Chemical Material Tracking System
CO	Carbon Monoxide
cu	Cubic
CRM	Cultural Resource Manager
CRMP	Cultural Resource Management Plan
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZM	Coastal Zone Management
dBA	Decibels, A-weighted Scale
DCR	Department of Conservation and Recreation
DGIF	Department of Game and Inland Fisheries
DOD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
EAP	Employee Assistance Program
EHS	Extremely Hazardous Substance
EIS	Environmental Impact Statement
EISA	Energy Independence and Security Act
EMCS	Energy Management Control System
EMO	Environmental Management Office
EMP	Emergency Management Plan
EPA	Environmental Protection Agency
EPACT	Energy Policy Act
EPCRA	Emergency Planning and Community Right-to-Know Act
ERD	Environmental Resources Document
ESA	Endangered Species Act
ESC	Erosion and Sediment Control
F	Fahrenheit
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft	Foot, Feet
FUDS	Formerly Used Defense Site
GSA	General Services Administration
GWMA	Groundwater Management Area
HAPs	Hazardous Air Pollutants
hr	Hour
HRS	Hazard Ranking System
HRSD	Hampton Roads Sanitation District
HSWA	Hazardous and Solid Waste Amendments of 1984
HCFC	Hydrochlorofluorocarbon
HVAC	Heating, Ventilating, Air Conditioning
HyMETS	Hypersonic Materials Environmental Testing System
IP	Implementation Plan
in	Inch
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
IRC	Ionizing Radiation Committee
ISCP	Integrated Spill Contingency Plan
kWh	Kilowatthour
l	Liter
LAFB	Langley Air Force Base
LaRC	Langley Research Center
LRCHAS	Langley Research Center Historical and Archaeological Society
lb	Pound
LEPC	Local Emergency Planning Commission
m	Meter
mg	Milligram

LIST OF ACRONYMS (continued)

mi	Mile
ml	Milliliter
MACT	Maximum Available Control Technology
MOA	Memorandum of Agreement
MEK	Methylene Ethyl Ketone
mph	Miles Per Hour
MS4	Small Municipal Separate Storm Sewer System
MSA	Metropolitan Statistical Area
MSL	Mean Sea Level
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NASM	National Air and Space Museum
NCSHPO	National Conference of State Historic Preservation Officers
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NETS	NASA Environmental Tracking System
NHL	National Historic Landmarks
NHPA	National Historic Preservation Act
NIRC	Non-Ionizing Radiation Committee
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxide
NMFS	National Marine Fisheries Service
NNW	Newport News Waterworks
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
O&M	Operations and Maintenance
ODC	Ozone-Depleting Compound
ODCP	Oil Discharge Contingency Plan
ODS	Ozone-Depleting Substance
ODU	Old Dominion University
OCSPP	Office of Chemical Safety and Pollution Prevention
OSHA	Occupational Safety and Health Administration
O_3	Ozone
P2	Pollution Prevention
PA	Programmatic Agreement
Pb	Lead
PCBs	Polychlorinated Biphenyls
PCTs	Polychlorinated Terphenyls
PM	Particulate Matter
ppm	Parts Per Million
RASA	Regional Aquifer System Analysis
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RFSGF	Refuse-Fired Steam-Generating Facility
RMW	Regulated Medical Waste
ROD	Record of Decision
RPA	Resource Protection Areas
RSO	Radiation Safety Officer
SAA	Satellite Accumulation Area
SARA	Superfund Amendment and Reauthorization Act
SDS	Safety Data Sheet
SDWA	Safe Drinking Water Act
SERC	State Emergency Response Committee
SHPO	State Historic Preservation Officer
SO_2	Sulfur Dioxide
SNAP	Significant New Alternatives Policy
SPCC	Spill Prevention, Control, and Countermeasure
SUE	Sudden Expansion Burners
SWDA	Solid Waste Disposal Act
SWM	Stormwater Management
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TPQ	Threshold Planning Quantity
TSDF	Transfer, Storage and Disposal Facility
TSCA	Toxic Substances Control Act
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VAC	Virginia Administrative Code
VASC	Virginia Air and Space Center
VDEQ	Virginia Department of Environmental Quality
VDHR	Virginia Department of Historic Resources
VDACS	Virginia Department of Agriculture and Consumer Services
VIMS	Virginia Institute of Marine Science
VMRC	Virginia Marine Resources Commission
VOCs	Volatile Organic Compounds
VPDES	Virginia Pollutant Discharge Elimination System
VWP	Virginia Water Protection
$\mu g/m^3$	Microgram Per Cubic Meter
WIP	Watershed Implementation Plan

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1.0 DESCRIPTION OF CENTER

1.1 LOCATION

The National Aeronautics and Space Administration (NASA) Langley Research Center (LaRC) is situated near the southern end of the lower Virginia Peninsula, approximately 241 kilometers (km) (150 miles) south of Washington, D.C. and 80 km (50 miles) southeast of Richmond, Virginia. LaRC is located within close proximity to several surface water bodies within the tidal zone of the Chesapeake Bay. The cities of Hampton, Poquoson, Newport News, and York County form a major metropolitan statistical area around LaRC. The Center is comprised of research facilities located in two areas which are approximately 4.8 km (3 miles) apart. The two areas, commonly called the West Area and the East Area, are divided by the runways of the Langley Air Force Base (LAFB) component of Joint Base Langley Eustis (JBLE), the headquarters of the Air Combat Command. NASA and LAFB operate as two separate Federal agencies that share a common property boundary. The East Area is located on 1.2 hectares (3 acres) of land permitted to NASA from LAFB. This area is the original 1917 portion of LaRC and contains several wind tunnels, research facilities, and administrative offices. The West Area occupies 310 hectares (764 acres) of land and contains the major portion of LaRC with the majority of the facilities located there. Figure 1-1 shows LaRC's regional location and Figure 1-2 shows the LaRC West and East Areas.

Figure 1-1
REGIONAL LOCATION

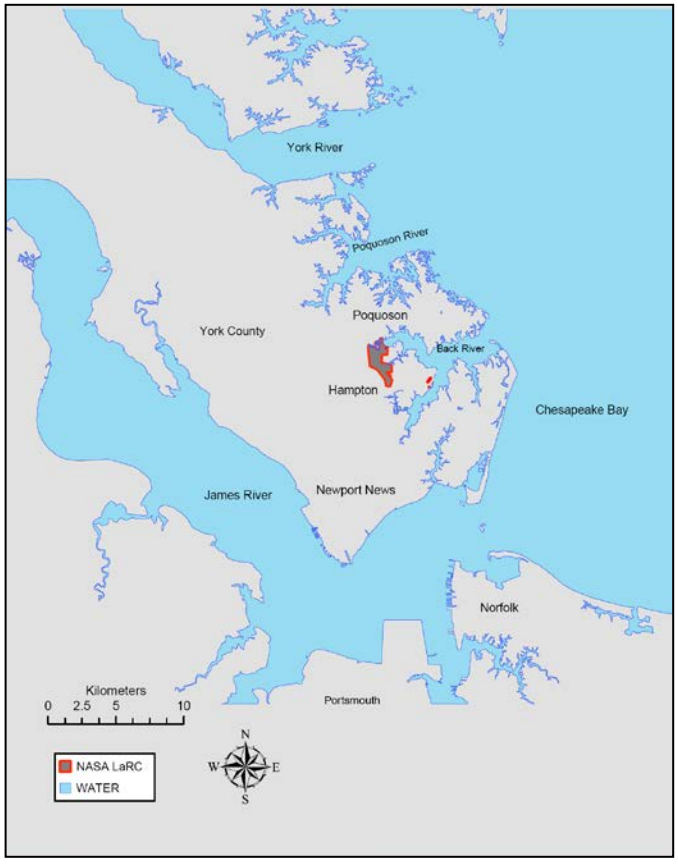
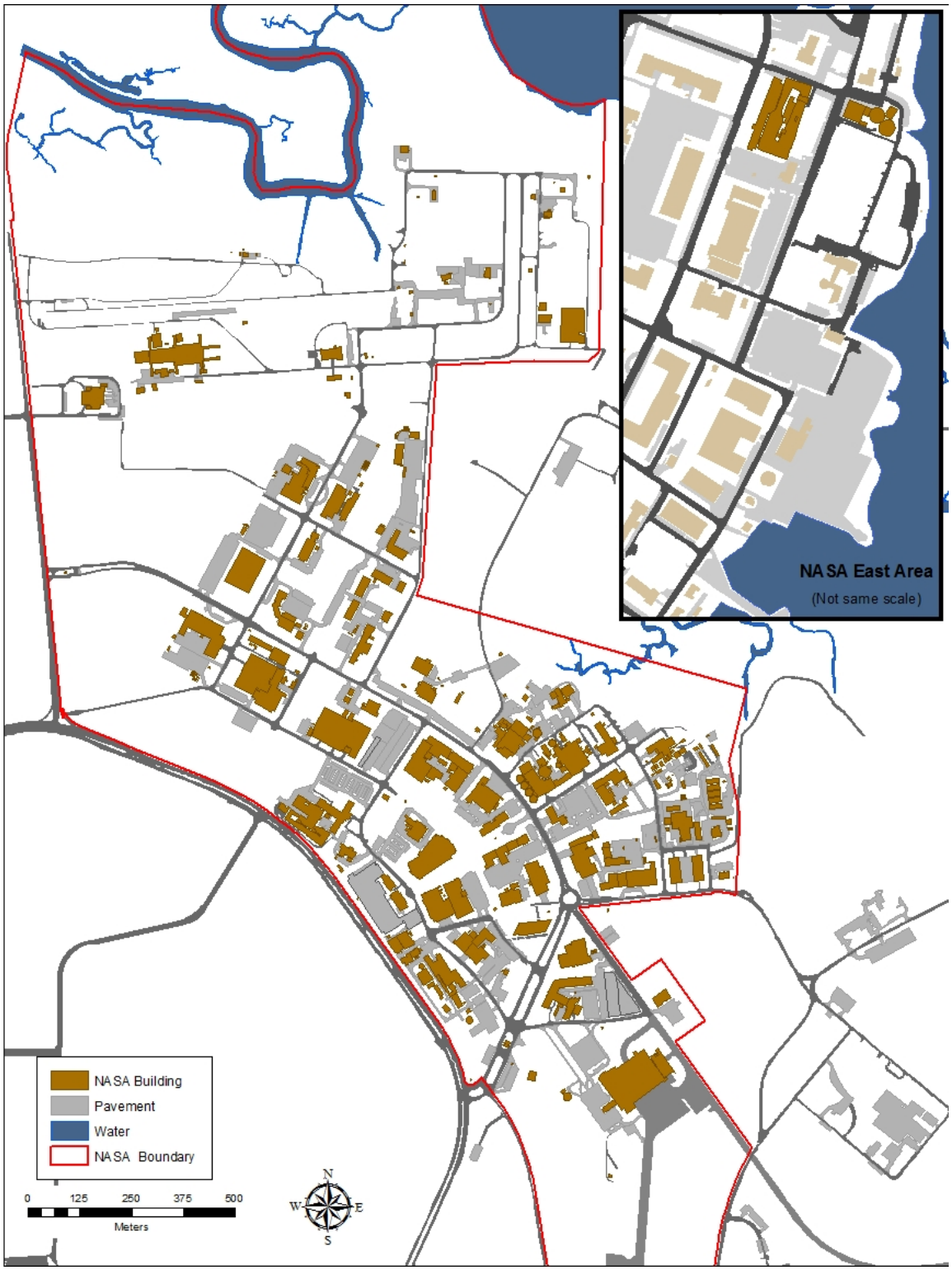


Figure 1-2
LaRC WEST AND EAST AREA OVERVIEW MAP



1.2 BACKGROUND AND MISSION

In 1917, the War Department purchased land in what is now Hampton, Virginia, for joint use by the Army and the National Advisory Committee for Aeronautics (NACA), the forerunner organization for NASA. The site was designated the Langley Field after Professor Samuel Pierpont Langley, an early pioneer in flight. Congress had created NACA to "supervise and direct the scientific study of the problems of flight" and the Langley Field served as an experimental airfield and proving ground for aircraft. The site was renamed Langley Memorial Aeronautical Laboratory in 1920 with the dedication of the first wind tunnel. As the organization grew, NACA concentrated mainly on laboratory studies at Langley, gradually shifting from aerodynamic research to military rocketry. As the Cold War brought an increasing priority to missile development, NACA made many contributions to the military missile programs in the mid 1950's.

In 1958, as a result of the escalating space race, President Eisenhower signed the National Aeronautics and Space Act establishing NASA. NASA absorbed the NACA intact: it's 8,000 employees, an annual budget of $100 million, the Langley, Ames and Lewis laboratories and two smaller test facilities. Langley Laboratory, which was then officially designated Langley Research Center, was the largest of the new agency's field Centers, with 3,368 government employees. NASA quickly incorporated other organizations and eventually created ten research and spaceflight Centers located around the United States.

Over the years, LaRC has made significant contributions to NASA's mission. Research performed at LaRC in the 1950's and 1960's helped aircraft break the sound barrier and played a major role in helping Americans reach the moon. In the 1970's, research at the Center focused on aircraft design to cut emissions and noise, as well as on testing space shuttle concepts. In the 1980's, LaRC and its complex of over 20 wind tunnels performed critical military aircraft research related to the Cold War. From the 1980's to the present, LaRC has continued to provide research support and technological advances in aerospace systems concepts and analysis; aerodynamics, aerothermodynamics, and acoustics; structures and materials; airborne systems; and atmospheric sciences. However, the majority of LaRC's work has been in aeronautics. Once the largest NASA Center, LaRC is now the fifth largest NASA Center. The most current information on LaRC's mission and program activities is available at:
http://gis-www.larc.nasa.gov/masterplan/NASA_Langley_Research_Center_Master_Plan

To fulfill its mission, LaRC employs approximately 3,400 individuals including administrators, researchers, technicians, maintenance staff, and on-site contractors. The Center is organized into groups and divisions based on current research and development areas. The most recent organizational chart for the Center is maintained on the Center's @LaRC home page. LaRC's major facilities are described in Table 1-1. Additional details on facility size and function are included in the infrastructure section of the Center's Master Plan.

Table 1-1
MAJOR FACILITIES AT LARC

Building No.	Building Name	Description
645	20-Ft Vertical Spin Tunnel	Used to conduct spin and tumbling research on aerospace vehicles, civil and military aircraft.
648	Transonic Dynamics Tunnel	Slotted-throat, single return, closed-circuit wind tunnel used for dynamic and aero-elasticity testing.
1208	Acoustics Research Facility	Conducts research to understand and control interior and exterior noise and its effects on aircraft and spacecraft, passengers, crew, and the public.
1212C	14X22 Ft Subsonic Tunnel	Low-speed testing of powered and un-powered models of various fixed- and rotary-wing civil and military aircraft.
1236	National Transonic Facility	High pressure, cryogenic, closed-circuit wind tunnel used to provide aeronautical data to the research, industry and DoD communities.
1244	Hangar Complex	Truss-supported hangar providing over 87,000 sq. ft. of clear floor space; currently houses the Rendezvous Docking Simulator (National Historic Landmark) suspended from hangar ceiling.
1247B 1247D	1247 Complex	Research areas, test chambers, laboratories, small wind tunnels, and a scramjet test facility.
1250	1250 Research Complex	Research areas used by various organizations for chemistry, climate and systems integration research.
1251 1251A	Unitary Wind Tunnel	Closed-circuit, continuous flow, variable-density tunnel with a test section range of Mach 1.5 to 4.6; studies force and pressure distribution, jet effects, dynamic stability, and heat-transfer. (Leased by Jacobs in 2014)
1265	8 Ft. High Temperature Tunnel	Conducts research in aero-thermal loads and high-temperature structures and thermal protection systems.
1267	1267 Research Complex	Provides for structures and materials testing using thermal, cryogenic and compression processes.
1293A	1293 Research Complex	Provides a broad range of computational and experimental capabilities in polymeric materials development.
1293B	Structural Dynamics Research Lab	Experimental and analytical capabilities to analyze structural dynamic response to environmental stimuli.
1297	Landing and Impact Research (LandIR) Facility	Large gantry providing impact, crash, landing simulation; system crash worthiness; human response to crash.

1.3 TENANT ORGANIZATIONS WITHIN LaRC

In addition to NASA and its support contractors, there are resident Federal, State, and support agencies at LaRC. These agencies are listed in Table 1-2.

Table 1-2
TENANT ORGANIZATIONS AT LANGLEY RESEARCH CENTER

Building No.	Building Designation	Agency	Facility Description/Use
1169	Audits, Inspections, Investigations	Office of Inspector General	Administrative Offices
1231C	Child Development Center	Langley Child Development Center	Child Development Center
1244C	Hangar Offices	Joint Research Program Office, AFDD, AMCOM, U.S. Army Vehicle Training Center, ARL	Administrative Offices
1288	Refuse-Fired Steam-Generating Facility	City of Hampton	Steam-Generating Facility

1.4 LaRC's ENVIRONMENTAL AND ENERGY PROGRAM

The Center's Environmental and Energy Program is managed by LaRC environmental staff working within the Center Operations Directorate. The main elements of the program are environmental compliance, management, and sustainability. LaRC environmental staff are responsible for reviewing LaRC's activities and projects for environmental impacts, providing guidance on regulatory requirements, acting as the formal point of contact with all environmental regulatory agencies, reviewing and maintaining environmental permits, and assisting LaRC personnel in pursuing and implementing cost effective energy efficiency and water conservation practices.

Sustainability and Environmental Management
In executing its mission, LaRC has adopted the Agency sustainability policy which includes the following objectives:

- Increase energy efficiency
- Increase the use of renewable energy
- Conserve and protect water resources through efficiency, reuse, and stormwater management
- Eliminate waste, prevent pollution, and increase recycling
- Purchase sustainable technologies and environmentally preferable materials, products, and services
- Design, construct, maintain, and operate high-performance sustainable buildings
- Utilize power management options and reduce the number of LaRC data centers
- Evaluate Center climate change risks and vulnerabilities and develop mitigation measures to manage both the short and long-term effects of climate change on the Center's mission and operations

- Raise employee awareness and encourage each individual in the LaRC community to apply the concepts of sustainability to every aspect of his/her daily work to achieve these goals
- Maintain compliance with all applicable federal, state, local, or territorial law and regulations related to energy security, a healthy environment, and environmentally sound operations
- Comply with internal LaRC and NASA requirements and agreements with other entities

In addition to adopting NASA's sustainability policy, LaRC has an Environmental Management System (EMS) that conforms to the requirements of EO 13834, "Efficient Federal Operations," as well as to guidance provided by NASA Procedural Requirement (NPR) 8553.1B, "NASA Environmental Management System." The EMS serves as the management framework under which LaRC identifies, manages, and improves the sustainable practices identified in the EO goals. The EMS helps LaRC to assess the potential impacts, benefits, and associated risks of its activities on mission accomplishment, environmental stewardship and community support. Environmental risks are regularly and systematically reevaluated to verify progress toward environmental goals and to ensure consideration of LaRC's changing environmental conditions and evolving mission requirements.

The EMS also establishes the necessary personnel structure to facilitate communication throughout all levels of Center management, ensuring that the Center's most significant environmental issues receive appropriate attention. In 2009, LaRC established an Environmental Management Committee (EMC), which reports to the Center Leadership Committee and is responsible for implementation of LaRC's EMS Program.

Environmental Review Process

Project or Program Managers initiating any new projects or actions at the Center are responsible for ensuring that the appropriate documentation is prepared in accordance with the requirements of Langley Procedural Requirement (LPR) 8500.1, Environmental and Energy Program Manual, and other relevant environmental laws, regulations, and Executive Orders. Complete documentation is required to ensure LaRC environmental staff can evaluate the proposed projects or actions for potential environmental impacts.

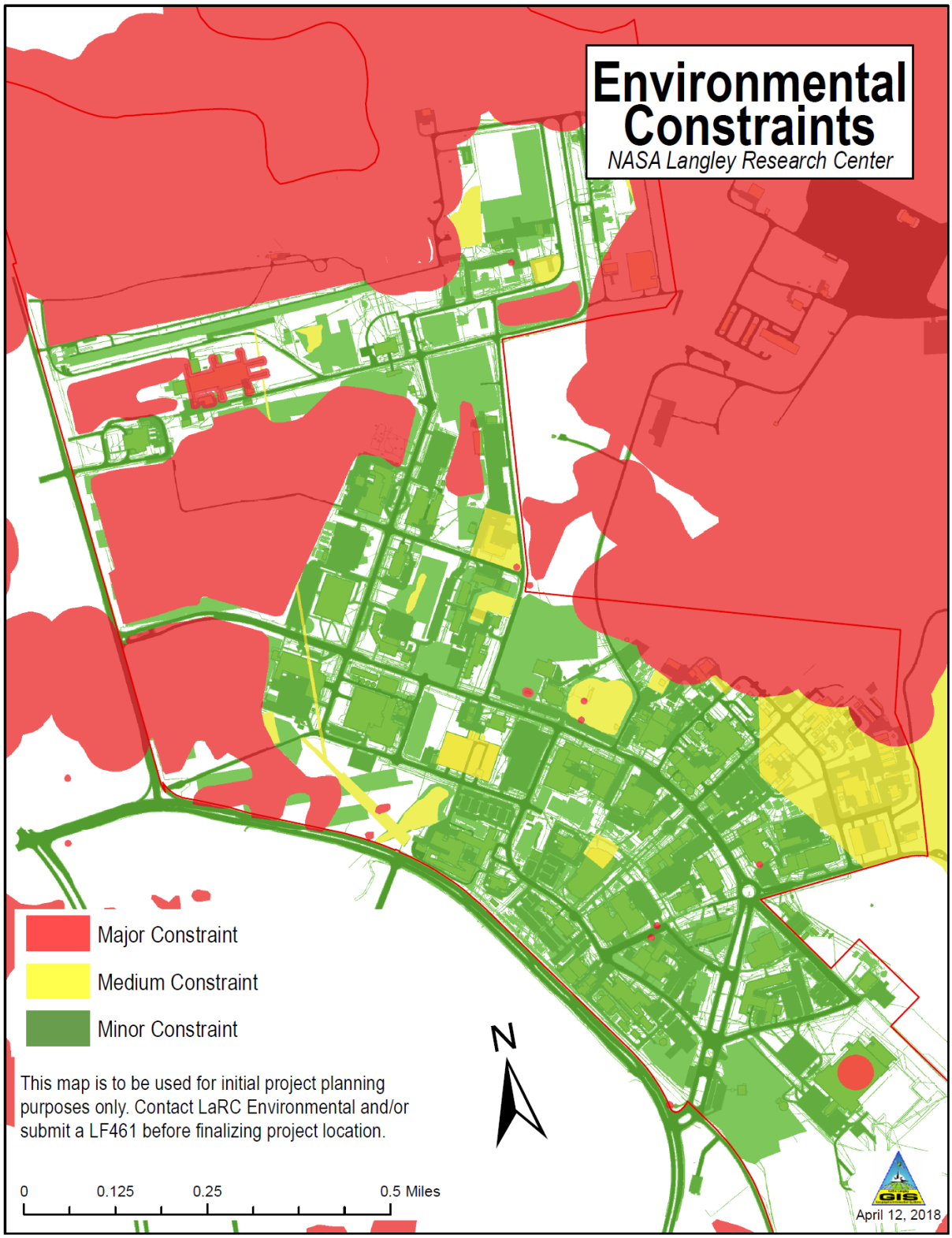
The first step in LaRC's environmental review process requires Project and Program Managers to complete the Langley Form (LF) 461, "Environmental Project Planning Form," which is a web-based form that is available to all Center employees. In addition to requiring a detailed description of the proposed action or project, it includes a series of "YES-NO" questions spanning various environmental media areas. Completed forms along with project documents are submitted electronically to the LaRC NEPA Manager who then coordinates review among LaRC environmental staff. The review takes into consideration the environmentally sensitive areas located throughout the Center, as shown in Figure 1-3.

If the review determines that the project or proposed action is covered by a categorical exclusion (CatEx) as defined in 14 CFR Part 1216, or is considered to have minimal or no potential to produce an environmental impact, the LaRC NEPA Manager may prepare a Record of Environmental Consideration (REC) to document the decision. For those actions not requiring a REC, the CatEx decision would be documented on the LF 461. Although no further NEPA

documentation is normally required following review of the LF 461 and/or completion of the REC, additional environmental requirements may apply to the project. These requirements, such as obtaining permits, following waste disposal procedures, etc. would be listed on the LF 461 or REC, and LaRC environmental staff follow up to ensure all requirements are followed throughout the duration of the project.

If the review determines that the project or proposed action has the potential to produce environmental impacts, an Environmental Assessment (EA) would be required. In some cases during the impact review process, it would become apparent that the action would produce a significant environmental impact. In these cases, an Environmental Impact Statement (EIS) may be required. LaRC Project and Program Managers are responsible for ensuring that the project schedule and budget includes preparation of the appropriate NEPA documentation.

Figure 1-3
Environmental Constraints at NASA LaRC



2.0 AIR RESOURCES

2.1 REGULATORY OVERVIEW

2.1.1 The Clean Air Act

The Clean Air Act (CAA) of 1970 was enacted by Congress to protect air quality in the United States. The CAA is implemented through air pollution laws administered and enforced by the U.S. Environmental Protection Agency (EPA). However, the EPA has largely delegated the task of administering air pollution laws to the States. The Virginia Department of Environmental Quality (VDEQ) administers the requirements of the Federal Clean Air Act in Virginia and enforces the State's air pollution laws and regulations.

Virginia's air quality plan, called a State Implementation Plan (SIP), must be reviewed and approved by the EPA in order for the state to enforce the CAA. The Air Quality Plan defines how the state will meet and maintain air quality standards and prevent significant deterioration of air quality in areas that are currently cleaner than the standards. The EPA requires that states implement an adequate system of enforcing air pollution regulations. Virginia's SIP was originally submitted to EPA in 1972. The SIP is a living document with more than 100 revisions made to the plan since its original submittal. EPA's actions on Virginia's SIP are summarized in Subpart VV of 40 CFR Part 52.

The CAA established the National Ambient Air Quality Standards (NAAQS). These standards limit concentrations of certain pollutants, called criteria air pollutants, in the ambient air. There are two standards, primary and secondary. Primary standards were established to protect the public's health and secondary standards were established to prevent environmental and property damage. Currently, there are six criteria pollutants limited by NAAQS: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone, (O_3), particulate matter (PM), sulfur oxides (measured as sulfur dioxide (SO_2)), and lead (Pb). These are regulated under the Virginia Air Pollution Control Law and the Regulations for the Control and Abatement of Air Pollution.

The CAA also set the National Emissions Standards for Hazardous Air Pollutants (NESHAP) and these pollutants are regulated by the State. The NESHAP regulations cover eight pollutants: arsenic, asbestos, benzene, beryllium, mercury, radionuclides, radon, and vinyl chloride. The regulations were established to protect public health by setting emission standards for these pollutants.

The CAA also requires New Source Performance Standards for stationary sources. This means that any new air pollution source must install appropriate air pollution control for that industry. Two of the goals of the CAA are to maintain ambient air quality in areas that already meet air quality standards (attainment areas) and to reach attainment in areas that do not currently meet the standards (non-attainment areas). In order to meet the CAA goals, Virginia regulates both new and existing air pollution sources through federal and state permitting programs.

In 1990, Congress amended the CAA. The CAA amendments (CAAA) expanded the previous eight NESHAP pollutants to include 189 toxic compounds called Hazardous Air Pollutants (HAPs). The original list of 189 toxics was modified in 1996 when caprolactam was delisted. In December 2005, the EPA removed methyl ethyl ketone (MEK) from the list of toxic air pollutants.

While NESHAPs were based on health considerations, the new HAPs regulations are based on available control technology. Maximum Available Control Technology (MACT) Standards were established for certain categories of sources and include specific emission standards and requirements for control technology for these 187 pollutants.

2.1.2 Air Permits

The air permit system is used to regulate and enforce air pollution laws and regulations. The CAAA established a permit program for large sources that release pollutants into the air. The national permit system mandated by the EPA is called the Title V Operating Permit Program. Under this program, air permits are issued by the State, or if the state fails to carry out the CAA satisfactorily, by the EPA. The essential concepts of the air permitting system include:

Potential to Emit - Potential to emit is the maximum physical and operational capacity of a source to emit any air pollutant. This potential is based on year-round, 24 hour per day operation, but does take into account restrictions and controls on the facility that are state and federally enforceable.

Applicable Requirements - Both the state and federal operating permit programs identify all requirements applicable to a source. These can include compliance, record keeping, reporting, emission controls, emission limits, work practices, operating hours, and other matters stemming from federal and state air laws and regulations as well as permits for constructing or modifying a facility.

Synthetic Minors and Potential to Emit - A source can avoid the requirements of a Title V permit if it can keep its potential to emit below the thresholds in the Title V definition of a major source. Synthetic minor sources agree to abide by emissions or operational limits that keep the source below the major threshold. A synthetic minor source will not be a Title V major source as long as the emission limits are enforceable through the state operating or modified source permits. LaRC is a synthetic minor source.

VDEQ administers the state's air Operating Permit Program. The goal of the Operating Permit Program is to require every facility to have one comprehensive permit for all air pollution sources in that facility. The permit includes information on which pollutants are being released, how much may be released, and what steps are being taken to reduce emissions, including the monitoring of air emissions.

2.1.3 Hampton Roads Air Quality Control

NASA LaRC is located within the Hampton Roads Intrastate Air Quality Control Region (AQCR). This AQCR is currently designated as an attainment area for all of the criteria pollutants. Previously, Hampton Roads had been a “non-attainment” area for the 8-hour NAAQS for ozone. On October 29, 2008 (73 FR 64210), EPA approved a revision to the Virginia SIP that established Hampton Roads as an Ozone Maintenance Area, on the list of maintenance areas found in regulation 9 VAC 5-20-203.

2.1.4 Ozone Depleting Compounds

The CAAA established a deadline of 2000 for the phase-out of the production of the Class I Ozone Depleting Compounds (ODCs) chlorofluorocarbons (CFCs), halons, and carbon tetrachloride, and 2002 for methyl chloroform. In 1992, these deadlines were accelerated in response to scientific findings that significant ozone depletion is underway in the northern hemisphere. The accelerated schedule required the phase-out of Class I ODCs by December 31, 1995. Also in 1992, the United States and other parties to the Montreal Protocol agreed to accelerate the phase-out of CFCs, carbon tetrachloride and methyl chloroform to the end of 1995 and halons to the end of 1993. Under the Montreal Protocol, the U.S. must also phase-out its use of Class II ODCs (hydrochlorofluorocarbons or HCFCs) by 2030.

In 1993, Executive Order 12843 directed Federal agencies to minimize the procurement of products containing Ozone-Depleting Substances (ODSs). NASA issued policy guidance in response to the Executive Order which required that NASA minimize the procurement of Ozone-Depleting Substances in anticipation of the phase-out of ODS production. Executive Order 13148 (issued April 2000) directed federal agencies to develop a plan by April 2001 to phase out the procurement of Class I ODS for all nonexcepted uses by December 31, 2010. In January 2007, Executive Order 13423 was issued. It required federal agencies to ensure it maximized the use of safe alternatives to ODSs, as approved by the EPA's Significant New Alternatives Policy (SNAP) program. Agency plans to replace ODSs were to target cost effective reduction of environmental risk by eliminating the use of ODSs in new equipment and facilities and by phasing out ODS applications as the existing equipment using those substances reached its expected service life. In October 2009, Executive Order 13514 directed agencies to ensure that 95 percent of new contract actions, including task and delivery orders, required products and services that utilized non-ozone depleting substances when applicable.

Executive Order 13693 (issued March 2015) directs federal agencies to promote sustainable acquisition and procurement by ensuring that environmental performance and sustainability factors are included to the maximum extent practicable in the planning, award, and execution phases of applicable acquisitions. This includes the purchase of SNAP chemicals or other alternatives to ozone-depleting substances and high global warming potential hydrofluorocarbons, where feasible, as identified by the SNAP program. EO 13834 (issued May 2018) supports the continued acquisition of products and services, in accordance with statutory mandates for purchasing preference, Federal Acquisition Regulation requirements, and other applicable Federal procurement policies.

2.2 NASA LANGLEY OPERATIONS

2.2.1 Regional Ambient Air Quality Monitoring

A summary of the regional ambient air concentrations of pollutants for calendar year 2019 is shown in Table 2-1. The table lists the national primary and secondary standards for ambient air quality and shows the observed ambient air concentration of criteria pollutants. Data is from the air quality monitoring station located near Building 1196 at LaRC. VDEQ operates the station and reports results to the EPA's Air Quality System (AQS) database.

Table 2-1
NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) AND OBSERVED AMBIENT CONCENTRATIONS FOR NASA LARC AREA

Pollutant	National Primary Standard	National Secondary Standard	Observed Ambient Concentration (2019)[1]
Particulate Matter <10μm 24-hour Average	150 $\mu g/m^3$	150 $\mu g/m^3$	18 $\mu g/m^3$ (2nd max)
Particulate Matter <2.5μm Annual Arithmetic Mean 24-hour Average	12 $\mu g/m^3$ 35 $\mu g/m^3$	15 $\mu g/m^3$ 35 $\mu g/m^3$	6.4 $\mu g/m^3$ 15 $\mu g/m^3$ (98th pct.)
Sulfur Dioxide 1-hour Average 3-hour Average	75 ppb None	None 0.5 ppm	1 ppb (2nd max)
Carbon Monoxide 8-hour Average 1-hour Average	9 ppm 35 ppm	None None	0.5 ppm max 0.7 ppm max
Nitrogen Dioxide Annual Arithmetic Mean 1-hour Average	53 ppb 100 ppb	53 ppb None	3 ppb 24 ppb (98th pct.)
Ozone 8-hour Average	0.070 ppm	0.070 ppm	0.061 ppm 4th max
Lead Rolling 3-Month Average	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$	Not measured at LaRC monitoring station.

Notes: ppm = parts per million, ppb = parts per billion, $\mu g/m^3$ = micrograms per cubic meter.
Most ambient standards are not to be exceeded more than once per year, but some require more complex averaging procedures.

[1] Site identified in AQS database as City of Hampton, AQS Site ID: 51-650-008, which became operational in June 2010.

Source: EPA AirData Monitor Values Report (www.epa.gov/airdata/)

2.2.2 LaRC's Air Permit

A Federal Title V Operating Permit is not required by the Center. LaRC qualifies as a synthetic minor because its air emissions are limited below the prescribed thresholds by its state operating permit. The major components of the Center's air permit are the Center-wide emissions limits, the air emissions sources regulated under the permit, and the conditions placed on these sources to ensure air emission limits are met.

The Center's air permit limits both emissions from individual air pollution sources and facility-wide emissions. Table 2-2 shows air pollutant emissions for calendar years 2018 and 2019 and the current facility-wide emission limits.

Table 2-2 EMISSION QUANTITIES AND PERMIT LIMITS			
Air Pollutant	**Quantity Emitted 2018 (tons/year)**	**Quantity Emitted 2019 (tons/year)**	**Permit Emission Limits* (tons/year)**
Carbon Monoxide	6.85	6.97	59.3
Nitrogen Oxides (as NO_2)	12.65	13.77	93.2
Particulate Matter (PM_{10})	0.82	0.77	12.0
Sulfur Dioxide	0.37	0.47	10.0
Total Volatile Organic Compounds (VOCs)	1.11	1.17	24.8
Total Hazardous Air Pollutants (HAPs)	<0.5	<0.5	16.5
Any Individual HAP	<0.5	<0.5	5.4
Source: LaRC 2018 and 2019 Emission Statements. *Limits from LaRC Air Permit dated 7/25/17 (Permit Condition 43).			

2.2.2.1 Air Pollution Sources

The air emission sources described below are permitted under the Center's current Air Permit. Table 2-3 lists locations of these air emissions sources.

The west area steam plant has four boilers: a 59-MMBtu/hr Cleaver Brooks – Nebraska boiler, a 120-MMBtu/hr Babcock & Wilcox boiler, and two 168-MMBtu/hr B&W boilers. All are dual fuel; natural gas is the primary fuel. The Nebraska boiler is permitted to burn low sulfur fuel oil under normal operating conditions; the remaining boilers are permitted to burn low sulfur fuel oil only in the event of an interruption of natural gas service. The boilers are equipped with flue gas recirculation and low nitrogen oxides (NOx) burners to reduce emissions. The west area steam plant provides steam for NASA LaRC research facilities. A majority of the institutional steam is provided by the Refuse-Fired Steam Generating Facility (RFSGF). The RFSGF is operated and maintained by the City of Hampton under a separate air permit.

The east area steam plant has two 14.645 MMBtu/hr boilers which combust only natural gas. These boilers provide steam for the research tunnel in Building 647 and provide some steam for space heating.

Space Heaters/Furnaces: One of LaRC's space heaters operates on low sulfur fuel oil; the remaining space heaters and small furnaces operate on natural gas. Equipment ranges in size up to 4 MMBtu/hr.

Sudden Expansion (SUE) Burners: LaRC's Jet Noise Laboratory owns two, Kaiser Marquardt 3" x 8" Sudden Expansion Burners. These propane fired burners are used in the tunnel for research activities, but are not currently in use.

National Transonic Facility Burners: Four natural gas fired burners heat the cold exhaust from the cryogenic tunnel to prevent formation of ground fog. These burners operate infrequently.

Emergency Generators and Fire Pumps: the Center operates diesel fueled emergency generators to provide power to specific equipment during interruption of electrical service. Three 1,750 kW diesel emergency generators (the largest on site) were installed at the new Computational Research Facility in January 2017. Diesel engines power the pumps for the aircraft hangar fire suppression system. The Center also has two natural gas fired emergency generators.

Arc-Heated Scramjet Test Facility: uses an electric arc heater to heat air in the research test chamber. Exhaust is a source of NOx emissions.

HyMETS Facility: uses an electric arc heater to heat air in the research test chamber. When operating in air mode, exhaust is a source of NOx emissions.

Direct-Connect Supersonic Combustion Test Facility: uses a hydrogen and air combustion heater with oxygen replenishment. Exhaust is a source of NOx emissions.

Combustion Heated Scramjet Test Facility: uses a hydrogen, air, and oxygen heater, and is currently not in service. Exhaust is a source of NOx emissions.

8-Foot High Temperature Tunnel: combustion-heated wind tunnel. Combustion exhaust from the tunnel is a source of criteria pollutants.

Degreaser/Parts Washers: solvent degreasers or parts washers are located in several facilities and are a source of VOC emissions.

Spray or Coating Booths: paint and plasma arc spray booths are located in several facilities and are a source of particulate matter, VOC, and HAP emissions.

Dust Collectors (including fabric filter and cyclone collectors): are located at several facilities and are used to reduce particulate matter emissions.

Investment Casting Wax Burn-out Furnace (Building 1237A): is a source of combustion emissions from the natural gas fired furnace burners and particulate emissions from the burning of wax and resin out of molds inside the furnace. The furnace is equipped with a secondary burner (afterburner) to reduce particulate emissions during burnout.

Underground Gasoline Storage Tanks: two 8,000 gallon underground gasoline storage tanks at the vehicle refueling area are a source of VOC and HAP emissions.

Tape Prepregging Machine (Building 1267A): is used to prepare resin impregnated, reinforced fiber tape from polymer resin. This machine is a source of VOC emissions.

Table 2-3
LOCATIONS OF PERMITTED AIR EMISSION SOURCES

Air Emission Source	Building Location(s)
Babcock & Wilcox Boilers and Cleaver-Brooks (Nebraska) Boiler	1215
Cleaver-Brooks Boilers	647
Space Heaters/Furnaces (low sulfur fuel oil-fired)	1297C
Space Heaters/Furnaces (natural gas-fired)	1122, 1187-1191, 1197, 1198, 1206, 1245, 1256C, 1297
Kaiser Marquardt Sudden Expansion Burners	1221B
Burners at the National Transonic Facility	1236
Emergency Generators and Fire Pumps (diesel-fueled)	641, 1201, 1211, 1215, 1236, 1244A, 1248, 1250, 1265 (non-emergency generator, staged in place but not installed yet),1268A-C, 1297G, 2101, 2102, 2103
Emergency Generators (natural gas-fueled)	1223B, 1247E
Arc-Heated Scramjet Test Facility	1247B
HyMETS Facility	1148
Direct-Connect Supersonic Combustion Test Facility	1221D
Combustion Heated Scramjet Test Facility	1221D
8-Foot High Temperature Tunnel	1265
Degreaser/Parts Washing Units	1199, 1236, 1244, 1267A, 1296
Paint or Coating Booths	1148, 1230A, 1232A, 1238B, 1244D, 1268D, 1293A, 1202 – conformal coating booth, 1230 – plasma arc booth (not in service)
Dust Collectors	1225
Investment Casting Wax Burn-Out Furnace	1237A
Underground Gasoline Storage Tanks	1199
Tape Prepregging Machine	1267A

2.2.2.2 Emission Source Conditions

The air permit contains enforceable conditions that limit the quantity of air pollutants that LaRC may emit. Specific permit requirements vary according to the air pollution source, but they generally include physical, operational, record keeping and reporting requirements. Physical requirements include control equipment to limit emissions such as low NOx burners on boilers

and filters on paint booths, as well as monitoring equipment such as meters and thermometers to measure emissions or process rates. Operational requirements include limits on the amount and type of fuel burned or materials processed, the frequency and duration of operations, and the types and amounts of product that can be used, such as paints and solvents.

Monthly record keeping requirements include documentation that physical and operational requirements are met, records of the quantity of products, fuels, and materials used, records on the frequency and duration of operations, and monthly emissions from each source. Reporting requirements include semi-annual fuel reports, an annual inventory update, and annual emission statements.

2.2.3 ODCs

NASA LaRC tracks the storage, purchase, and use of ODCs and actively seeks alternatives for eliminating or reducing their use. Currently, CFCs are used for building and automotive air conditioners and for high-precision cleaning operations. The Center has substituted Class II ODCs for Class I ODCs, instituted recycling and reclamation of Class I ODCs still in use, and converted some processes to eliminate using ODCs altogether. Consumption data are submitted to NASA Headquarters via the NASA Environmental Tracking System (NETS) annually.

Table 2-4 shows CFC storage, purchase, and use at NASA LaRC in 2018 and 2019. In 2018, KSC transferred a large tank of CFC 113 to LaRC for cleaning equipment used in liquid oxygen service.

Table 2-4
LaRC CHLOROFLUOROCARBONS (CFC) - CLASS I SUBSTANCES

Material	Quantity (lbs.)					
	2018 Storage	2018 Purchase	2018 Use	2019 Storage	2019 Purchase	2019 Use
CFC 12 Refrigerant	46	0	25	41	0	5
CFC 113 Cleaner/Solvent	35,870	37,210	5,217	33,476	0	2,394
CFC 114 Refrigerant	30	0	0	30	0	0
TOTAL (lb.)	**35,946**	**37,210**	**5,242**	**33,547**	**0**	**2,399**

Source: NASA NETS, ODS Quantities by Site Report, FY2018, FY2019

2.2.4 Climate

The climate in the LaRC area is a modified continental type with generally mild winters and warm, humid summers. Mountains to the west and the Chesapeake Bay and Atlantic Ocean to the east are the major factors affecting LaRC's climate. The mountains produce various modifying effects on passing storms and air masses, while the nearby open bodies of water, slow to react to atmospheric changes, contribute greatly to the humid summers and mild winters.

Daytime high temperatures during the winter are usually near 10° Celsius (C) (50°Fahrenheit (F))

with nighttime lows of near 0°C (30°F). A maximum temperature of 27°C (81°F) and a minimum of -20°C (-3°F) are the extremes recorded during the winter season. The maximum temperature is below freezing on an average of 5 days each year, while the minimum temperature falls below freezing 13 to 17 days a month during the winter months.

Daytime highs during the summer are usually in the middle upper 20s°C (80s°F) with nighttime lows generally around 20°C (70°F). Maximum temperatures up to 40°C (105 °F) and minimum temperatures as low as 6°C (43°F) are the extremes recorded during this period. The average date of the last freezing temperature in spring is March 25, and the average date of the first freeze in fall is November 17. Freezing temperatures have occurred as late as April 21 and as early as October 27.

Precipitation is well distributed throughout the year with the minimum in July and August and the maximum in November and April with an annual average of 1.19 m (47 in). Monthly totals have ranged from less than one-quarter of an inch (in) to over 0.38 m (15 in). The highest daily total, 0.15m (over 6 in) occurred during September 1972. Nearly 40 days each year have thunderstorm activity, which is close to the average for the state. In winter, some of the precipitation occurs as snow. The average is about 0.23m (9 in) a year, but total snowfall is extremely variable, ranging from none to nearly 1.14m (45 in).

South to southwest winds predominate, but a secondary maximum from a northerly direction reflects the progression of weather systems across the state. Cloudiness is least during the fall season, averaging about five-tenths coverage, and greatest in winter, with six-tenths coverage.

Hurricanes and other tropical disturbances seldom move close enough to affect LaRC. In most cases, when they arrive in this area, they have decreased in strength to less than hurricane intensity, but they may still cause considerable damage from high winds and heavy rains. Category II and III hurricanes have been recorded a few times in the last 60 years. Category IV hurricanes have been recorded in the area twice in the last 400 years. Tornadoes are quite rare. Thunderstorms, accompanied by lightning and high winds, are much more frequent and produce the greatest amount of storm damage in the area.

2.3 REFERENCES

Virginia Department of Environmental Quality, Air Quality Information, https://www.deq.virginia.gov/Programs/Air.aspx.

U.S. Environmental Protection Agency, AirData Website, https://www.epa.gov/outdoor-air-quality-data.

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3.0 WATER RESOURCES

3.1 REGULATORY OVERVIEW

3.1.1 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) protects public health by regulating the nation's public drinking water supply. It authorizes the EPA to set national health-based standards for drinking water and its sources – rivers, lakes, reservoirs, springs, and ground water wells. The EPA has implemented regulations to enforce the SDWA in 40 CFR Parts 141 through 149.

The most direct oversight of water systems is conducted by state drinking water programs. States can apply to the EPA for the authority to implement SDWA within their jurisdiction if their standards are at least as stringent as the EPA's. The Virginia State Department of Health has primary responsibility for administration and enforcement of primary drinking water regulations and related requirements applicable to public water systems in Virginia. There are no identified drinking water aquifers. The water supply for NASA LaRC is obtained from Newport News Waterworks. The system at NASA LaRC consists only of distribution facilities; there are no water production or treatment facilities.

3.1.2 Clean Water Act

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972. The CWA gave the EPA the authority to set discharge standards on a technology-based or industry basis in addition to setting water quality standards for all contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit is obtained. The CWA, as amended by the Oil Pollution Act of 1990, also regulates discharges of oil to waters of the U.S. Facilities which, due to their location, could reasonably be expected to discharge harmful quantities of oil to U.S. waters, are required to prepare a Spill Prevention Control and Countermeasure (SPCC) Plan and/or Facility Response Plan.

The Commonwealth of Virginia State Water Control Law forms the basis for protecting water quality, prevention and control of pollution, and reducing existing pollution of state waters. VDEQ Water Division sets stream quality and water use standards for all state waters.

3.1.3 Virginia Pollutant Discharge Elimination System Permit Program

The CWA's primary mechanism for imposing limitations on pollutant discharges is a national permit program established under Section 407 and referred to as the National Pollutant Discharge Elimination System (NPDES). Under this program, the State of Virginia has implemented the Virginia Pollutant Discharge Elimination System (VPDES) program in conformance with the applicable NPDES regulations, 40 CFR Section 122.26(d)(2) and 40 CFR Section 122.34(b)(5). The VPDES Permit Regulation, 9 VAC 25-31, establishes the procedures and requirements for this Program to manage industrial and municipal wastewater discharges. The Virginia Department of Environmental Quality (DEQ) is responsible for the VPDES permitting program.

3.1.4 Total Maximum Daily Loads

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a 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 load among the various sources of that pollutant. Permitted point sources can receive a waste load allocation to meet an established TMDL.

3.1.5 Virginia Erosion and Sediment Control Law and Regulations

In accordance with the Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations, VDEQ implements the state Erosion and Sediment Control program to help prevent destruction of property and natural resources caused by soil erosion, sedimentation and nonagricultural runoff from regulated "land-disturbing activities." ESC regulations, 9 VAC 25-840, specify the "minimum standards" that must be followed on all regulated activities including: criteria, techniques and policies. State law explains the rights and responsibilities of local and state governments to administer erosion and sediment control programs, as well as those of property owners who must comply with them.

3.1.6 Virginia Stormwater Management Act and Program

VDEQ is the lead agency for developing and implementing statewide stormwater management and nonpoint source pollution control programs to protect the Commonwealth's water quality and quantity. VDEQ is responsible for the issuance and enforcement of individual and general permits that control stormwater discharges from municipal separate storm sewer systems (MS4) and construction activities. VDEQ administers these programs through Virginia Stormwater Management Program (VSMP) Regulation (9 VAC 25-870), authorized by the Virginia Stormwater Management Act (62.1-44.15:24 of the Code of Virginia).

3.1.7 Navigable Waters Protection Rule

The U.S. Environmental Protection Agency (EPA) and the Department of the Army published the Navigable Waters Protection Rule to define “waters of the United States” (WOTUS) in the Federal Register, effective June 22, 2020. The Navigable Waters Protection Rule is the second step in a comprehensive, twostep process intended to review and revise the definition of ‘‘waters of the United States’’ consistent with the Executive Order signed on February 28, 2017, ‘‘Restoring the Rule of Law, Federalism, and Economic Growth by Reviewing the ‘Waters of the United States’ Rule.’’ This final definition increases the predictability and consistency of Clean Water Act programs by clarifying the scope of ‘‘waters of the United States’’ federally regulated under the Act. In this final rule, the agencies interpret the term “waters of the United States” to encompass: The territorial seas and traditional navigable waters; perennial and intermittent tributaries that contribute surface water flow to such waters; certain lakes, ponds, and impoundments of jurisdictional waters; and wetlands adjacent to other jurisdictional waters.

3.1.8 Wild and Scenic Rivers

The Wild and Scenic Rivers Act (16 U.S.C. 1271, et seq.) establishes requirements for water resource projects affecting wild, scenic, or recreational rivers within the National Wild and Scenic Rivers System. The protective restrictions under the Act mostly apply to federal agencies; however, private projects that require federal agency approval or permits may also be affected.

3.1.9 Groundwater Management Act

Increasing concerns over drawdown in the coastal plain and other aquifers led to the development of legislation to regulate withdrawal. The General Assembly determined that, pursuant to the Groundwater Act of 1973, the continued, unrestricted usage of ground water contributes to pollution and shortage of ground water, thereby jeopardizing the public welfare, safety and health. In areas classified as Groundwater Management Areas (GWMA), withdrawals of groundwater is now regulated under the Ground Water Management Act of 1992 (Code of Virginia, Title 62.1, Chapter 25) and the Groundwater Withdrawal Regulations (9 VAC 25-610), through the Groundwater Withdrawal Permitting Program.

3.2 NASA LANGLEY OPERATIONS

3.2.1 Surface Waters

NASA 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 western boundary of NASA 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 portion of the West Area in the south drains to Tides Mill Creek. The East Area drains to the Back River. The local waterways are influenced by tides in the Chesapeake Bay. 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 the NASA LaRC property qualify for the provisions of the Wild and Scenic Rivers Act, although some do in the Hampton Roads area.

3.2.2 Groundwater

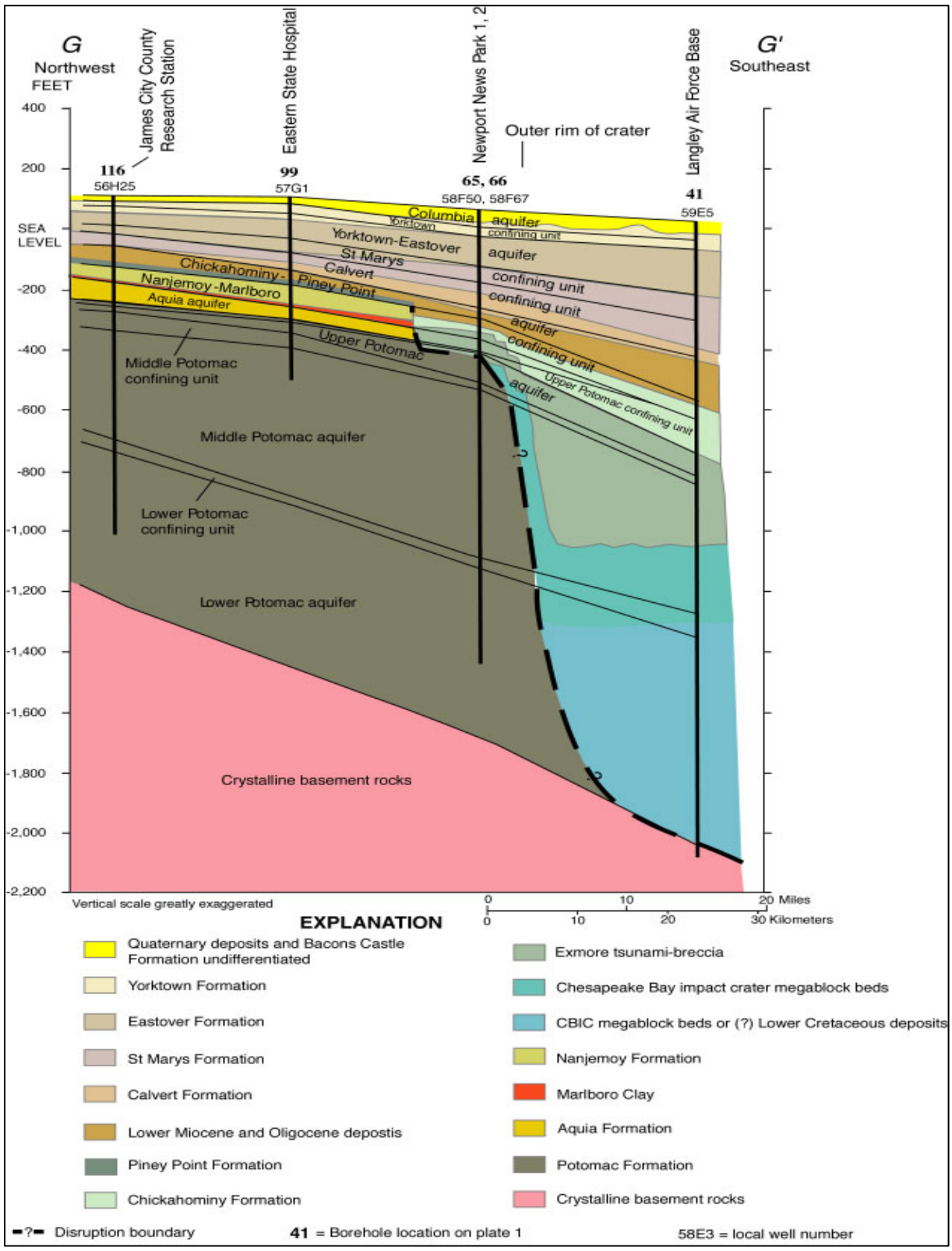
Hydrogeology

A hydrogeologic model of the Virginia Coastal Plain was originally developed as part of the Regional Aquifer System Analysis (RASA) program of the U.S. Geological Survey (USGS) (Meng and Harsh, 1988). This RASA regional-scale model was then revised, in the early 1990's by the USGS, in cooperation with state and local agencies, to incorporate reinterpretations of the hydrogeologic framework from southeastern Virginia (Hamilton and Larson, 1988) and York-James peninsula (Laczniak and Meng, 1988) studies. More recently, USGS scientists have discovered that a comet or meteorite struck the Earth about 35 million years ago near the present-day mouth of the Chesapeake Bay. The resulting 56-mile wide crater, with epicenter located at Cape Charles, Virginia, severely disrupted several Coastal Plain aquifers and created Virginia's

"inland saltwater wedge" that limits the amount of fresh water available in the lower bay region (Powars et al, 1993). Collaborative research further characterized the stratigraphic features created by the impact and the resulting hydrogeologic framework, ground-water flow system, and regional water quality, which was incorporated into existing USGS models for the Virginia Coastal Plain. In 2009, USGS published a Simulation of Groundwater Flow in the Coastal Plain Aquifer System of Virginia (Heywood and Pope, 2009).

Groundwater in the Coastal Plain is present primarily in pores in the sediments. Thick sequences of porous and permeable strata form regional aquifers, and less permeable strata form confining units between the aquifers. Figure 3-1 illustrates current information on geological framework in relation to cross-sectional hydrogeological units from Meng and Harsh (1988) and Laczniak and Meng (1988) that traverse the lower York-James Peninsula.

Figure 3-1
LOWER YORK-JAMES PENINSULA CROSS SECTIONAL HYDROGEOLOGICAL UNIT



Groundwater Flow

Groundwater in the Virginia Coastal Plain 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 NASA LaRC is tidally influenced at locations near Brick Kiln Creek and Tabbs Creek. A total of 41 shallow wells (depth up to 6 m or 20 ft), 13 intermediate wells (22.9 m or 75 ft), and 9 deep wells (depths over 29 m or 95 ft) have been installed over the years to identify/monitor potential contamination of groundwater at NASA LaRC. Table 3-1 lists the sites where the groundwater monitoring wells are located. The wells are sampled periodically and the LaRC Environmental Management Office (EMO) maintains all records regarding monitoring well sampling events.

Table 3-1
NASA LANGLEY RESEARCH CENTER
MONITORING WELLS

Site	Number of Wells	Well Type
Chemical Waste Pit (Pyrotechnics Area	3	Shallow
Construction Debris Landfill	15	Shallow
Construction Debris Landfill	6	Intermediate
Construction Debris Landfill	4	Deep
Stratton Road Substation	6	Shallow
Area E Warehouse	5	Shallow
Site 15	7	Shallow
Perimeter	5	Shallow
Perimeter	7	Intermediate
Perimeter	5	Deep
TOTAL	**63**	

As reported in the 2012 Water Resources Report to the General Assembly, state-wide groundwater withdrawals over a five year period from 2007-2011 averaged 188.9 MGD. Groundwater withdrawals have lowered water levels in Virginia Coastal Plain aquifers and have resulted in drawdown in the Potomac aquifer exceeding 60 meters (200 feet) in some areas by 2003 (Heywood and Pope, 2009).

NASA LaRC is located within the regulated Eastern Virginia GWMA. The Eastern Virginia GWMA comprises all areas east of Interstate 95. Any person or entity located within a declared

GWMA must obtain a permit to withdraw 300,000 gallons or more of groundwater in any one month. Among the criteria for issuing groundwater withdrawal permits are the evaluation of the withdrawal and an assessment of the probable additional groundwater drawdown resulting from the proposed withdrawal.

3.2.3 Water Quality

Surface Waters Quality

The VDEQ Water Division collects water quality data on a regular basis for the Brick Kiln Creek location. This data is collected near the Route 134 Bridge over the creek, located approximately 1.6km (1 mile) northwest of NASA LaRC. The VDEQ collects water quality data on a regular basis from five other monitoring stations located in the Back River around NASA LaRC and LAFB.

Stream quality standards, applicable to the Back River and its tributaries, which are an important source of shellfish, crabs, and fish, are available at: https://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityStandards.aspx.

Tabbs Creek, a tributary of the Back River, drains entirely within NASA LaRC and LAFB property. Sampling studies conducted in the 1980's showed polychlorinated biphenyl (PCB) and polychlorinated terphenyl (PCT) contamination in the creek sediment and in the storm sewer lines connected to Outfall 009. In 1992, NASA LaRC conducted sampling of Tabbs Creek as part of the remedial investigation. The study analyzed water samples from Tabbs Creek and compared the sample results to EPA's Ambient Water Quality Criteria (AWQC) and the Commonwealth of Virginia surface water standards for human-health-based criteria and ecology-based criteria. The assessments concluded that the contaminants found in surface water did not pose significant risks to human health or the environment. The contaminated portion of the storm sewer system was cleaned in 1995 under a Federal Facilities Compliance Agreement signed by NASA LaRC in 1990 with EPA and Virginia State agencies. In the spring of 2000, LaRC completed clean-up of the PCB/PCT contaminated sediments in Tabbs Creek. Documentation on the sampling results, cleanup activities and federal compliance agreements are maintained by EMO.

In regards to regulated discharges of oil to waters of the U.S under the CWA, NASA LaRC does not operate any oil transfer operations over water and does not store more than 1,000,000 gallons of oil onsite. Therefore, NASA LaRC is not required to submit a Facility Response Plan to the EPA or the Coast Guard as laid out in the Oil Pollution Act of 1990. The Center has an Integrated Spill Contingency Plan (ISCP) that complies with the SPCC requirements of the EPA's Oil Pollution Prevention Regulations. The plan is updated in accordance with SPCC requirements. Copies of this plan are maintained by the EMO.

Impaired Waters

The EPA has established the Chesapeake Bay TMDL, which is considered by many as a comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks and rivers. This TMDL is the largest ever developed. It identifies the necessary pollution reductions of nitrogen,

phosphorus, and sediment across Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia and sets pollution limits necessary to meet applicable water quality standards in the Bay. LaRC actively participated in this TMDL process and submitted information to the state to help the state generate a Phase III Watershed Implementation Plan (WIP).

The Northwest and Southwest branches of the Back River are identified on the State's list of impaired waters dues to high levels of Fecal Coliform that impact recreation and shellfish harvesting. Several segments of the Back River, including Brick Kiln Creek, are listed on the Virginia 305(b)/303(d) Water Quality Assessment Integrated Report as an impaired waterbody due to violation of the State's water quality standard for fecal coliform and enterococcus. Potential sources of bacteria in the watershed are MS4 regulated areas and nonpoint sources; including livestock, wildlife, pets, and human activities, failing septic systems, and Sanitary Sewer Overflows (SSOs).

NASA LaRC Applicable TMDLs

As stated in Section 10.4 of the Chesapeake Bay TMDL, federal facilities in the Chesapeake Bay drainage area, including LaRC, are required to participate in the TMDL process and meet WLA reductions. Specifically, for federal facilities this equates to a reduction of 9% of nitrogen loads, 16% of phosphorous loads, and 20% of sediment loads from impervious regulated acres, and 6% of nitrogen loads, 7.25% of phosphorous loads, and 8.75% sediment loads beyond 2009 progress loads for pervious regulated acreage. LaRC is actively working with the Chesapeake Bay Program's Federal Facilities workgroup and has been responding to data calls for updates to land cover and the implementation of best management practices (BMPs) that are used to track progress toward meeting the reduction goals under the Bay TMDL. LaRC will address this TMDL through the MS4 permit process over three permit cycles (15 years). BMP implementation on existing developed lands and areas of new construction are used by LaRC to achieve nutrient and sediment reductions, and are required for TMDL and MS4 compliance. In addition, LaRC submitted Phase 2 of the TMDL Action Plan that demonstrates LaRC's ability to ensure compliance and includes the means and methods LaRC will use to meet reduction levels.

In addition, a Back River Bacteria TMDL Report has been developed to meet fecal coliform standards by establishing TMDLs for eighteen listed segments. These listed segments fail to meet the Water Quality Standards for bacteria (fecal coliform, enterococcus, and E. coli) and do not support the shellfish harvesting designated use. NASA LaRC submitted public comment on the draft Back River TMDL published in March 2017; the final Back River TMDL was published in spring 2018. NASA LaRC discharges to Brick Kiln Creek, Tabbs Creek, and the NW Branch of the Back River, all of which are covered under this TMDL. NASA LaRC has a Waste Load Allocation for fecal bacteria, with the main source of bacteria being from wildlife.

Groundwater Quality

Groundwater at NASA LaRC is often brackish because of the Chesapeake Bay's close proximity and marine deposits found in the soil. Since 1995, samples collected from the monitoring wells at LaRC have not shown contamination of the groundwater. The LaRC EMO maintains the results of periodic groundwater level measurements and sample analysis. Typically, ground water at NASA LaRC can be encountered at 1.5 - 2.1 m (5-7 ft) depth.

In 2017, NASA LaRC installed a groundwater well and pressure sensor to record well depth. The well was installed for compliance with an Administrative Order from the Hampton Roads Sanitation District (HRSD), and to monitor tidal and rainfall fluctuations. The well is located near Building 1308 and all data is transmitted to the OSI PI system for remote monitoring. Through groundwater well analysis, the groundwater at NASA LaRC is minimally tidally influenced, with tidal fluctuations ranging between 0.3 - 0.6 m (1-2 ft).

3.2.4 Water Permits

NASA LaRC does not draw water from the surface water resources, nor does it have any collection or treatment facilities. Since the Center obtains all of its water from independent sources and the public water system, and it does not sell the water or operate as an interstate commerce carrier, LaRC is exempt from the SDWA and Virginia Waterworks Regulations.

NASA LaRC operates under three water discharge permits, two from the State and one from the HRSD. These permits limit the types and quantities of pollutants discharged, and establish monitoring and recordkeeping requirements. Any discharge not allowed under these permits is a violation. The water discharge permits are:

- *HRSD Permit No. 0085* allows LaRC to discharge nonhazardous industrial wastewater and sanitary sewage to the HRSD sanitary sewer system. HRSD does not provide treatment for hazardous wastes. The HRSD Permit specifies the allowable discharges, pollutant limitations, and monitoring requirements.

- *Virginia Stormwater Management Program MS4 Permit No. VAR040092*, administered by the VDEQ, requires that NASA LaRC develop, implement, and enforce a stormwater management program to reduce the discharge of pollutants from the Center to the maximum extent practicable. LaRC's stormwater management program must include minimum control measures (MCMs) as specified in the permit and best management practices (BMPs) must be implemented to meet the control measures. This permit is also used to address any applicable TMDLs.

- *VPDES (Industrial) Permit No. 0024741*, administered by the VDEQ, authorizes NASA LaRC to discharge to surface waters in accordance with the effluent limitations and monitoring requirements set forth in the Permit. NASA LaRC has 16 outfalls that are permitted to discharge industrial process wastewater and/or stormwater runoff. Table 3-2 provides a summary of the 16 outfalls and Figure 3-2 shows the locations of the outfalls at NASA LaRC.

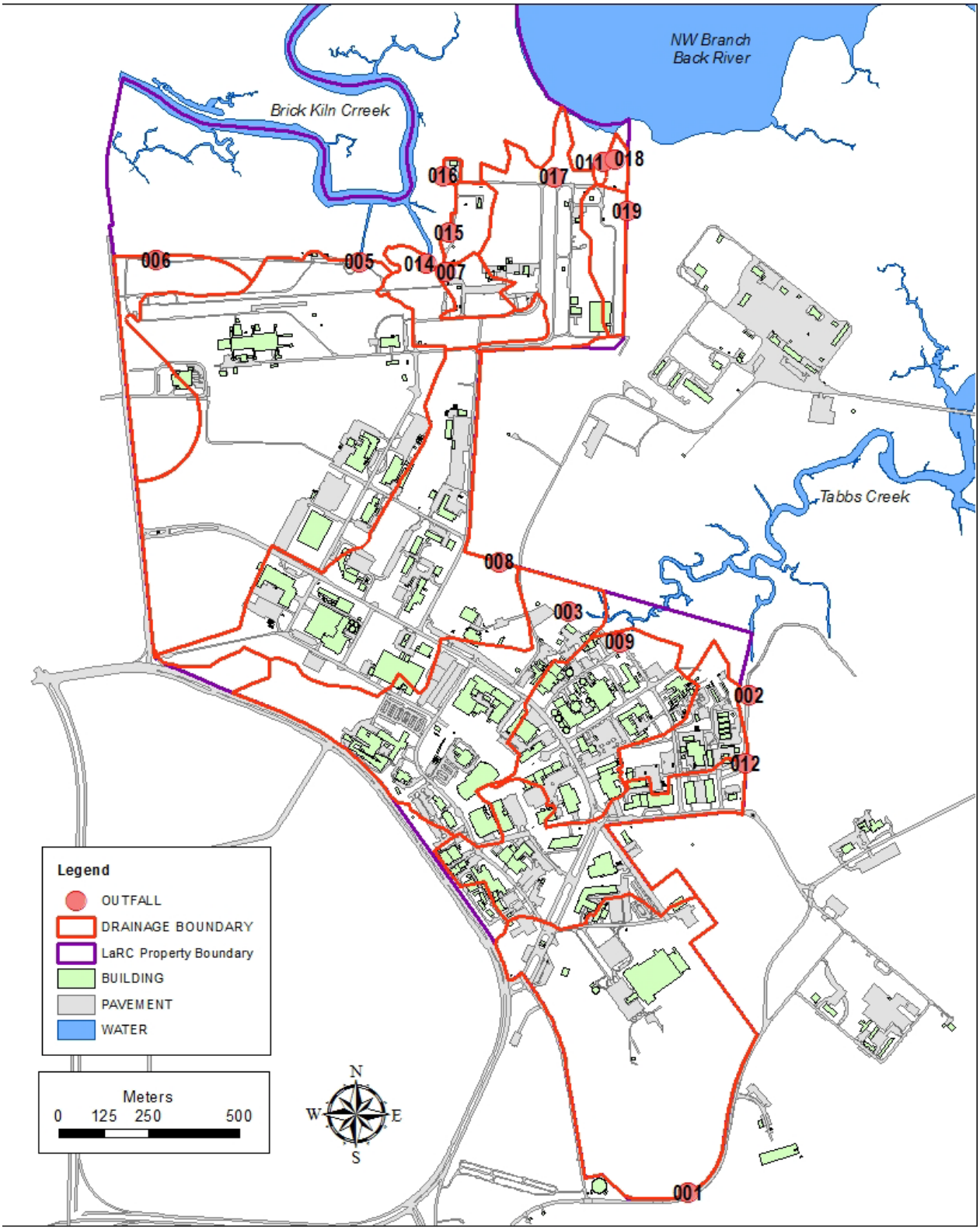
A summary of the LaRC's 16 VPDES industrial permit outfalls and a map showing their locations can be found in Table 3-2 and Figure 3-2, respectively. All of LaRC's water quality testing parameters that are dictated by regulatory permits have been summarized in Table 3-3.

Table 3-2
NASA LARC STORMWATER OUTFALL SUMMARY

Outfall	Source	Receiving Water Body
001	Cooling Tower Blowdown, Stormwater Runoff	Tides Mill Creek, Chesapeake Bay
002	Stormwater Runoff	Tabbs Creek, Chesapeake Bay
003	Cooling Tower Blowdown, Stormwater Runoff (oil/water separator), Water Softener Backwash Brine	Tabbs Creek, Chesapeake Bay
005	Cooling Tower Blowdown, Stormwater Runoff, Water Softener Backwash Brine	Brick Kiln Creek, Chesapeake Bay
006	Stormwater Runoff	Brick Kiln Creek, Chesapeake Bay
007	Stormwater Runoff	Brick Kiln Creek, Chesapeake Bay
008	Cooling Tower Blowdown, Stormwater Runoff, Car Washing	Tabbs Creek, Chesapeake Bay
009	Cooling Tower Blowdown, Stormwater Runoff (oil/water separator), Jet Cutting Effluent Water, Intermittent Compressor Condensate, Car Washing	Tabbs Creek, Chesapeake Bay
011	Stormwater Runoff	Northwest Branch of Back River
012	Cooling Tower Blowdown and Stormwater Runoff	Tabbs Creek, Chesapeake Bay
014	Stormwater Runoff	Brick Kiln Creek, Chesapeake Bay
015	Stormwater Runoff	Brick Kiln Creek, Chesapeake Bay
016	Stormwater Runoff	Brick Kiln Creek, Chesapeake Bay
017	Stormwater Runoff	Northwest Branch of Back River
018	Stormwater Runoff	Northwest Branch of Back River
019	Stormwater Runoff	Northwest Branch of Back River

Table 3-3 NASA LARC WATER PERMITS – WATER QUALITY TESTING PARAMETERS		
HRSD Permit No. 0085		
Quarterly pH test at Building 1223		
VPDES Permit No. VA0024741		
Outfall	**Pollutant Source**	**Water Quality Testing Parameter**
003	Cooling Tower Blowdown, Stormwater Runoff, De-aerator Tank Condensate Overflow, Water Softener Backwash Brine	Flow, pH, Temperature, Total Residual Chlorine, Ammonia, Total Phosphorus Total Residual Copper, and Total Residual Zinc every 6 months
009	Cooling Tower Blowdown, Stormwater Runoff, Water Jet Metal Cutting Effluent, Intermittent Compressor Condensate, Mach 6 Nozzle Water Jacket System Water, Basement Sump Oil Water Separator, Aircraft Spot Cleaning, Vehicle Wash Water	Flow, pH, Temperature, Total Residual Chlorine, Ammonia, Total Phosphorus Total Residual Copper, and Total Residual Zinc every 6 months
001, 002, 005, 008, 012	Cooling Tower Blowdown, Water Softener Backwash Brine, Stormwater Runoff, Aircraft Spot Cleaning, Vehicle Wash Water	No testing required.
006, 007, 011,014, 015, 016, 017, 018, 019	Stormwater Runoff	No testing required.
MS4 Permit No. VAR040092		
Outfall	**Pollutant Source**	**Water Quality Testing Parameter**
Point Source	Stormwater	No testing required.

Figure 3-2
NASA LaRC Outfalls



3.2.5 Stormwater Management

NASA Langley has approval from VDEQ to administer its own stormwater program through the submission of annual VSMP Standards and Specifications. This document, "NASA Langley Research Center Annual Standards and Specifications: Erosion and Sediment Control (ESC) & Stormwater Management (SWM)" (hereafter referred to as the "LaRC SWM Annual Standards and Specs), outlines the requirements for Stormwater Management and Erosion and Sediment Control for construction and demolition activities on Center and provides the authority for enforcement of requirements by the Environmental staff. EMO evaluates projects under these standards and specs and determines the need for registration for permit coverage with VDEQ based on the size of the land disturbance.

It is LaRC's policy that all land-disturbing activities apply ESC practices and SWM best management practices, regardless of the size of disturbance. These practices must ensure that there is no discharge of sediment from a project and that a project does not adversely affect water quality. Projects not in compliance with these requirements are subject to enforcement action. The following requirements are enforced for land-disturbing activities on Center:

- Land-disturbing activities less than one acre are subject to the following requirements. Land-disturbing activities (as defined in §62.1-44.15:51 of the Code of Virginia) of at least 929 square meters (10,000 square feet) or when deemed necessary by EMO Environmental Staff (to a minimum of 2,500 square feet) require a site-specific ESC Plan that is compliant with the Virginia Erosion and Sediment Control Regulations (9 VAC 25-840). This plan shall be approved by the EMO Environmental staff prior to any land disturbing work commencing. In addition, when deemed necessary by the EMO Environmental staff, a land-disturbing activity (to a minimum of 232 square meters or 2,500 square feet) shall prepare a site-specific Stormwater Management (SWM) Plan that is compliant with the VSMP Regulations (9 VAC 25-870). This plan shall be approved by the EMO Environmental staff prior to any land disturbing work commencing.

- Land-disturbing activities of at least one acre of land require coverage under VDEQ General Permit No. VAR10, the General VPDES Permit for Discharges of Stormwater from Construction Activities (referred to as the "construction general permit", or CGP). Operators of such activities are required to submit a permit fee and registration statement to VDEQ to apply for CGP, and submit a Stormwater Pollution Prevention Plan (SWPPP) as required by VSMP Regulations (9 VAC 25-870) to EMO for review and approval before the commencement of any land disturbance activities. The requirements for SWPPP contents are outlined in the LaRC SWM Annual Standards and Specs.

Stormwater is typically regulated under LaRC's aforementioned stormwater permits. However, as a federal facility LaRC is also subject to the stormwater requirements of Energy Independence and Security Act (EISA) Section 438. EISA Section 438 essentially requires projects over 5,000 square feet in size to implement stormwater management best management pre-development practices that will maintain the predevelopment hydrology of the site.

Being in the environmentally sensitive Chesapeake Bay watershed also adds additional requirements to LaRC's water quality planning initiatives. LaRC is subject to the requirements of Executive Order 13508. Most of the requirements of the Executive Order fell onto the EPA and

regulating States to develop plans of action for the Bay. NASA LaRC's primary part for participation and compliance with Executive Order 13508 is covered by LaRC's MS4 permit and the TMDL Action Plan.

3.2.6 Sources of Water Pollution

Water pollution sources at LaRC are limited due to the relatively low level of industrial operations at the Center. The major pollutants are the chemicals used to treat the boilers and cooling towers. Discharge of these pollutants is in accordance with the Center's VPDES permit. The disposal or discharge of laboratory chemicals into sinks or drains is a potential pollutant source; however LaRC policy prohibits this practice. The Center employs various Best Management Practices (BMPs) to prevent or mitigate stormwater and/or sewer system pollution from facility activities. These include employee training, preventive maintenance, visual inspections, spill prevention and response, sediment and erosion control, good housekeeping, and record keeping and reporting. BMPs are also employed in the Center's pesticide and herbicide program.

Land-disturbing and construction activities are carried out in compliance with appropriate State requirements (Permit VAR10) and, historically, have not caused any increased sediment discharge into receiving waters. LaRC will continue to minimize these pollutant streams through permitting, inspections, and the use of best management practices.

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4.0 LAND RESOURCES

4.1 REGULATORY OVERVIEW

4.1.1 Coastal Zone Management Act

The Federal Coastal Zone Management Act of 1972 (16 USC § 1451 et seq.) requires that federal actions that will have reasonably foreseeable effects on the land or water uses or natural resources of a State's coastal zone must be consistent with federally approved State Coastal Management Programs. These "coastal effects" include direct effects, as well as cumulative and secondary effects resulting from the Federal action(s).

VDEQ is the lead agency for the Virginia Coastal Zone Management (CZM) Program. Although Federal lands are excluded from Virginia's Coastal Management Area (CMA), any activity on Federal land that has reasonably foreseeable coastal effects must be consistent with the enforceable policies of the CZM Program. Enforceable policies of Virginia's CZM Program that must be considered when making a Federal Consistency Determination include the following: Coastal Land Management, Dunes Management, Fisheries Management, Nonpoint Source Water Pollution Control, Point Source Water Pollution Control, Shoreline Management, Subaqueous Lands Management and Wetlands Management. A description of these programs and the administering agencies can be found at:
https://www.deq.virginia.gov/Programs/CoastalZoneManagement.aspx.

4.1.2 Wetlands

In accordance with Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (USACE) requires a permit for all activities involving a discharge of dredged or fill material in waters of the United States, including wetlands. The EPA and USACE have joint authority and coordinate review of permit applications, development of regional and general permits, and enforcement activities (varies by region). The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) are reviewing agencies and provide comments within their respective areas of expertise, which include compliance with Section 7 of the Federal Endangered Species Act (See Section 6.1.1). The regulations implementing the Section 404 permit program are contained in 33 CFR Parts 320 – 330 and 40 CFR Part 230. Under the Section 404 permit program, a project involving discharge of dredge or fill material may require an individual permit, or it may be covered under the terms and conditions of a regional or nationwide general permit.

As the primary agency with authority under Section 404 of the CWA for wetland delineation, the USACE developed a manual in 1987 for delineating regulated wetlands. According to the manual, an area is considered to be a jurisdictional wetland if under normal circumstances it meets all three of the following criteria: (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology. The manual defines these criteria and describes the conditions that indicate that the three wetland criteria are present. The manual and other documents relating to wetlands delineation are available at:
http://www.cpe.rutgers.edu/Wetlands/1987-Army-Corps-Wetlands-Delineation-Manual.pdf.

Within Virginia, projects involving the use or development of wetlands require a permit under VDEQ's Virginia Water Protection (VWP) Permit Program. Information on the permit regulations and fees is available at:
https://www.deq.virginia.gov/Programs/Water/WetlandsStreams.aspx.

4.1.3 Executive Order 11990 - Protection of Wetlands

Executive Order 11990 requires each Federal agency to "take action to minimize the destruction, loss, or degradation of wetlands, unless there is no practicable alternative, and then the proposed action must include all practicable measures to minimize harm to wetlands." Federal agencies must provide an opportunity for early public review of any plans or proposals for new construction in wetlands.

4.1.4 Executive Order 11988 - Floodplain Management

Executive Order 11988 requires each Federal agency to "take action to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural beneficial values served by floodplains in carrying out its responsibilities." Federal agencies must determine whether a proposed action will occur in a floodplain, and must consider alternatives. If there are no practicable alternatives to locating a project within the floodplain, the project proponent must include floodplain protection provisions and issue a public notice explaining why the proposed action is located within the floodplain. A floodplain assessment must be included in any EA or EIS for the project.

4.1.5 Virginia Wetlands Act

The Virginia Wetlands Act (Chapter 13 of the Laws of Virginia Relating to Submerged Lands, Wetlands, and Coastal Primary Sand Dunes and Beaches, Title 28.2-1300 through 28.2-1320) requires a permit from Virginia Marine Resources Commission (VMRC) for any activity which would use or develop a tidal wetland. The VMRC has issued wetland guidelines that specify the criteria for evaluating the permit application. The VMRC also has issued a Wetlands Mitigation-Compensation Policy (4VAC20-390).

4.1.6 Virginia Chesapeake Bay Preservation Act

The Virginia General Assembly passed the Chesapeake Bay Preservation Act in 1988 with the purpose of improving the health of the bay by managing non-point source pollution in its tributaries. The Act requires localities to protect lands within their jurisdictions in order to protect the Chesapeake Bay water quality. To do so, each locality must adopt a program based on the Act and the Chesapeake Bay Preservation Area Designation and Management Regulations. Localities must enact zoning and subdivision ordinances that provide restrictive criteria for land use and development in Chesapeake Bay Preservation Areas (CBPAs). In the City of Hampton, the CBPAs require conformance with performance criteria. These areas include Resource Protection Areas (RPAs) and Resource Management Areas (RMAs) as designated by the local government:

- RPAs include tidal wetlands, certain non-tidal wetlands and tidal shores, and a minimum 30 m (100 ft) vegetated buffer area located adjacent and landward of these features and along both sides of any water body with perennial flow.

- RMAs, which require less stringent performance criteria, include those areas of the City within 30 m (100 ft) of the inland limit of the RPA.

The City of Hampton does not have jurisdiction over federal property and the CBPA requirements do not apply to NASA LaRC, however, the Center has set its own policy to avoid land use in areas analogous to RPAs and RMAs.

4.2 NASA LANGLEY OPERATIONS

4.2.1 Geology and Topography

NASA LaRC sits on the rim of a 35-million year old crater that was identified in 1993, but was not confirmed until several years later (Poag, 1996). In the summer of 2000, the U.S. Geological Survey drilled a 635 m (2,084 ft) deep hole in the grassy area SW of Building 1190 at NASA LaRC to obtain core and rock sediment samples from beneath the Center. The samples were part of an ongoing project to research the impacts of the crater on the Chesapeake Bay and southeastern Virginia's groundwater resources. Drilling continued through 2006 at other sites in southeast Virginia.

Additional information on the impacts of the crater on the Chesapeake Bay and the southeastern Virginia groundwater resources is available at:
https://woodshole.er.usgs.gov/epubs/bolide/

4.2.2 Seismicity

Although Virginia is a state with considerable seismic activity, earthquakes are low intensity (VI or less on the Modified Mercali Scale), and are concentrated in the central and western portions of the state in the Piedmont and the Valley and Ridge physiographic provinces. LaRC is located in an area designated as Seismic Risk Zone 1, which is an area with minor damage expected. Additional information on Virginia's seismicity can be found at: https://earthquake.usgs.gov/earthquakes/byregion/virginia.php.

4.2.3 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. The surface is a deposited loam from 0.6 m (2 ft) to 1.8 m (6 ft) in depth. The majority of soils in the non-tidal wetland areas are Chicahominy silt loam and clay, Munden loamy fine sand, fine sandy loam and sand, and those in the tidal areas are mainly Bohicket muck. Current information on soils at NASA LaRC is available at: https://websoilsurvey.nrcs.usda.gov/app/.

4.2.4 Land Use

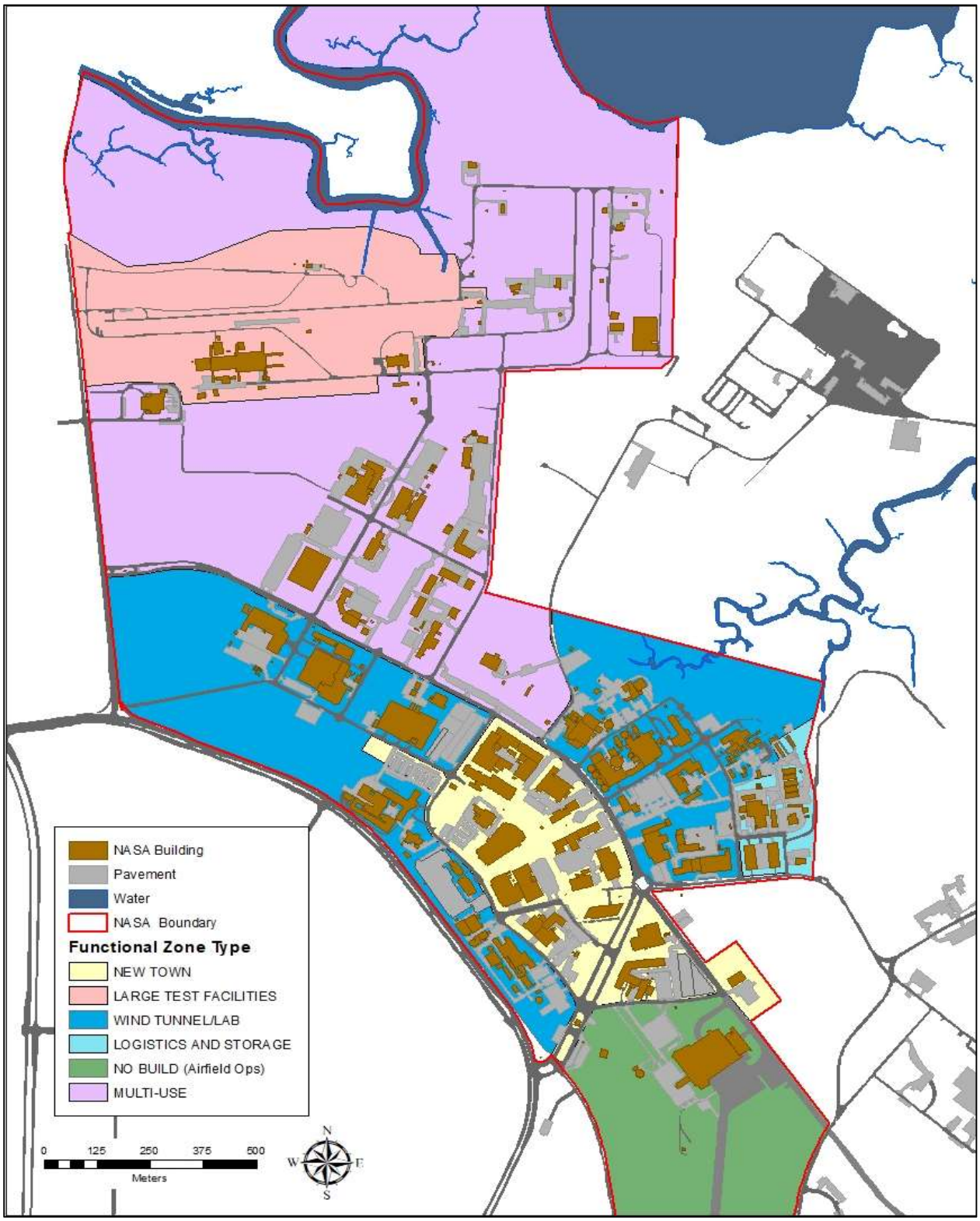
NASA LaRC is situated within the Hampton Roads Metropolitan Statistical Area (MSA) which consists of the Virginia Cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg; the Virginia Counties of Gloucester, Isle of Wight, James City, Mathews, and York; and Currituck County in North Carolina.

Langley Air Force Base, part of Joint Base Langley Eustis, dominates land use in the immediate vicinity of LaRC. To the east of LaRC are the northwest and southwest branches of the Back River, beyond which is the Chesapeake Bay. To the south and north of LaRC are the densely developed residential communities of Hampton and Poquoson. The area to the west of LaRC is one of the least developed areas of the City of Hampton; development immediately outside the western-southwestern LaRC boundary consists of two residential trailer parks, an apartment complex, and an auto racetrack.

4.2.4.1 Land-Use Planning Zones

NASA LaRC has a current Facilities Master Plan that supports the Center's strategic approach to programmatic facility planning and prioritization. Figure 4-1 shows LaRC's functional zones.

Figure 4-1
NASA LaRC FUNCTIONAL ZONES



Most of the West Area at LaRC is developed, although several large contiguous tracts of undeveloped land exist within the area. The largest undeveloped sections of the West Area consist of a wooded tract in the southern portion adjacent to LAFB, an extensive wooded area along State Route 172, and individual open tracts scattered throughout the northern portion of the Center. The East Area is fully developed.

In 2016 timeframe, LaRC initiated establishing City Environment for Range Testing of Autonomous Integrated Navigation (CERTAIN) unmanned aerial systems (UAS) ranges throughout the Center. Phase I of CERTAIN was established in the North 40 with subsequent ranges being added in future phases. Figure 4-2 shows the CERTAIN range phases. As of 2020, only Phases I and II have been approved. Phase III and beyond require coordination with LAFB and approval from Center management.

Figure 4-2
CERTAIN UAS Range Phases

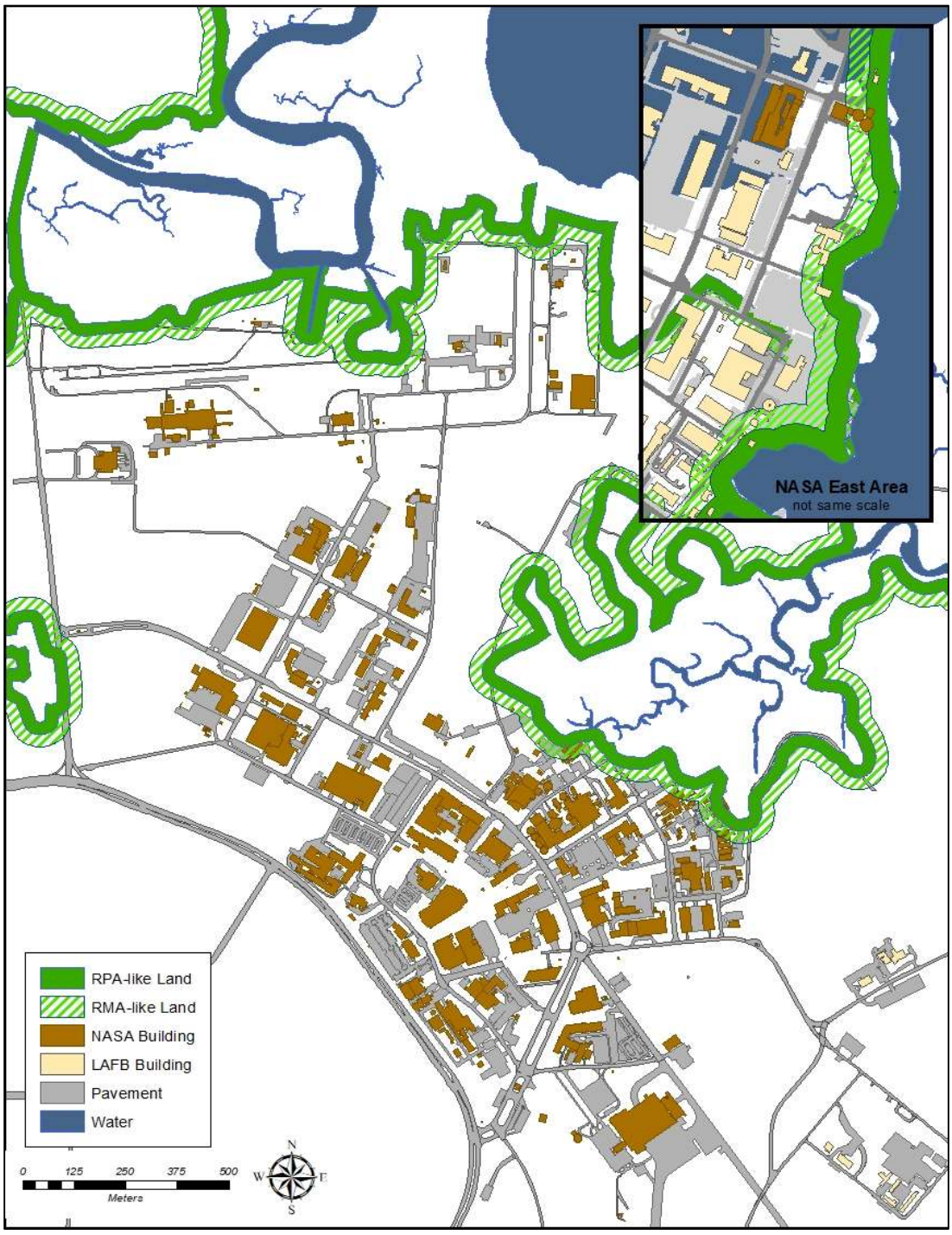
4.2.4.2 Land Use Planning

Chapter 4 of LPR 8500.1 contains the procedures to be followed in new project planning at NASA LaRC. These procedures were established in accordance with the requirements of NEPA and the NASA regulations implementing the provisions of NEPA at 14 CFR 1216.3.

Activities and projects at LaRC must be carried out in a manner that is consistent to the maximum extent practicable with CZMA applicable enforceable policies. LaRC must submit a Federal Consistency Determination to VDEQ in the early planning stages for projects that could affect natural resources, land uses, or water uses in the coastal zone.

Although CBPAs are not applicable on Federal property, LaRC's land use planning policy is to avoid areas that are analogous to RPAs and RMAs to the maximum extent possible. Figure 4-3 shows the areas that meet the definition of RPAs and RMAs at LaRC.

Figure 4-3
Land Similar to RPAs and RMAs at LaRC



4.2.5 Wetlands

NASA LaRC is located in an area of low topographic relief surrounded by a shallow estuarine environment. The Center is close to the northwest and southwest branches of the Back River, and is within the tidal zone of the Chesapeake Bay. The principal drainage ways in the vicinity of the Center, Brick Kiln Creek and Tabbs Creek are tidal creeks with extensive tidal marshes.

In 1991 Old Dominion University (ODU) performed a wetland field survey at NASA LaRC to identify and map the boundaries of forested wetlands. The predominant wetland areas in the vicinity of NASA LaRC identified were the tidal marsh wetlands associated with Brick Kiln Creek and Tabbs Creek. These wetland areas were identified as an estuarine emergent marsh dominated by nearly uniform stands of saltmarsh cordgrass (*Spartina alternaflora*) in the lower intertidal zone, and saltmarsh hay (*S. patens*) and salt grass (*Distichlis spicata*) in the high intertidal zone. Additional dominants in the high marsh were groundsel tree (*Baccharus halmifolia*), rush (*Juncus spp*.), big cordgrass (*S. cynosuroides*) and marsh elder (*Iva fructens*). Common reed (*Phragmites australis*) was common around the upper fringes of the marshes and in areas that have been disturbed by materials such as fill and riprap.

The ODU survey identified three types of forested wetlands at the Center: red maple (*Acer rubrum*) swamp, sweetgum (*Liquidambar styraciflua*) swamp, and water oak (*Quercus nigra*) pond wetlands. The red maple swamp wetland is dominated by red maple with some sweetgum. The sweetgum swamp is dominated by sweetgum, with black gum (*Nyssa sylvatica*) and willow *oak (Q. phellos*). The water oak pond wetland is dominated by water oak and laurel oak (*Q. laurifolia*). These wetlands were identified primarily along the upper reaches of the Brick Kiln Creek and Tabbs Creek marsh wetlands, and in the undeveloped portion of the LaRC West Area. The survey determined that the forested wetlands may be remnants of a larger wetland area that had been converted to non-wetland by ditches and draining. Shrub-scrub wetlands were identified in limited areas, mostly in ditches adjacent to the marsh wetlands. Young red maple, sweetgum, and willow (*Salix sp*.) characterize the shrub-scrub wetlands.

In 2001, as part of a potential development project and at LaRC's request, the USACE reviewed the wooded property to the south and east of the Center's main gate and determined that no jurisdictional wetlands exist at the site.

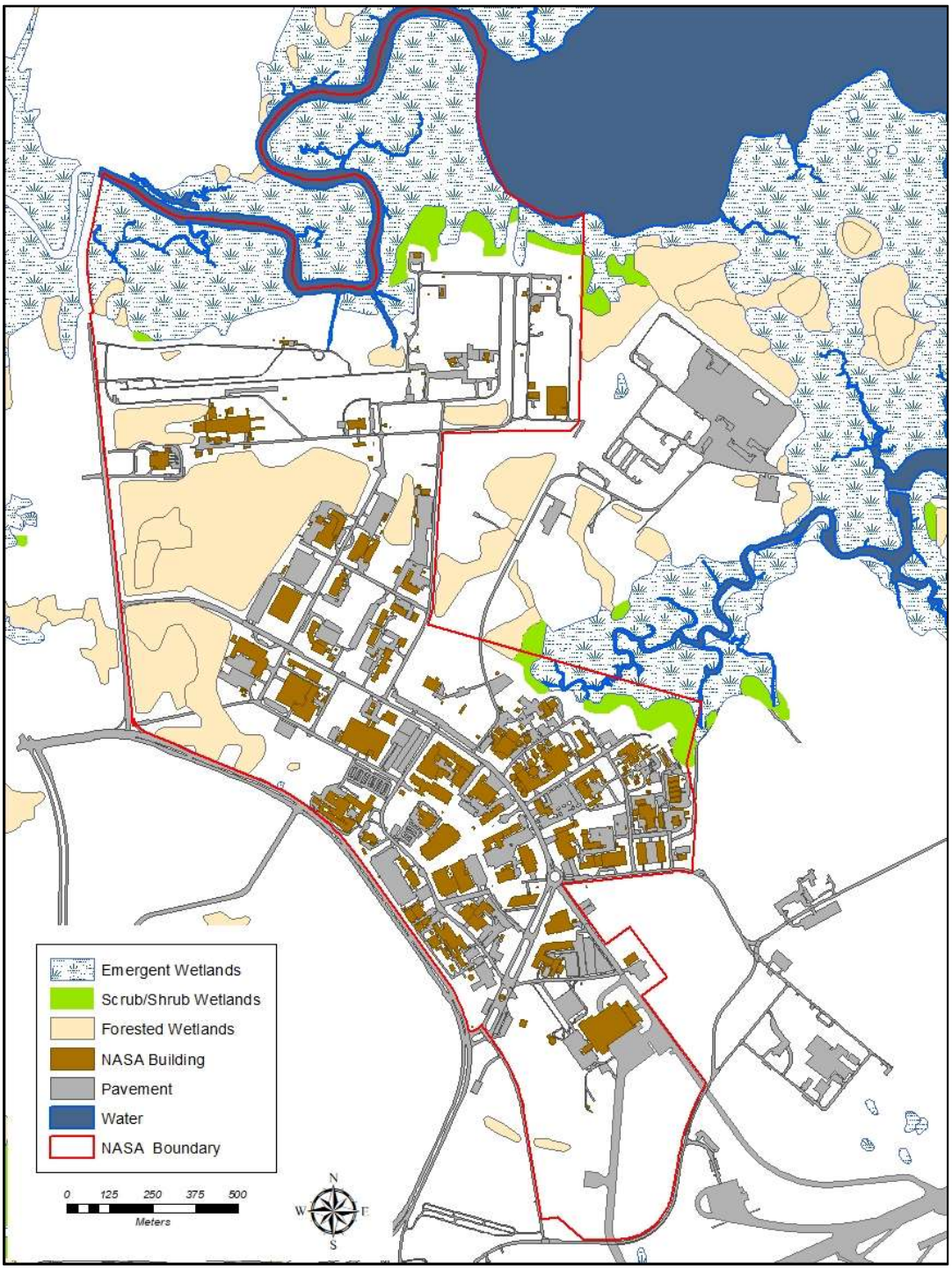
In the fall of 2004, to update and verify portions of the 1991 ODU survey, NASA LaRC performed a wetlands delineation study on approximately 54 hectares (134 acres) of mixed pine, hardwood forest and lawn. Field reconnaissance of the wooded portion of the site found the canopy to be approximately 50 years old, consisting primarily of sweet-gum (*Liquidambar styraciflua*) and red maple (*Acer rubrum*). The subcanopy is composed of red maple, sweet-gum, and paw paw (*Asimina triloba*). The sapling/shrub stratum consists of predominantly paw paw, American holly (*Ilex opaca*), and waxmayrtle (*Myrica cerifera*). The herbaceous stratum in the upland areas consists of primarily Japanese honeysuckle (*Lonicera japonica*) and Virginia Creeper (*Parthenocissus quinquefolia*). The herbaceous strata in the non-tidal wetlands consists primarily of jack-in-the-pulpit (*Arisaema triphyllum*), poison ivy (*Toxicodendron radicans*), and sedges (*Carex* spp.). The herbaceous strata in the tidal wetlands consist of common reed (*Phragmities australis*) salt grass (*Distichlis spicata*) and cord grass (*Spartina alterniflora*). Soils on the property are mapped by the USDA Soil Conservation Service as part of the Soil Survey of Tidewater Cities Area, Virginia. Soils are mapped throughout the study area as Chickahominy silt

loam and Bohicket muck. Field findings indicated the soils primarily consisted of poorly drained to moderately well-drained, dark gray (10YR 4/1) and grayish brown (10YR 5/2) soils, with mottling in many areas. Hydrologic indicators of non-tidal wetlands on-site consist of primary and secondary indicators. Primary indicators observed were inundation, saturation within 12 inches, watermarks, sediment deposits and drainage patterns. Secondary indicators included a positive facultative (FAC)-neutral test, hypertrophied lenticels, shallow rooting, fluting and multiple trunks.

Wetlands delineation survey reports and USACE jurisdictional determination letters are maintained by the LaRC EMO. Current map data is maintained by the LaRC GIS team and is incorporated into the Center's master plan website.

Figure 4-4 identifies the location of wetlands in LaRC's West Area according to the most current National Wetlands Inventory (NWI) which is utilized by LaRC's GIS team to generate maps. No wetlands data is currently available for LaRC's East Area. According to the NWI, approximately 66 hectares (163.2 acres) total of scrub shrub, emergent and forested wetlands are present in LaRC's West Area.

Figure 4-4
NASA LaRC Wetlands – West Area



4.2.6 Floodplains

Executive Order 11988 defines a floodplain as "the lowland and relatively flat areas adjoining inland and coastal water including flood prone areas of offshore islands, including at a minimum, that area subject to one percent or greater chance of flooding in any given year." A 100-year floodplain is defined as the area that has a one percent chance of flooding in any given year. Floodplains are delineated by a floodstage elevation on maps prepared by FEMA.

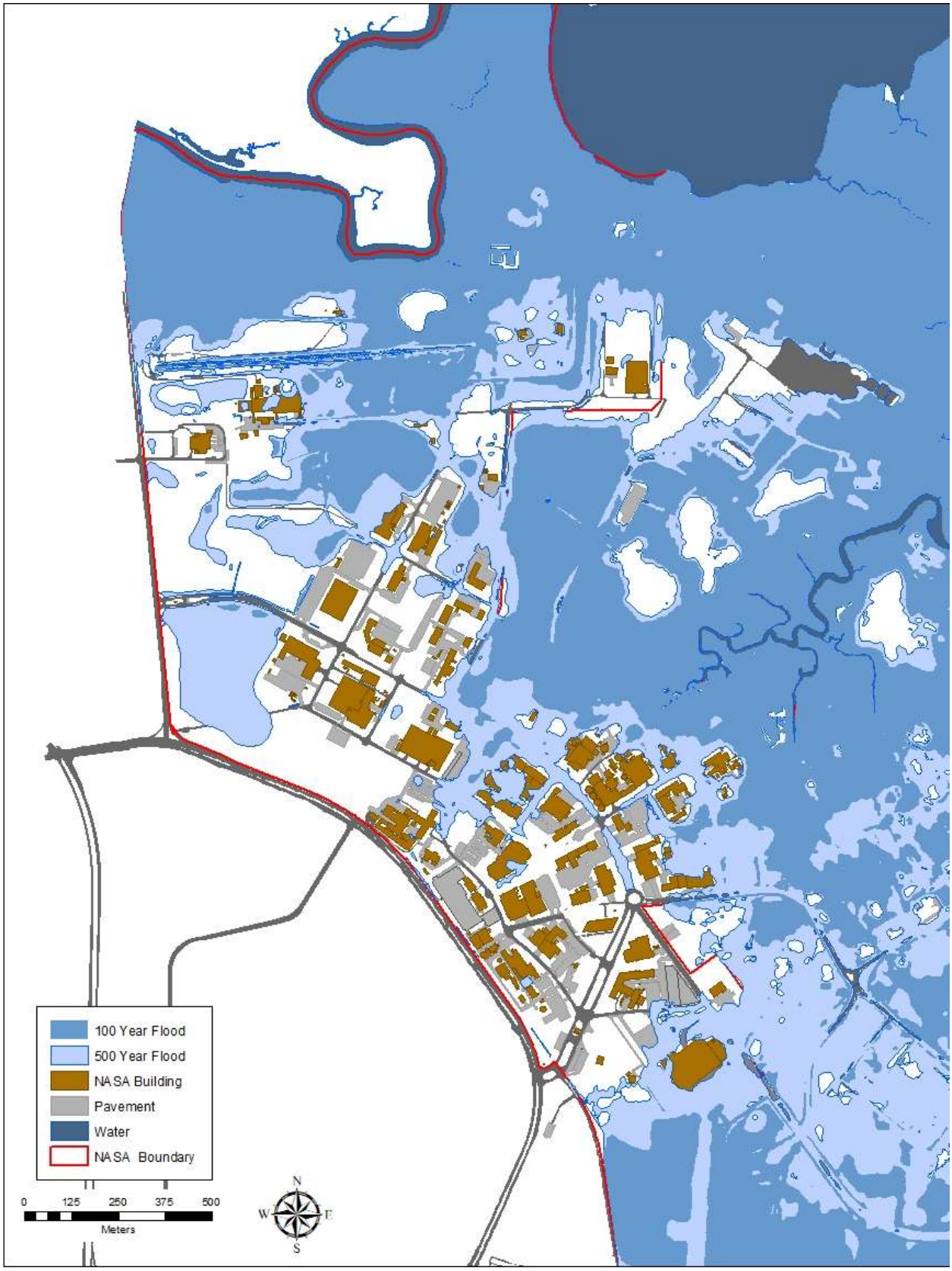
The stillwater elevation for the 100-year floodplain for the City of Hampton near LaRC is estimated by FEMA at 2.6 m (8.5 ft) above mean sea level (MSL), while the stillwater level for the 500-year floodplain is 2.9 m (9.8 ft) above MSL (Figure 4-4). FEMA has estimated 100-year floodwater levels with accompanying waves at about 3.3 m (11.3 ft) above MSL near the Center. Approximately one-third of LaRC is within the 100-yr floodplain. Figure 4-5 shows the 100-yr and 500-yr floodzones at LaRC.

The most destructive hurricanes affecting Virginia in the last century were in 1933, 1954, 1969 and 2003. The 1933 hurricane is reported to have caused the water level in the Back River near NASA LaRC to rise to about 2.6 m (8.5 ft) above MSL. In 2003, the storm surge caused by Hurricane Isabel resulted in a 2.4 m (8 ft) rise in water level. The USACE has conducted Hurricane Evacuation Studies in Virginia to provide a comprehensive detailed plan for responding to flood threats from major hurricanes. The analysis suggests that the LaRC area may be inundated to different levels, as indicated below, depending on the hurricane intensity:

Hurricane Category	Stillwater Level above MSL
Category 2	2.7 m (8.8 ft)
Category 3	3.8 m (12.5 ft)
Category 4	4.8 m (15.6 ft)

A Category 2 hurricane could produce a water level similar to a 100-year flood in the LaRC area. A Category 3 hurricane may produce a level higher than a 500-year flood event in the area. At such high water levels, a majority of the Center would be under several feet of water.

Figure 4-5
FLOODPLAINS AT NASA LaRC



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https://www.deq.virginia.gov/Programs/CoastalZoneManagement.aspx

Virginia Water Protection (VWP) Program:
https://www.deq.virginia.gov/Programs/Water/WetlandsStreams.aspx

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5.0 AQUATIC AND TERRESTRIAL BIOTIC RESOURCES

5.1 REGULATORY OVERVIEW

5.1.1 Fish and Wildlife Conservation Act of 1980

The Fish and Wildlife Coordination Act of 1958 (16 U.S.C 661-666c) and the Fish and Wildlife Conservation Act of 1980 (16 U.S.C. 2901 et seq.) were enacted to ensure that states and Federal Agencies conserve and promote the conservation of non-game fish and wildlife and their habitats. A Federal Agency must consult with the U.S. Fish and Wildlife Service and state wildlife agencies when planning water resource projects involving impoundment, diversion, deepening, modification or control of a body of water. Consultation is necessary to assess the impacts on wildlife resources and possibly modify the plans to prevent loss or damage to such resources.

5.1.2 The Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act of 1972, Public Law 92-522, prohibits the harassment or taking of marine mammals except during commercial fishing, capture under scientific research or public display permits, harvest by Native Americans for food, or other incidental take as authorized on case-by-case basis.

5.1.3 The Migratory Bird Treaty Act and the Migratory Bird Conservation Act

These two acts ensure protection of migratory waterfowl and seabird species that are native to the United States. The Migratory Bird Treaty Act (MBTA) of 1918, as amended, deemed the taking, killing, or possessing of any migratory bird, including nests and eggs of such birds, unlawful. The Migratory Bird Conservation Act of 1929, as amended, established a Migratory Bird Conservation Commission to approve areas of land or water recommended by the Secretary of the Interior for acquisition as reservations for migratory birds. In administering such areas, the Secretary may manage timber, range, and agricultural crops; manage other species of animals; and enter into agreements with public and private agencies.

Additionally, guidance was released by the U.S. Fish and Wildlife Service in April 2018 to clarify what constitutes as a prohibited take of birds under the MBTA. The guidance concludes that the take of birds resulting from an activity is not prohibited by the MBTA when the underlying purpose of that activity is not to take birds. The MBTA's prohibitions on take apply when the purpose of an action is to take migratory birds, their eggs, or their nests. Conversely, the take of birds, eggs or nests occurring as the result of an activity, the purpose of which is not to take birds, eggs or nests, is not prohibited by the MBTA.

5.1.4 The Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c), enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead,

or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

5.1.5 Virginia Natural Area Preserves Act

The Virginia Natural Area Preserves Act, 10.1-209 through 217 of the *Code of Virginia*, was passed in 1989 and codified DCR's powers and duties related to statewide biological inventory: maintaining a statewide database for conservation planning and project review, land protection for the conservation of biodiversity, and the protection and ecological management of natural heritage resources (the habitats of rare, threatened, and endangered species, significant natural communities, geologic sites, and other natural features). The Virginia Natural Area Preserves System was established to protect some of the most significant natural areas in the Commonwealth. A site becomes a component of the preserve system once it is dedicated as a natural area preserve by the Director of the Department of Conservation and Recreation. Natural area dedication works in much the same way as a conservation easement by placing legally binding restrictions on future activities on a property. The Natural Area Preserve System includes examples of some of the rarest natural communities and rare species habitats in Virginia.

5.1.6 Invasive and Exotic Species Management

The control of invasive species is a primary management concern because of the potential impacts invasive species have on environmental stability. EO 13112 (Invasive Species) called upon executive departments and agencies to take steps to prevent the introduction of invasive species, and to support efforts to eradicate and control invasive species that are already established. EO 13112 also created the NISC to oversee implementation of the order and encourage proactive planning and action by other federal agencies. EO 13751 (Safeguarding the Nation from the Impacts of Invasive Species) amends EO 13112 and directs actions to continue coordinated federal prevention and control efforts related to invasive species. EO 13751 maintains the NISC and incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into federal efforts to address invasive species.

5.2 NASA LANGLEY OPERATIONS

NASA LaRC is located in the Coastal Plain of southeastern Virginia. The predominant ecological feature of this 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 in the vicinity of LaRC are 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.

NASA LaRC has an Integrated Natural Resources Management Plan (INRMP) which was developed to ensure operations and natural resource conservation strategies at the Center are integrated and consistent with good stewardship as well as applicable federal, state, and/or local natural resource management laws and regulations. The NASA LaRC INRMP also provides recommendations, goals, and implementation strategies for management of LaRC’s natural resources.

In 1973, Boyd and Ware prepared a listing of flora and fauna at NASA LaRC and LAFB (Boyd and Ware, 1973). In 1985, the Virginia Herpetological Society published a survey of amphibians and reptiles that may be found in the NASA LaRC area (Tobey, 1985). LaRC has conducted several biological surveys, including wetland surveys (ODU, 1991a, b, c and 1992) and the Tabbs Creek Remedial Investigation (Ebasco, 1995c). In 1993, LaRC contracted with ODU-Applied Marine Research Laboratory to perform a multi-season baseline survey of the flora and fauna of the Center. The field effort was conducted during 1994 and the survey report was issued in 1995 (ODU, 1995). Additionally, Geo-Marine, Inc. conducted a survey of bald eagles and peregrine falcons at LAFB in 1994 under contract with the ACOE (Geo-Marine, 1995). Science Applications International Corporation (SAIC) conducted a facility-wide land habitat classification and species identification survey in 2009.

Since 2009, LaRC has reforested 1.5 hectares (3.6 acres) with a mix of native hardwoods and pines. Many of these trees are strategically planted in areas around LaRC's nearby waterways. The trees act as riparian buffers to protect local waterways and provide valuable habitat. Furthermore, these projects are an expensive way for LaRC to earn "credits" toward pollution reduction goals for the Chesapeake Bay TMDL. Additional reforestation efforts are planned in the future in order to maximize groundwater absorption, improve water quality, and expand forested habitats.

5.2.1 Terrestrial Flora

Fourteen habitat types were documented at the Center during the SAIC (2009) survey. The dominant habitat types consist of Developed and Maintained Areas. Developed Areas include man-made structures consisting of buildings, roads, sidewalks, parking lots, industrial equipment and various infrastructure facilities. Maintained Areas include all vegetated urban areas consisting of grasses, shrubs and ornamental vegetation that are routinely maintained. Of the non-developed and non-maintained habitat, the majority consists of Coastal Plain Forest, of which there are seven habitat sub-categories. The Coastal Plain Forest are dominated by hardwood, with evergreens being predominant in the southern forested area.

Other areas that do not exist in a natural state include Disturbed Areas and Drainage Areas. Disturbed Areas may consist of bare ground that has been graded or otherwise cleared. This habitat type/classification has limited ability to support vegetation or other cover. Vegetation, if present, is widely spaced and scrubby. Drainage Areas consist of linear water passages where the water course is interrupted by controlled structures such as culverts.

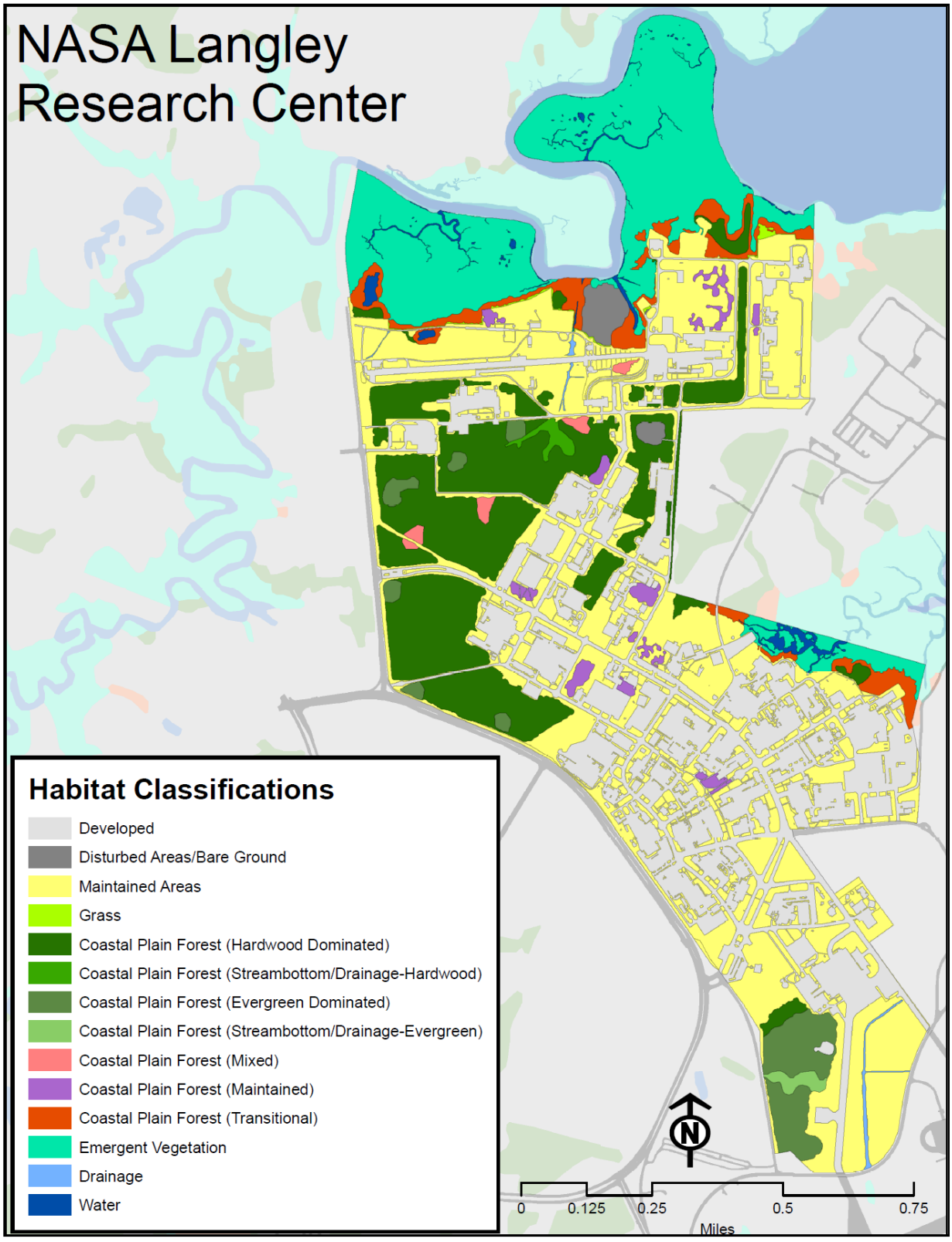
The western portion of the LaRC consists of several large forested areas separated by either dirt or paved roads, and there is another large forested area at the southern tip of the facility. There are also a few areas of Grass Habitat, which includes all vegetated areas consisting of herbaceous vegetation not routinely maintained.

Habitat types found during the SAIC (2009) survey are described in Table 5-1 and are shown in Figure 5-1. Appendix 3 is a partial list of plant species occurring at NASA LaRC identified by ODU (1995) and the SAIC (2009) surveys.

Table 5-1
FOREST HABITAT TYPES AND DESCRIPTIONS AT NASA LARC

Habitat Type	Description	Area
Coastal Plain Forest (Hardwood Dominated)	This habitat is a diverse group of occasionally flooded forests occupying relatively well-drained bottomland ecosystems. Characteristic tree species vary with soil type, flooding regime and successional status. Ecosystems with some microtopographic heterogeneity support a variable mixture of Sweetgum, Sycamore, Red Maple, Willow Oak and Hickory.	114.8 acres
Coastal Plain Forest (Evergreen Dominated)	This habitat is a diverse group of occasionally flooded forests occupying relatively well-drained bottomland ecosystems. Characteristic tree species vary with soil type, flooding regime and successional status. Ecosystems with some microtopographic heterogeneity support a variable mixture of evergreen trees consisting of Loblolly pine and Eastern Red Cedar.	20.2 acres
Coastal Plain Forest (Mixed)	This habitat is a diverse group of occasionally flooded forests occupying relatively well-drained bottomland ecosystems. Characteristic tree species vary with soil type, flooding regime and successional status. Ecosystems with some microtopographic heterogeneity support a near even mixture of evergreen trees consisting of Loblolly Pine and Eastern Red Cedar and hardwood trees consisting of Sweetgum, Tulip tree, Red Maple, and Sycamore.	2.8 acres
Coastal Plain Forest (Streambottom/ Drainage-Hardwood)	This habitat is a diverse group of occasionally flooded forests occupying relatively well-drained bottomland ecosystems. Characteristic tree species vary with soil type, flooding regime and successional status. Ecosystems with some microtopographic heterogeneity support a variable mixture of Sweetgum, Sycamore, Red Maple, Willow Oak and Hickory, American Elm and Black Gum.	2.1 acres
Coastal Plain Forest (Streambottom/ Drainage-Evergreen)	This habitat is a diverse group of occasionally flooded forests occupying relatively well-drained bottomland ecosystems. Characteristic tree species vary with soil type, flooding regime and successional status. Ecosystems with some microtopographic heterogeneity support a variable mixture of evergreen trees consisting of Loblolly pine and Eastern Red Cedar.	2.0 acres
Coastal Plain Forest (Maintained)	This habitat is a diverse group of maintained forested urban areas. This habitat type is characterized by a contiguous overstory of mature trees species with minimal midstory vegetation and maintained understory vegetation. Ornamental landscaping trees/vegetation is not included in this classification. Only trees characteristic of the Coastal Plain forest types are included.	8.5 acres
Coastal Plain Forest (Transitional)	This habitat type can be represented by a gradient or continuum, becoming more terrestrial or more aquatic depending on the distance from each of the two primary habitats. This habitat type can consist of a diverse group of trees, scrub/shrubs and grasses that border wetland herbaceous vegetation. Characteristic transitional species vary with soil type, flooding regime and microtopographic heterogeneity. This habitat type supports all Coastal Plain Forest species as well as Estuarine and Marine species.	20.2 acres

Figure 5-1
GENERAL HABITAT TYPES



Forested Areas Summary

The following forest type summaries are from the ODU (1995) survey. The southern portion of the mixed deciduous/pine forest tract is the least disturbed with a 60-to-70-year-old forest predominating. A scattering of individual trees from 100 to 200 years old is present in this section, principally in the wetter portions. The remainder of the tract is composed of forest predominantly 50 to 60 years old, with some 30-year-old sections.

In the wetter sections of this forest, the overstory is dominated by sweetgum *(Liquidambar styraciflua*), red maple (*Acer rubrum*), loblolly pine (*Pinus taeda*), and American elm *(Ulmus americana*); with cherrybark oak (*Quercus falcatus var. pagodafolia*), green ash *(Fraxinus pennsylvanica*), willow oak (*Quercus phellos)*, and persimmon (*Diospyros virginiana*) as co-dominants. The shrub/sapling layer is dominated by wax myrtle (Morella cerifera), paw paw (*Asimina triloba*), sweetgum, and red maple; with spicebush (*Lindera benzoin*) and elderberry (*Sambucus canadensis*) as co-dominants. The understory is dominated by honeysuckle (*Lonicera japonica*), poison ivy (*Toxicodendron radicans*), Nepal microstegium *(Eulalia viminea*), and Virginia knotweed (*Polygonum virginianum*); with paw paw, netted chainfern (*Woodwardia areolata*), and false nettle (*Boehmeria cylindrica*) as co-dominants.

In the drier portions of the forest, the overstory is dominated by sweetgum, loblolly pine, red maple, and persimmon, with sassafras (*Sassafras albidum*), shagbark hickory (*Carya ovata*), and black cherry (*Prunus serotina*) as co-dominants. The shrub/sapling layer is dominated by paw paw, sweetgum, red maple, and wax myrtle, with American holly (*Ilex opaca*) and dogwood (*Cornus florida*) as co-dominants. The understory is dominated by honeysuckle, Virginia Creeper (*Parthenocissus quinquefolia*), paw paw, and trumpet creeper (*Campsis radicans*); with may apple (*Podophyllum peltatum*), Indian hemp (*Apocynum cannabinum*), and beggar's tick (*Desmodium glutinosum*) as co-dominants.

The parcels of disturbed forest range from 30 to 50 years old. The overstory in these parcels is dominated by red maple, sweetgum, loblolly pine, and persimmon; with sassafras, black cherry, and hackberry (*Celtis laevigata*) as co-dominants. The shrub/sapling layer is dominated by wax myrtle, sweetgum, sassafras, and paw paw; with American holly and hackberry as co-dominants. The understory is dominated by honeysuckle, wild onion (*Allium canadense*), and catchweek bedstraw (*Galium aparine*); with ebony spleenwort (*Asplenium platyneuron*), and Virginia knotweed as co-dominants.

The pine dominated areas are approximately 60 years old. The overstory in the drier portions is dominated by loblolly pine with sweetgum and red maple as co-dominants. The shrub/sapling layer is dominated by sweetgum, paw paw, and ironwood (*Carpinus carolinus*). The understory is dominated by honeysuckle and poison ivy. In the wetter portions, the overstory is dominated by hackberry and green ash, sweetgum, tuliptree (*Liriodendron tulipifera*), American sycamore (*Platanus occidentallis*), and red maple as co-dominants. The shrub/sapling layer is dominated by sweetgum and spicebush. The understory is dominated by poison ivy, paw paw, honeysuckle, and jewelweed (*Impatiens capensis*).

The tracts with brackish influence range from 30 to 50 years old. The overstory is dominated by sweetgum, black cherry, sassafras, and hackberry; with cherrybark oak, loblolly pine, and persimmon as co-dominants. The shrub/sapling layer is dominated by wax myrtle, hackberry, and

sassafras, with sweetgum and cherrybark oak as co-dominants. Honeysuckle, blackberry (*Rubus spp*.), trumpet creeper, wild rye (*Elymus virginicus*), and halberd leaf *greenbrier (Smilax bona-nox*) dominate the understory.

Forest edges are typically dominated by old field/roadside vegetation. This type of habitat of NASA LaRC represents an ecologically important habitat type. It exists wherever woodland or forest gives way to open field. Plant species present in these edge habitats include honeysuckle, ragweed (*Ambrosia artemisifolia*), bushclovers (*Lespedeza spp*.) blackberries (*Rubus spp*.), asters (*Aster spp*.), goldenrods (*Solidago spp*.) thorough-worts (*Eupatorium capillifolium, E. fistulosum,* and *E. coelestinum*), bearsfoot (*Polymnia uvedalia*), and verbesina (*Verbesina occidentalis*).

There are numerous open fields at NASA LaRC; most are relatively small areas between buildings that are mowed too frequently to have any significant habitat value. One open field area that does have significant habitat value is the large open fields located in the northern part of the facility. The frequency of mowing here is sufficient to discourage the succession of woody vegetation, and maintains the area in a perpetual early old-field successional stage, dominated by perennial grasses and forbs. Old-field habitats such as this provide nesting habitat for a number of ground-nesting bird species, and foraging habitat for numerous bird and small mammal species.

5.2.2 Terrestrial Fauna

Wildlife species identified by Byrd and Ware in 1973, Tobey in 1985, Geo-Marine in 1995, ODU-AMRL in 1995 and SAIC in 2009 are listed in Appendix 1. Mammals known to occur at NASA LaRC include white-tailed deer, rabbit, raccoon, squirrels, muskrats, opossums, shrews, and fox. Numerous amphibian and reptile species are common to the area. Numberous species of birds, including waterfowl and wading birds, use the coastal marshes for foraging and/or roosting, including various species of herons, egrets, ducks, gulls, and geese. Species observed in Tabbs Creek include the following: caspian tern, great blue heron, green heron, osprey, herring gull, great egret, white ibis, Virginia rail, plover, killdeer, sandpiper, red-winged blackbird, and grey catbird (Ebasco, 1995c).

5.2.3 Aquatic Vegetation

Four basic aquatic community types were found to occur at NASA LaRC (ODU, 1995) (see Figure 5-1).

<u>Brackish Tidal Marshes</u>

The tidal marshes at NASA LaRC are dominated by saltmarsh cordgrass (*Spartina alterniflora*), seashore saltgrass (*Distichlis spicata*), saltmeadow cordgrass (*Spartina patens*), and needlegrass rush (*Juncus roemerianus*); with alkali bulrush (*Scirpus robustus*) and *fimbry (Fimbristylis spadicea*) as co-dominants. The marsh edges contain sections dominated by common reed (*Phragmites australis*), and occasionally, big cordgrass (*Spartina cynosuroides*). Some marsh edge sections support scrub/shrub communities dominated by eastern false-willow (*Baccharis halimifolia*), wax myrtle, and big-leaf sumpweed (*Iva frutescens*), with winged sumac (*Rhus copallinum*) and chinese privet (*Ligustrum sinense*) as co-dominants. The understory in the scrub/shrub communities are dominated by seaside goldenrod (*Solidago sempervirens*), halberd-leaf saltbush (*Altriplex patula*), and halberd-leaf greenbrier.

Brackish Ponds with Occasional Tidal Influence

A brackish permanent pond located in the northwestern corner of NASA LaRC property contains emergent vegetation dominated by seaside saltgrass, saltmeadow cordgrass, needlegrass rush, and alkali bulrush. The surrounding shrub community is dominated by eastern false-willow, wax myrtle, and big-leaf sumpweed. The understory in this community is dominated by halberd-leaf greenbrief, common greenbrier (*Smilax rotundifolia*), seaside goldenrod, and halberd-leaf saltbush.

A brackish, semi-permanent pond on the north side of the Landing Loads Test Facility, beside the historic Winder-Garrett cemetery, is predominantly freshwater and is normally dry for a short period each year. The dominant emergent vegetation is swamp *rosemallow (Hibiscus moscheutos*) and shoreline sedge (*Carex hyalinolepsis*). In certain portions of the pond, Virginia blueflag (*Iris virginica*) is co-dominant.

Palustrine Freshwater Ponds

The ponds are palustrine forested ponds located in the large contiguous tract of forest along the western side of NASA LaRC. The overstory in these habitats is dominated by willow oaks, laurel oak (*Quercus laurifolia*), red maple, and black gum (*Nyssa sylvatica*). Wax myrtle, paw paw, fetterbush (*Leucothoe racemosa*), and elderberry dominate the shrub layer. The understory is dominated by common greenbrier, poison ivy, cutleaf grapefern (*Botrichium dissectum*), and red maple seedlings, with some ponds co-dominated by netted chainfern, fowl manna grass (*Glyceria striata*), and Elliot's goldenrod (*Solidago elliotii*).

Brackish and Freshwater Ditch Systems

The brackish ditches are primarily located in the northern portion of NASA LaRC and empty directly into Brick Kiln Creek. The emergent vegetation in these ditches is dominated by saltmarsh cordgrass near their northern limits, with seaside saltgrass, alkali bulrush, and common reed co-dominant elsewhere.

The freshwater ditch system drains most of the central and western portions of NASA LaRC. Most of this system drains into the brackish ditches in the northern portion of NASA LaRC and a small portion drains to the east directly into Tabbs Creek. A third freshwater drainage crosses the center of the pine forest in the southeast corner of NASA LaRC. The system empties into the drainage ditch system of the LAFB airfield. The emergent vegetation in most of these ditches is dominated by grass-leaf arrowhead (*Sagittaria graminea*), cespitose knotweed *(Polygonum cespitosum*), Virginia dayflower (*Commelina virginica*), Nepal microstegium, lady's thumb (*Polygonum Persicaria*), and Virginia bugleweed (*Lycopus virginicus*).

5.2.4 Aquatic Species

Tabbs Creek and Brick Kiln Creek are polyhaline tidal creeks comprising intertidal habitats, including mudflats, salt marshes, and shallow subtidal habitats. The diversity of habitats supports numerous aquatic and semi-aquatic species, resulting in high rates of primary and secondary production. Tidal creeks are especially important as nursery areas for larval and juvenile fishes.

In addition, numerous species of fish and crustaceans use these systems for foraging and refuge. Many of these species are migratory and use tidal creeks on a seasonal basis.

The dominant species of invertebrates of Tabbs Creek observed during the remedial investigation (Ebasco, 1995b) included crustaceans and mollusks, such as blue crab (*Callinectes sapidus*), wharf crab (*Sesarma reticulatum*), fiddler crab (*Uca pugnax*), grass shrimp *(Palaemonetes pugio*), and saltmarsh periwinkle (*Littoraria irrorata*), which were distributed throughout the Creek in high densities. Eastern oyster (*Crassostrea virginica*) and ribbed mussel (*Geukensia desmissa*) were present only near the confluence of the Creek and the Northwest Branch of Back River, probably as a result of salinity, substrate, and submergence conditions. Juvenile quahogs (*Mercenaria mercenaria*) were the dominant species found throughout Tabbs Creek.

Portions of the Back River near Tabbs Creek are leased for oyster bedding. Oyster catches in recent years have declined, most likely due to the virus MSX and the bacterium Dermocestidium. Shellfishing in, and the consumption of shellfish from, Tabbs Creek and portions of the Northwest and Southwest Branches of Back Creek are prohibited by the Virginia State Department of Health due to high levels of bacteria.

The dominant fish species found in Tabbs Creek include mummichog (*Fundulus heteroclitis*), Atlantic menhaden (*Brevoortia tyrannus*), spot (*Leiostomus xanthurus*), and croaker (*Micropogonias undulatus*). A 1975 fisheries survey of the Back River system by the Virginia Institute of Marine Science (VIMS) showed the presence of the following species: bay anchovy (*anchoa mitchilli*), striped anchovy (*anchoa hepsetus*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogon undulatus*), oyster toadfish (*Cynoscion regalis*), hogchocker (T*rinectes maculatus*), scup (*Stenotomus chrysops*), silver perch (*Bairdella chrysops*), Atlantic spadefish (C*haetodipterus faber*), pinfish (*Lagodon rhombodies*), lookdown (*Selene vomer*), dusky pipefish (*Syngnathus floridae*), and northern pipefish (*Syngnathus fuscus*) (NASA LaRC, 1979). Appendix 2 lists aquatic species collected by ODU (ODU, 1995) in waters near NASA LaRC.

5.2.5 Biotic Resource Management and Monitoring

Because there is no regulatory mandate, NASA LaRC does not have an ongoing program for biotic resource management and monitoring. However, the detection and control of invasive species is a primary management concern of federal agencies, including NASA, because of the potential impacts invasive species have on environmental stability and the degradation they can cause to the natural environment.

In 2005, NASA joined the National Invasive Species Council (NISC) to assist federal agencies to combat invasive species by providing information from satellites (NASA 2005b). NASA has aided the NISC in identifying saltcedar (*Tamarix* spp.), cheatgrass (*Bromus tectorum*), Canadian thistle (*Cirsium arvense*), and numerous aquatic species infestations throughout the United States (NASA 2006). In addition,

In compliance with EO 13112, NASA LaRC's INRMP contains detailed information on the overall goal and objectives of invasive species management to protect ecosystems and native species. In addition, NASA LaRC strictly adheres to applicable State and local erosion and sediment control/storm water management laws and regulations to ensure minimal impact to aquatic or terrestrial species.

Though there is little potential for commercial forest management, forest resources do provide a number of social, environmental, and economic benefits including aesthetic enhancement, water quality improvement, and wildlife habitat. Reforestation efforts are planned in the future in order to maximize groundwater absorption, improve water quality, and expand forested habitats. LaRC also has a tree replacement strategy for trees removed during construction or demolition projects. For each tree removed, a combination of trees totaling the diameter at breast height (DBH) of the tree removed shall be planted.

5.3 REFERENCES

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6.0 ENDANGERED, THREATENED, AND SPECIES OF CONCERN

6.1 REGULATORY OVERVIEW

6.1.1 Endangered Species Act of 1973

The Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 through 1543) was enacted "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation of such endangered species and threatened species." The Act states, "All Federal departments and agencies shall seek to conserve endangered species and threatened species and utilize their authorities in furtherance of this Act." Federally listed threatened and endangered (E+T) species are monitored and regulated by the U.S. Fish and Wildlife Services (USFWS).

The term *endangered species* applies to "any species that exists in such small numbers that it is in danger of extinction throughout all or a significant portion of its range." The term *threatened species* pertains to "any species which is likely to become an endangered species within the foreseeable future through all or a significant portion of its range." The Secretary of the Interior, or the Secretary of Commerce makes determination of endangered or threatened species for species over which the Secretary of Commerce has program responsibilities. The list of endangered and threatened species, and proposed candidates for listing, are published in the Federal Register on an annual basis (50 CFR Part 17).

When the USFWS proposes a species for listing under the Endangered Species Act, it is required to consider whether there are geographic areas that contain essential features on areas that are imperative to conserve the species. The USFWS may designate an area as critical habitat. Critical habitat is the specific areas within the geographic area, occupied by the species at the time it was listed, that contain the physical or biological features that are essential to conservation of endangered and threatened species and that may need special management or protection.

Section 7 of the Endangered Species Act requires Federal agencies to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species. If a proposed project may directly or indirectly affect an endangered or threatened species, the Federal agency must consult with the USFWS and, if applicable, the National Marine Fisheries Service (NMFS). The Federal agency must determine the type of consultation required, informal or formal, and coordinate with the appropriate field offices.

For projects occurring in Virginia, the USFWS Virginia Field Office has an eight step, automated project review process. The process includes contacting the Virginia state offices described below and generating project maps and species lists utilizing the USFWS Information for Planning and Conservation (iPaC) tool.

6.1.2 Virginia Endangered Species

The Virginia Department of Game and Inland Fisheries (VDGIF), the Virginia Department of Conservation and Recreation (VDCR), and the Virginia Department of Agriculture and Consumer

Services (VDACS) cooperate to provide protection for Virginia's threatened and endangered species. The VDGIF has legal authority for preservation of vertebrate and other invertebrate endangered and threatened species. The VDCR Division of Natural Heritage (DCR-DNH) produces an inventory of the Commonwealth's natural resources, and maintains a database of ecologically significant sights. The VDACS is the regulatory authority for the conservation and preservation of threatened and endangered plant and insect species.

Virginia Endangered Species Act, and Program

The Virginia Endangered Species Act (Title 29.1-563) was enacted to provide protection to species of fish and wildlife threatened with extinction in Virginia. The same definitions for endangered and threatened species in the Federal Act apply to the State Act and provisions for conserving such fish and wildlife species are specified, as well as restriction of the taking, transport, processing, or sale of such species within Virginia. The Act explicitly states that any new Federal listing automatically becomes a State listing; these State-listed species are published in Virginia Regulation 4VAC15-20-130.

The VDGIF is responsible for the State endangered species program for fish and wildlife. In addition, Virginia keeps a State listing of species of special concern. The term, *species of special concern*, refers to any species that is restricted in distribution, uncommon, ecologically specialized, or threatened by other imminent factors. VDCR's Natural Heritage Program has powers and duties related to statewide biological inventory: maintaining a statewide database for conservation planning and project review, land protection for the conservation of biodiversity, and the protection and ecological management of natural heritage resources. The DCR-DNH defines Natural Heritage Resources as the habitats of rare, threatened and endangered species, significant natural communities, geologic sites, and other natural features. The Natural Heritage Program ranks natural resources for protection priorities. The most current information about Virginia's rarest species and significant natural communities can be found at: https://www.dcr.virginia.gov/natural-heritage/rare-species-com

Virginia Endangered Plant and Insect Species Act, and Program

In 1979, the Endangered Plant and Insect Species Act of the Code of Virginia, authorized the VDACS to conserve, protect, and manage endangered species of plants and insects. The Act uses the same definitions of threatened and endangered species as the Federal Act, but excludes species determined not to be in the best interests of mankind. The Virginia Endangered Plant and Insect Species Act currently lists thirty-three plant and insect species that are declared endangered or threatened in Virginia.

The VDACS Virginia Endangered Plant and Insect Species Program personnel cooperates with the USFWS, DCR, and other agencies and organizations on the recovery, protection, or conservation of listed threatened or endangered species and designated plant and insect species that are rare throughout their worldwide ranges. In those instances where recovery plans developed by USFWS are available, adherence to the order and tasks outlined in the plans should be followed to the extent possible. The VDACS also manages the sale and movement of such species within the State of Virginia.

6.1.3 Birds of Conservation Concern

In 2008, the USFWS released 'Birds of Conservation Concern' (BCC) in a continuing effort to assess and prioritize bird species for conservation purposes. BCC are a subset of protected birds under the MBTA and include all species, subspecies, and populations of migratory nongame birds that are likely to become candidates for listing under the ESA without additional conservation actions. An online version of the document is available at https://www.fws.gov/migratorybirds/pdf/management/BCC2008.pdf. This document can be used as a barometer of the condition of the country's avifauna. Birds included in the BCC 2008 lists are deemed priorities for conservation actions, and the lists will be consulted for actions taken on federal lands in accordance with Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds". BCC species will also receive priority attention in the USFWS when allocating research, monitoring, and management funding. NASA LaRC is located in Bird Conservation Region (BCR) 30 – New England/Mid-Atlantic Coast. Forty-five (45) bird species are listed for Region 30.

6.2 NASA LANGLEY OPERATIONS

The NASA LaRC INRMP is utilized as a planning document and a management tool to ensure operations and natural resource conservation strategies are integrated and consistent with legal requirements. The INRMP also provides recommendations, goals, and implementation strategies for management of LaRC's natural resource assets, including protecting habitat areas where endangered and threatened species may be present.

Of 1,665 (1,274 Endangered and 391 threatened) species that are currently U.S listed as endangered or threatened, there are 75 listed species whose ranges extend to Virginia (USFWS). A list of the Federal Threatened and Endangered species can be found at: https://www.fws.gov/endangered/.

6.2.1 NASA Langley Surveys

The most current biological surveys of NASA LaRC include the facility-wide habitat classification and species survey in 2009 by SAIC and the facility-wide fish, wildlife, and plant surveys by ODU conducted in 1995. The findings from the surveys are included in Appendices 1, 2, and 3.

Sixty-six plant species were identified at NASA LaRC by SAIC in the 2009 survey and 164 plant species were identified during the 1995 ODU survey. No plants listed as threatened or endangered were found in any of the habitat types at NASA LaRC. Two species encountered in the 1995 survey were rare or uncommon in the area: the maroon Carolina milkvine (*Matalea carolinensis*) and the southern adder's tongue (*Ophioglossum vulgatum*). Although not sited during the ODU or SAIC surveys of NASA LaRC, growing clumps of the Purple Milkweed (*Asclepias Purpurascens*) were identified by Environmental staff during 2018. This plant is listed as S2 (state-listed imperiled) on the DCR-NHR Rare Plants list, with S1 being the highest, most critical ranking the state assigns. There are only 25 known state-wide occurrences of purple milkweed; NASA LaRC has taken measures in order to protect the rare species. Appendix 6-3 contains a partial list of plant species found at NASA LaRC and their wetland indicator status.

Seven species of reptiles and amphibians were identified at NASA LaRC by SAIC in the 2009 survey and sixteen species were identified during the ODU survey (Appendix 6-1). No special status species were encountered during the surveys. However, species like the canebrake rattlesnake (*Crotalus horridus* formerly *C. horridus actricaudatus*), Eastern glass lizard (*Ophisaurus ventralis*) and various species of sea turtles (*Caretta, Lepidochelys, Chelonia*, etc.) can be found in the greater Hampton Roads area.

Three mammalian species were encountered at NASA LaRC during the 2009 survey by SAIC and fourteen species of mammals were identified during the ODU survey (Appendix 6-1). Based on historical distribution data, twelve additional species could inhabit the area but were not observed during the study. None of the mammals are currently listed as threatened, endangered, or species of concern.

A total of 25 avian species were observed at NASA LaRC during the SAIC survey in 2009, and 118 avian species were observed during the 1995 ODU survey. As of 2020, three of these are State-listed threatened species, seen in Table 6-1. The gull-billed tern (*Sterna nilotica*), and the Henslow's sparrow (*Ammodramus henslowii*) were determined to be transient migrants who use the NASA LaRC facility solely as a foraging stop. Although not sited during the ODU or SAIC surveys of NASA LaRC, the peregrine falcon (*Falco peregrinus*) was sited at adjoining LAFB during a survey of the base in 1994 (Geo-Marine, 1994). This species uses the base, and presumably parts of NASA LaRC, primarily for foraging; no nesting or long-term roosting was found (Appendix 6-1).

Thirty-three finfish species were collected at NASA LaRC during the ODU study (Appendix 6-2). All species were common to the lower Chesapeake Bay and its tributaries. No endangered, threatened, or special concern species inhabit or use the NASA LaRC community.

6.2.2 Special Status Species

NASA LaRC is located in the Coastal Plain of southeastern Virginia. The predominant ecological feature of this 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.

The VDGIF's Fish and Wildlife Information Services (VaFWIS) was used to ensure the protection of the Commonwealth's sensitive wildlife resources. The VaFWIS provides the most current and comprehensive information about Virginia's Wildlife resources. In order to evaluate potential impacts, a desktop analysis was done using the Geographic Search function of the VaFWIS system. The report generated a list of wildlife species that have the potential to occur within 3 miles of NASA LaRC.

Based on the VaFWIS analysis conducted on April 2020, a total of 542 special status species were reported as potentially occurring within 3 miles of NASA LaRC, of which 24 species are Federal-listed or State-listed as Endangered and Threatened. Documentation of the VaFWIS analysis and the complete report is maintained by EMO Environmental staff.

According to surveys done on Center, the VaFWIS report, and the BCC list, a total of fourteen species with special status (i.e. State-listed Threatened and BCC) have been documented on or around NASA LaRC, seen in Table 6-1.

Table 6-1

SPECIAL STATUS SPECIES DOCUMENTED AT NASA LaRC

Common Name	Scientific Name	Status
Sparrow, Henslow's	*Ammodramus henslowii*	ST, BCC
Falcon, peregrine	*Falco peregrinus*	ST, BCC
Tern, gull-billed	*Sterna nilotica*	ST, BCC
Pied-billed Grebe	*Podilymbus podiceps*	BCC
Snowy Egret	*Leucophoxy thula*	BCC
Bald Eagle	*Haliaeetus leucocephalus*	BCC
Solitary Sandpiper	*Tringa solitaria*	BCC
Lesser Yellowlegs	*Totanus flavipes*	BCC
Least Tern	*Sterna albifrons*	BCC
Wood Thrush	*Hylocichla mustelina*	BCC
Blue-winged Warbler	*Vermivora pinus*	BCC
Prairie Warbler	*Dendroica discolor*	BCC
Worm-eating Warbler	*Helmitheros vermivorus*	BCC

Notes: FE = Federal Endangered FT = Federal Threatened SE = State Endangered ST = State Threatened BCC = Birds of Conservation Concern (not a legal status)

Source: Virginia Department of Game and Inland Fisheries, VA Fish and Wildlife Information Services, 2020

Numerous species of birds, including waterfowl and wading birds, use the coastal marshes for foraging and/or roosting. The three State-listed threatened species documented on or around LaRC were determined to be transient migrants who use the NASA LaRC facility solely as a foraging stop. No Federal-listed E+T species, or State-listed endangered species have been documented at NASA LaRC. In addition, NASA LaRC does not have any geographic areas listed as critical habitat as defined by the USFWS.

Detailed information on management goals and guidelines to protect and enhance resources for special status species can be found in LaRC's INRMP Section 5.1, *Bird Management*, and Section 5.5, *Threatened, Endangered, and Species of Concern Management.*

6.2.3 Surrounding Areas

A list of Natural Heritage Resources in the LaRC area is available through the Environmental Review Coordinator at DCR-DNH. A description of proposed project(s) and site conditions, a USGS topographic map depicting project boundaries, and an official request form must be sent to the Coordinator to obtain the list.

In 2013, the DCR-DNH Biotics Data System reviewed the NASA Langley East Area and West Area for occurrences of natural heritage resources. The Biotics Data System documented the presence of natural heritage resources in the East area. However, due to the scope of projected activities and distance to the resources, DCR-DNH did not anticipate any negative impacts to these natural heritage resources.

The West Area is located within the Back River Marshes Conservation Site. Conservation sites are tools for representing key areas of the landscape that warrant further review for possible conservation action because of the natural heritage resources and habitat they support. Conservation sites are polygons built around one or more rare plant, animal, or natural community designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain on a scale of 1 to 5 with 1 being the most significant. Back River Marshes Conservation Site has been given a biodiversity significance ranking of B3, which represents a site of high significance. The natural heritage resources of concern at this site are:

- *Circus cyaneus,* Northern harrier
- *Cistothorus platensis,* Sedge wren

The primary threat to both of these species includes human disturbance and destruction of wetland habitat necessary for breeding and wintering.

To minimize adverse impacts to the ecosystem, NASA Langley strictly adheres to applicable state and local erosion and sediment control/storm water management laws and regulations, and the following best management practices to ensure minimal impact to wildlife and natural resources:

- Avoid and minimize impacts to undisturbed forest, wetlands, and streams to the fullest extent practicable.
- Maintain undisturbed naturally vegetated buffers of at least 100 feet in width around all on-site wetlands and on both sites of all perennial and intermittent streams.
- Design stormwater controls to replicate and maintain the hydrographic condition of the site prior to the change in landscape, to the fullest extent possible.
- Attempt to restrict tree removal and ground clearing activities adhere to a time-of-year restriction from March 15 through August 15 of any year to protect nesting resident and migratory songbirds.
- Adhere to erosion and sediment controls during ground disturbance.

6.3 REFERENCES

U.S. Fish and Wildlife Service, https://www.fws.gov/

U.S. Fish and Wildlife Service, Birds of Conservation Concern, https://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php

U.S. Fish and Wildlife Service, Environmental Conservation Online System, https://ecos.fws.gov/ecp/

Virginia Department of Conservation and Recreation, http://www.dcr.virginia.gov/

Virginia Department of Conservation and Recreation, Division of Natural Heritage, http://www.dcr.virginia.gov/natural-heritage/

Virginia Department of Game and Inland Fisheries, https://www.dgif.virginia.gov/

Virginia Department of Game and Inland Fisheries, Fish and Wildlife Information Service (VaFWIS) and Initial Project Assessments, https://www.dgif.virginia.gov/environmental-programs/fish-and-wildlife-information-section/

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7.0 HAZARDOUS AND SOLID WASTE

7.1 REGULATORY OVERVIEW

7.1.1 Resource Conservation and Recovery Act (RCRA) and Waste

RCRA is the law under which the EPA regulates all aspects of waste management from generation to ultimate treatment, storage, and disposal. With several amendments, including the Hazardous and Solid Waste Amendments (HSWA) of 1984, RCRA and its subsequent regulations govern solid waste recycling and disposal; federal procurement of products containing recycled materials; waste minimization; hazardous waste generators transporters; treatment, storage and disposal facilities (TSDFs); and underground storage tanks (USTs).

7.1.2 VDEQ

VDEQ Waste Management Division administers nonhazardous (including infectious waste) and hazardous waste programs. In 1984, VDEQ was granted authorization to administer Virginia's hazardous waste program and its subsequent regulations for treatment, storage, disposal, and transportation of hazardous waste. The VDEQ also has authorization to administer the HSWA of 1984, which includes the corrective action program. Virginia requirements for cleanup activities rely on EPA regulations found in 40 CFR Part 300. VDEQ also administers Virginia's UST Program that was approved by the EPA in December of 1998.

7.2 NASA LANGLEY OPERATIONS

7.2.1 Solid Waste Disposal

NASA LaRC's mission results in the generation of significant volumes of municipal solid waste. The major items are: paper (white and mixed); wood; metals (copper, aluminum, steel, and specialty metal); cardboard and paperboard products; plastics; grounds maintenance waste; food wastes (cafeteria); glass, specialized materials (composites, plastics, ceramics, and alumina); and remediation and facility maintenance wastes (debris, rags, absorbents).

LaRC works with the General Services Administration (GSA) to sell scrap metals such as aluminum, copper and steel, and excess materials having salvage value. Scrap materials of little or no value such as building materials, tree and shrub trimmings, and broken concrete are transported to a licensed landfill for disposal. Excess equipment is given to the GSA to be recycled to private vendors for resale.

Approximately 526 metric tons (580 tons) per year of LaRC solid waste is burned in the Refuse-Fired Steam Generating Facility (RFSGF) located on Wythe Creek Road. The waste is general facility trash that is not recyclable. The plant has the capacity to burn 181 metric tons (200 tons) per day of refuse from the City of Hampton, the city of Poquoson, NASA LaRC, several other federal installations, and the private sector. In the event that the RFSGF closes down operations, LaRC may send its solid waste to a local landfill.

Regulated Medical Waste (RMW) is generated at LaRC’s Health Clinic located at Building 1216. The clinic has a RMW Plan and operates as a facility that generates less than 100 gallons per week

of RMW under exemptions from permitting in Virginia regulations 9VAC20-120-170. Each month the RMW generated at the clinic are properly packaged and labeled according to Virginia RMW requirements. Disposal services are contracted out and the RMW is disposed at a certified incinerator.

The EMO tests paint removal and spill cleanup wastes to ensure that the materials are properly disposed. Wastes that are non-hazardous, non-regulated waste are consolidated into dumpsters and sent for disposal to a local landfill. Remediation and spill debris material that contain RCRA listed hazardous waste or exhibit hazardous characteristics are sent to a permitted hazardous waste disposal facility.

7.2.2 Solid Waste Recycling

The overall objective of LaRC's recycling program is to develop an efficient and cost effective program that: meets or exceeds recycling goals established by statutory requirements and applicable Executive Orders, maximizes collection of recyclables and proceeds from their sale, and preserves and conserves the environment and its resources.

Tables 7-1 and 7-2 provide a summary of the recycling activities at the Center. Income returned to LaRC from recycling activities is used to fund pollution prevention and recycling initiatives.

Table 7-1
SUMMARY of RECYCLING ACTIVITIES at NASA LaRC

Material	Collection Method
PAPER, CARDBOARD, TONER CARTRIDGES, ALUMINUM CANS, PLASTIC BOTTLES	Collected throughout the Center by the Logistics Management Branch (LMB) for recycling and rebate.
OIL FILTERS (from vehicle maintenance)	Collected by vehicle maintenance personnel and shipped off site for recycling.
OIL (Synthetic/Phosphate Ester)	Collected in drums, consolidated by the EMO and shipped off site for recycling and rebate.
METAL (Scrap aluminum, copper, ferrous metals)	Sorted by type and collected in drums and hoppers. GSA sells the metal for LaRC.
FLUORESCENT BULBS	Collected in drums/boxes, consolidated by the EMO and shipped off site for recycling.
USED FUELS	Collected in drums, consolidated by the EMO and shipped off site for recycling at no cost.
BATTERIES (Lead acid, Nickel Cadmium)	Accumulated in containers. Collected by the EMO and shipped off site for recycling.
ORGANICS (Yard waste)	Grass clippings are left on the lawn. Some leaves are collected and are composted.

Table 7-2 LaRC RECYCLING DATA FOR FY 2017 – 2019			
Type of Material	**FY17 (lbs.)**	**FY18 (lbs.)**	**FY19 (lbs.)**
Aluminum	4,020	11,523	1,340
Batteries	7,204	17,993	4,265
Cardboard	63,880	71,580	62,000
Construction and Demolition (C&D) Debris	6,723,410	41,690	4,272,520
Copper (incl. copper wire)	0	0	0
Ferrous Metals	360,104	444,423	518,390
Fluorescent Lighting Tubes	3,092	2,795	3,772
Mixed Paper	40,540	63,860	42,980
Toner Cartridges	1,322	974	644
Used Oil	0	39,607	30,042
White Paper	38,700	39,580	24,040
Plastic Bottles	6,658	7,575	9,155
Total	**7,248,930**	**741,600**	**4,969,148**

7.2.3 Hazardous and Regulated Waste

The Center's hazardous and regulated waste program is managed by the LaRC EMO. LaRC is a generator of hazardous waste under EPA ID Number VA2800005033. The Center is not authorized to transport hazardous waste off site, store hazardous waste beyond a 90-day accumulation period, or dispose of hazardous waste on site. LaRC uses appropriately permitted contractors to transport wastes from the less than 90-day hazardous waste accumulation facility, Building 1166, to off-site treatment, storage and disposal facilities (TSDFs).

7.2.3.1 Hazardous and Regulated Waste Generation

LaRC generates a wide variety of wastes including gases, solvents, fuels, metals and polymers from research. LaRC also generates Toxic Substances Control Act (TSCA) regulated and special wastes such as asbestos, transformer oils, and PCB capacitors. See Chapter 8, Toxic Substances, for TSCA information.

Table 7-3 gives a summary of PCB waste disposal and Table 7-4 gives a summary of hazardous wastes generated at LaRC for calendar years 2015, 2017 and 2019. The hazardous waste information is taken from the biennial report for the respective years.

Table 7-3 REGULATED WASTE DISPOSAL (lbs.)			
Type of Waste	**CY 2015**	**CY 2017**	**CY 2019**
PCB Material (light ballasts, capacitors, and small transformers).	546	623	6,050

Table 7-4 HAZARDOUS WASTE DISPOSAL (lbs.)			
Type of Waste	**CY 2015**	**CY 2017**	**CY 2019**
Aqueous Caustic / Acidic Solutions, Corrosive	2,706	5,245	4,420
Clean up Debris	152	296	798
Compressed Gas / Aerosol Cans	1,144	1,421	1,077
Contaminated / Unused Fuel	2,609	13,177	337
Facility Painting Debris	86	270	4,515
Flammable Solvents	2,043	1,396	1,218
Lab Packs – Acutely Hazardous Waste	0	3	0
Lab Packs - Mixed Lab Packs	7,487	5,000	9,402
Metals, Paint Remediation Wastes	2,616	1,764	2,803
Out of Date Chemicals	803	223	6,614
Contaminated Solvent Rags	971	893	927
Electrical Devices	0	1,015	0
Explosives or Reactive Organic Solids	0	152	0
Total	**20,617**	**30,855**	**32,111**

7.2.3.2 Hazardous and Regulated Waste Management

NASA LaRC is a large-quantity generator of hazardous waste and has operated the less than 90-day hazardous waste accumulation facility at Building 1166 since 1991. In addition, NASA LaRC operates over 250 satellite accumulation areas (SAAs) located in various facilities throughout the Center. The EMO maintains a current list of SAAs.

Center personnel who manage or oversee the management of hazardous wastes at SAAs are required to receive waste management training annually. The EMO provides training and maintains appropriate documentation. The EMO web site has information about the Center's waste management program as well as other environmental media areas. The website is available to on-site personnel at: https://emis.ndc.nasa.gov/.

Hazardous, regulated, and nonhazardous wastes are picked up from the SAAs and transported by the EMO to Building 1166 for packaging and storage. Every 80-85 days, the drum and labpack waste is shipped off site for disposal at an appropriately permitted disposal facility. Other wastes, such as oil and nonhazardous solids, are accumulated in bulk containers and shipped off-site when full.

In most cases, the waste is classified using generator knowledge of the waste generation process. The EMO will sample the waste to ensure it meets the generator's description. In the case where unknown or questionable wastes are turned in for disposal, the EMO will obtain samples of the material. All waste samples are sent off site and analyzed by a qualified environmental laboratory. Once the waste constituents are identified, the material is properly labeled for disposal.

Asbestos waste generated by removal/abatement projects at the Center is properly packaged and labeled as required for waste disposal. The remediation contractor performing the asbestos removal/abatement activity is responsible for disposal, and ships the asbestos wastes off-site to a permitted asbestos landfill.

Compressed gas cylinders generally are leased under contract from off-site suppliers or purchased under certain circumstances. Empty cylinders are either returned to the supplier, refilled, or de-valved and sold as scrap metal.

The EMO is responsible for reviewing and signing all manifests and shipping documents associated with LaRC waste disposal. Shipment documentation to include manifests, land disposal forms, bills of lading, and waste profiles are maintained by the EMO.

Any TSDF used for the disposal of LaRC generated hazardous waste must be approved through a NASA TSDF Audit. The EMO environmental support contractor maintains the approved TSDF list and ensures that LaRC's hazardous waste is properly disposed of at an approved facility.

7.2.4 Waste Minimization

NASA LaRC's policy is to minimize the volume and toxicity of wastes generated by mission operations to the extent technically possible and economically feasible. Source reduction, recycling, recovery and reuse are employed whenever possible. LaRC facility personnel and contractors follow these procedures for waste minimization:

- Review purchase orders to verify quantities of hazardous materials ordered are reasonable and to determine if a less hazardous material can be substituted.

- Continuously review operations to assure they are conducted efficiently, to reduce hazardous material use whenever possible.

- Segregate wastes so that non-hazardous wastes do not become contaminated.

Funds from the sale of recyclable solid wastes are available to help pay for implementation of waste minimization and pollution prevention initiatives.

7.3 REFERENCES AND RESOURCES

Environmental Management and Sustainability Plan, 2018 Update. NASA Langley Research Center, Hampton, Virginia.

LPR 8500.1, Environmental and Energy Program Manual. NASA Langley Research Center, Hampton, Virginia.

Environmental Management Office Web Site. NASA Langley Research Center, Hampton, Virginia. https://emis.ndc.nasa.gov/

8.0 TOXIC SUBSTANCES

8.1 REGULATORY OVERVIEW

The Toxic Substances Control Act (TSCA) of 1976 is currently administered by the EPA's Office of Chemical Safety and Pollution Prevention (OCSPP). Title I of the Law regulates the production and distribution of commercial and industrial chemicals in the U.S. and ensures that the chemicals do not pose any adverse risks to human health or the environment. TSCA requires that any chemical that reaches the consumer marketplace be tested for possible toxic effects prior to commercial manufacture. In addition, Subchapter I bans the production and distribution of polychlorinated biphenyls (PCBs) and regulates proper disposal and management of any remaining PCBs.

Title II of the Law regulates asbestos to include requiring inspections for asbestos-containing material, establishing an accrediting program for persons involved in asbestos identification and abatement, and implementing response actions for cleanup and removal of asbestos.

Title III of TSCA regulates radon and sets a national goal for radon levels in buildings so that air within buildings should be as free from radon as the ambient air outside. Implementing radon programs, training and public awareness are also included in the regulations.

TSCA supplements other federal statutes, including the Clean Air Act and the Toxic Release Inventory under EPCRA.

8.2 NASA LANGLEY OPERATIONS

TSCA's primary applicability at NASA LaRC relates to the removal and disposal of PCB-contaminated equipment, the management of building materials and pipes that contain asbestos, and indoor radon abatement.

8.2.1 Polychlorinated Biphenyls

LaRC requires that all fluids and equipment containing any percentage of PCBs must be carefully controlled and monitored. LaRC completed the retrofilling or replacement of the fluid in electrical equipment that was greater than 50 ppm PCB, with fluids that are non-PCB. Older facilities located throughout the Center with older lighting fixtures still have small fluorescent lamp ballasts which could contain greater than 50 ppm PCB. The EMO maintains an inventory of transformers located at the Center; all but two transformers contain low levels (less than 50ppm) of PCBs.

The EMO maintains primary responsibility for the management of PCB and non-PCB material at NASA LaRC. The Center retains a maintenance contractor to inspect and service electrical equipment and to respond to any leaks or spills. EMO is responsible for the storage and disposal of PCB material, such as light ballasts, and for PCB sampling and analysis. The EMO also reviews and signs all shipping documents related to PCB material to ensure that an approved disposal facility and proper packaging and transportation are used. Disposal records are maintained by the EMO.

As part of its continuing environment enhancement effort, NASA LaRC has completed cleanup of leaking hydraulic systems containing hydraulic fluids with PCBs and PCTs. PCB contamination was identified in soils at the Area E Warehouse (Ebasco, 1992a); however, because of the low levels of contamination, no cleanup action was required. Spills and leaks from past operations had resulted in contamination of stormwater sewers discharging from Outfall #9 to Tabbs Creek. NASA LaRC completed cleanup of these storm sewers in early 1995. NASA LaRC completed cleanup of PCB and PCT contamination of Tabbs Creek in May 2000. In the East Area, several storm sewers had been found to be contaminated with PCBs from NASA LaRC operations (Ebasco, 1993b). The affected storm sewer lines were cleaned to remove PCB and PCT in the sediment. The cleanup was completed in December of 1996.

The Center has a PCB Management Spill Prevention Countermeasure and Control Plan that is maintained by the EMO. Additional information regarding management and disposal of PCBs at the Center can be found in LPR 8500.1, Chapter 8, Polychlorinated Biphenyl Management.

8.2.2 Asbestos

It is NASA LaRC policy to comply with all Federal and State regulations applicable to asbestos. It is not Center policy to remove or implement other abatement techniques simply because asbestos is present in a building unless the condition of asbestos is such that the health of the building occupants is jeopardized. If a health hazard is found to exist, prompt and effective action is taken. The Center has a continual inspection program of each facility to determine the presence of asbestos-containing building materials (ACBM). The LaRC Safety Office maintains records of asbestos operations and sampling reports.

An Operations and Maintenance (O&M) program is required for each LaRC facility where ACBMs are identified. The principal objective of the O&M program is to minimize the exposure of facility occupants to asbestos. The program includes posting warning signs at buildings that have asbestos, notifying building occupants of the location of the asbestos, periodic inspections, and training for all personnel, including janitorial and custodial staff, who conduct activities that may expose them to asbestos fibers.

NASA LaRC ensures appropriate disposal of all removed asbestos either through its project management group or by requiring evidence of proper disposal for all contracted operations. The EMO reviews and signs all shipping documents related to asbestos material to ensure that an approved disposal facility and proper packaging and transportation are used. Disposal records are maintained by the EMO.

Additional information about asbestos management and disposal at LaRC can be found in LPR 8500.1, Chapter 9, Asbestos, and LPR 1740.3, Section 6.5, Asbestos Configuration Management.

8.2.3 Radon Management

In 1990, LaRC participated in the NASA Radon Monitoring Study that was conducted at thirteen NASA Centers. LaRC monitored 21 of its own buildings for radon gas. The highest readings were detected in Building 1169 (2.1 picocuries per liter). Since the lowest action level in the NASA Radon Monitoring Plan is 4 picocuries per liter, LaRC was not required to take any action.

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9.0 INSECTICIDES AND HERBICIDES

9.1 REGULATORY OVERVIEW

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was passed in 1947 primarily as a consumer protection statute to regulate the manufacture, sale, distribution, and use of pesticides. The Act required that pesticides must be registered with the U.S. Department of Agriculture (USDA) before they could be marketed in interstate commerce. In addition, a label with manufacturer's name and address, name, brand and trademark of the product, net contents, ingredient list, warning statement to prevent injury, and directions for use was required to ensure safe use.

Since 1947, FIFRA has been amended many times. These amendments include requiring that all pesticide labels contain a Federal Registration Number and caution words such as "warning", "danger", "caution", "keep out of reach of children", and requiring that manufacturers remove all safety claims from the labels. The authority for FIFRA was transferred from the USDA to the EPA in 1970. The EPA currently has the authority to regulate pesticides to prevent unreasonable adverse effects on the environment (40 CFR Parts 150-189). There are also Occupational Safety and Health Administration (OSHA) occupational pesticide standards at 29 CFR Part 1910.

A 1994 White House Memorandum, *Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds*, promotes practices that minimize the adverse effects of landscaping on the local environment. Federal agencies are encouraged to reduce their need for fertilizer and pesticides and adopt Integrated Pest Management (IPM) practices. IPM involves using biological and natural controls to manage pests, such as proper plant selection, correct mowing height, and periodic pruning.

Under the Endangered Species Act, Federal agencies must ensure that any action they carry out or authorize is not likely to jeopardize the continued existence of any species listed on the Endangered Species List, or to destroy or adversely modify an endangered species' critical habitat. Registration of pesticides and their use under FIFRA is required to ensure that endangered species are not jeopardized.

At the state level, pesticide policy is delegated primarily to the Virginia Department of Agriculture and Consumer Services (VDACS) at VA Code §3.2-109. In addition, the VPDES permit program may also require monitoring of pesticide pollutants in stormwater discharges at permitted facilities.

The VDACS consists of eleven members from each congressional district appointed by the Governor and the presidents of Virginia State University and Virginia Tech are ex officio members of the board. Among the many powers delegated to the Board by the Governor are establishing standards, training, and testing for certification of commercial applicators, registered technicians, and private applicators. The VDACS licenses businesses that manufacture, sell, store, recommend for use, mix or apply pesticides, and require registration of pesticides for manufacture, distribution, sale, storage, or use in the Commonwealth. Further, the VDACS requires reporting and record keeping related to licensing and registration.

9.2 NASA LANGLEY OPERATIONS

LaRC's policy regarding the use of pesticides is to follow Integrated Pest Management (IPM) practices whenever possible. Much of the Center's land and foliage is allowed to grow naturally, without any fertilizer or pesticide applications. Grass clippings are returned to the lawn to restore important nutrients. Trees and shrubs are periodically pruned and dead or diseased limbs are discarded. The wetland, forest, and forest edge landscapes of LaRC have varieties and species of plants and trees that are suitable to and thrive in this area. Of the Center's 310 hectares (764 acres) of land, less than one-twentieth of one percent is treated with pesticides. These treatments are on an as needed basis and applications are limited to minimal quantities.

A contractor manages the pesticide program at NASA LaRC. Pesticides include insecticides, herbicides, rodenticides, termiticides and avicides. The contractor uses only EPA approved/registered pesticides upon approval and issuance of a NASA safety permit for the use of potentially hazardous materials. The pesticides are mixed, stored, and applied according to their current Federal use restrictions. As required by law, records of restricted use pesticides are maintained by the contractor. IPM practices are used by the contractor wherever possible and application is performed or supervised by state-certified applicators and/or registered technicians. The performance work statement for LaRC's Grounds Maintenance and Pest Control Services contract requires that the contractor hold a valid Virginia state license or certification for each category of pest control work involved and requires the contractor to obtain any required state or local permits for the possession, procurement, or use of any chemicals. All chemicals are required to be applied in strict accordance with the product's EPA or State registered labeling.

General pest control at LaRC is performed by way of service request and involves the mitigation of cockroaches, water bugs, ants, rodents, fleas, mites, spiders, wasps, and other arthropoda. Wood destroying pest control, animal and bird control, ornamental, and turf pest control are other operations performed by the contractor on an as needed basis. Bait formulations are required to be used whenever possible for cockroach and ant control. When spray is necessary, it is required to be applied precisely to cracks and crevices and never to exposed surfaces. Fogging, of any type, needs approval by the LaRC prior to application. Rodent control inside facilities is almost always done by trapping rather than rodenticide. There are, however, a few rare cases in which rodenticide is deployed, such as under false floors.

The contractor also performs scheduled and preventative maintenance pesticide application at LaRC. Food processing areas of Building 2102 are treated on a twice-monthly preventative maintenance schedule. During lawn repair work, where initial grass seeding is required, fertilization takes place and is generally limited to areas less than 464 m^2 (5,000 sq. ft). A balanced fertilizer, such as formula 10-10-10 is broadcast in a granular form at an established rate of 4.5 Kg/93 m^2 (10 lbs/1,000 sq. ft). Herbicide application provides non-crop control of emerged annual and perennial weeds with glyphosate used exclusively. Selective equipment includes a 378 liter (100 gallon) spray tank utilized for treating areas that include fence lines, right of way, outdoor electrical substations and large gravel fenced enclosures. Application rates are based on product label recommendations. Between 3,028 and 3,785 liters (800 and 1,000 gallons) of diluted herbicides are applied annually at NASA LaRC.

Pesticides and application equipment are stored in locked cabinets at Building 1285. This facility is within the 100-year floodplain. EPA guidelines recommend that "when practicable, [the storage

facility] should be located where flooding is unlikely" (40 CFR 165). However, these guidelines are mandatory only for EPA's own operations and not those of other agencies. By location, the NASA LaRC facility is susceptible to floodwaters of a 100-year frequency storm. However, continued practice of shelved storage of containers should minimize potential problems due to floodwaters.

A second contractor is responsible for treating the cooling tower water at LaRC. Treatment includes the application of various chemicals, some of which are algaecides. Algaecides are included in the definition of pesticides as stated in FIFRA 2(t) and 2(u) and the Virginia Pesticide Control Act; therefore, the contractor's operations are regulated by FIFRA and State regulations.

Contractor employees are trained and certified by the manufacturer to apply the algaecides and other treatment chemicals. Some facilities have pumping systems that continually feed the cooling tower water with the chemicals while other towers require manual feeding. The contractor on a daily, weekly, and monthly basis maintains application records. The algaecides are registered and properly labeled with warnings. Weekly cooling tower sampling is performed by the manufacturer or the contractor and the chemical analysis is conducted at Building 1215.

Since the larger cooling towers require higher volumes of algaecide, the algaecide is stored at each individual location. Containers are appropriately staged within dikes at each storage location. A centralized chemical storage facility that is utilized for the treatment of small cooling towers is located in Building 1197. Since the containers are refilled by either the manufacturer or by water treatment personnel, disposal of empty containers is not necessary.

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10.0 RADIOACTIVE MATERIALS AND NON-IONIZING RADIATION

10.1 REGULATORY OVERVIEW

OSHA regulates radiation and high radiation areas for the work place (29 CFR 1910.1096). Radiation area means any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any 1 hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirem. High radiation area means any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

10.2 NASA LANGLEY OPERATIONS

As part of the safety program at LaRC, the Center has developed procedural requirements that implement the Nuclear Regulatory Commission (NRC), OSHA, and other Federal regulations governing radiation sources. LPR 1710.5, *Ionizing Radiation*, assigns responsibilities and authorities for radiological health and safety at NASA LaRC. The document also defines the requirements for procurement, use, handling, storage, shipment, and disposal of sources of ionizing radiation, as well as personnel monitoring and emergency procedures. A similar document, LPR 1710.8, *Non-Ionizing Radiation*, implements NASA's internal regulations governing non-ionizing radiation sources, such as lasers and radiofrequency radiation sources.

LaRC's organization for radiation safety includes the Ionizing Radiation Committee (IRC) and Non-Ionizing Radiation Committee (NIRC), subcommittees of LaRC's Executive Safety Council. The IRC and NIRC exercise centralized control over sources of ionizing and non-ionizing radiation at LaRC, which is accomplished through the documented review and approval of all procurement, handling, and use of radiation producing materials. The committees ensure audits are conducted annually of each facility's possession and use of sources of ionizing and non-ionizing radiation. NASA LaRC has identified a Radiation Safety Officer (RSO) for the Center who serves as a member on both the IRC and NIRC and assists radiation users as the primary contact on a day-to-day basis for matters relating to radiation safety. The RSO provides administrative and technical guidance to LaRC personnel in the safe use of radiation sources and performs periodic radiation protection surveys and radiation safety evaluations.

10.2.1 Ionizing Radiation Sources

Table 10-1 summarizes authorized ionizing radiation sources at NASA LaRC by building location and custodian. The RSO monitors these sources and maintains compliance with Federal and State permitting requirements. LaRC holds a NRC license (No. 45-01052-21, expiration 2025) for radioactive materials. In addition, X-ray sources, which are not covered by NRC regulations, are maintained at the following LaRC buildings: 1148,1177, 1205, 1206, 1216, 1230B, and 1293C.

Table 10-1 IONIZING RADIATION SOURCES		
Location	**Custodian**	**Isotope(s)**
Building 1250	Science Directorate	Po-210 Kr-85
Building 1254	Safety and Mission Assurance Office	Am-241 Am-241/Be
Building 1232	Safety and Facility Assurance Branch	Cs-137 Eu-152
Building 1148	Advanced Materials and Processing Branch	Am-241/Be, Cs-137, Co-60, Tl-204, Sr-90, Po-210, Cd-109
NASA LaRC Radiation Safety Officer 2020		

10.2.2 Non-Ionizing Radiation Sources

Non-ionizing radiation sources at NASA LaRC include laser research labs and use of laser technology in flow visualization, velocity measurements, and atmospheric and space research. Table 10-2 provides an inventory of non-ionizing radiation sources at NASA LaRC.

Table 10-2 NON-IONIZING RADIATION SOURCES	
Location	**Type of Non-Ionizing Radiation Source**
Building 644	Laser (Class 3/ Class 4)
Building 1148	Laser (Class 3/ Class 4) Radiofrequency/Microwave
Building 1200	Laser (Class 3/ Class 4)
Building 1202	Laser (Class 3/ Class 4) Radiofrequency/Microwave
Building 1208	Laser (Class 3/ Class 4)
Building 1212	Laser (Class 3/ Class 4)
Building 1214	Laser (Class 3/ Class 4)
Building 1220	Radiofrequency/Microwave
Building 1221	Laser (Class 3/ Class 4)
Building 1230	Laser (Class 3/ Class 4) Magnetic Field
Building 1232A	Magnetic Field
Building 1236	Laser (Class 3/ Class 4)
Building 1238	Laser (Class 3/ Class 4)
Building 1242	Laser (Class 3/ Class 4)
Building 1244	Laser (Class 3/ Class 4) Radiofrequency/Microwave
Building 1247	Laser (Class 3/ Class 4)
Building 1250	Laser (Class 3/ Class 4) Radiofrequency/Microwave
Building 1251	Laser (Class 3/ Class 4) Radiofrequency/Microwave
Building 1267A	Laser (Class 3/ Class 4)
Building 1293	Magnetic Field
Building 1299	Laser (Class 3/ Class 4) Radiofrequency/Microwave
NASA LaRC Radiation Safety Officer 2020	

10.2.3 Excess Radioactive Materials

Occasionally, excess radioactive materials from individual facilities are placed in the Radioactive Material Storage Facility, Building 1254 for future use in research and development. The RSO maintains the inventory of radioactive materials and assures that the disposal of radioactive waste is safe and complies with Federal, State, local, and LaRC requirements. The storage facility is located outside the 100-year and 500-year floodplains. Even during a catastrophic hurricane event, any flooding of the facility would not be expected to expose LaRC or the environment to significant radiation from Building 1254. The storage facility is located well outside the blast safety zone that may be seriously affected by accidental explosions in the LAFB ordinance storage area located adjacent to NASA property.

Building 1254 is a very small, concrete block facility with no windows and is completely enclosed by a chain link fence. The building and fence remain locked at all times. No significant potential for radioactive emission from the facility exists.

10.3 REFERENCES AND RESOURCES

Ionizing and Non-ionizing Radiation Source List, LaRC Radiation Safety Officer, NASA Langley Research Center, Hampton, Virginia.

LPR 1710.5, Ionizing Radiation, NASA Langley Research Center, Hampton, Virginia.

LPR 1710.8, Non-Ionizing Radiation, NASA Langley Research Center, Hampton, Virginia.

11. 0 UNDERGROUND AND ABOVEGROUND STORAGE TANKS

11. 1 REGULATORY OVERVIEW

11.1.1 Federal

EPA regulations for underground storage tanks (USTs) are in 40 CFR Part 280. USTs have stringent performance requirements including corrosion protection, proper installation, overflow protection, and release prevention and detection. Regulatory changes effective in October 2018 require inspecting overfill prevention equipment, testing containment sumps for piping interstitial monitoring, testing release detection equipment operation, 30 day and annual walkthrough inspections, and follow up testing after repairs.

The EPA also has oil spill prevention, control and countermeasures (SPCC) regulations (40 CFR Part 112) that apply to facilities with USTs and aboveground storage tanks (ASTs) which, due to their location, could discharge oil into navigable waterways.

SPCC regulations require preparation and implementation of a spill prevention control and countermeasure plan. The regulations present minimum requirements for spill prevention, including containment and diversion equipment to protect navigable waters. The EMO has developed and maintains an Integrated Spill Contingency Plan (ISCP) which contains all the required elements of the SPCC Plan, the Oil Discharge Contingency Plan (ODCP), and the hazardous waste contingency plan. The ISCP is documented in the Langley Management System as Langley Procedural Requirement (LPR) 8715.12.

11.1.2 Commonwealth of Virginia

The EPA granted approval of Virginia's UST Program in 1998. VDEQ is the implementing agency for UST activities in the state. Virginia's UST regulations can be found at 9 VAC 25-580. Virginia's requirements are similar to Federal requirements with a few exceptions where Virginia regulations are more stringent.

In accordance with Virginia UST regulations, municipalities are responsible for issuing permits to temporarily or permanently close a regulated UST. The City of Hampton has the authority to issue such permits to LaRC.

Virginia regulates ASTs under the Facility and Aboveground Storage Tank Regulation (9 VAC 25-91-10 *et seq*.). The regulations require AST registration, notification, closure, and pollution prevention. The regulations also require that an ODCP be developed for facilities that store a total capacity of 25,000 gallons or greater of oil. ODCP and SPCC requirements are very similar. LaRC's ISCP (LPR 8715.12) contains all required elements of the ODCP.

11.2 NASA LANGLEY OPERATIONS

LaRC has many tanks storing petroleum and fuel. Table 11-1 lists active ASTs and Table 11-2 lists active USTs. Any leaks or releases are reported as required to the appropriate Virginia and/or Federal agencies by the EMO. The ISCP contains an inventory of tanks and other oil filled

equipment located throughout the Center.

TABLE 11-1
LARC ABOVEGROUND STORAGE TANKS

Building	Type of Material Stored	Capacity (Gallons)	Construction Material	Year Installed	Comments
641	ULSD	100	Steel – Double wall	2009	Generator Base Tank
1166	Used Oil	5,000	Steel – Single wall	1991	Containment Dike
1199	E85	6,000	ConVault	2003	
1199	Motor Oil	300	Steel - Double-wall	2009	
1201	ULSD	350	Steel – Double wall	2009	Generator Base Tank
1211	ULSD	250	Steel – Double wall	2009	Generator Base Tank
1215	Empty	1,000	ConVault	1999	Cleaned & closed with VDEQ in 2017.
1215	No. 2 Fuel Oil	100	Steel - Double wall	2006	Day Tank – Inside
1215	ULSD	1,200	Steel – Mobile Fuel Truck		Parked in Containment
1221C/D	JP-10	100	Steel with containment dike	2003	Feed Tank
1221C/D	JP-10	100	Steel - Double wall	2003	Fuel Collection Tank
1228	Empty	500	ConVault	1999	Cleaned & closed with VDEQ in 2017.
1236	ULSD	500	ConVault	1999	Retired in place 2019, for Waukesha generator
1236	ULSD	894	Steel - Double wall	2020	Generator Base Tank
1244	Gasoline	1,000	ConVault	1999	
1244	AVGAS	2,000	ConVault	2004	AVGAS 100LL
1244	jet fuel	6,000	Steel – Mobile Fuel Truck		Parked in Containment
1244	jet fuel	5,000	Steel – Mobile Fuel Truck	2009	Parked in Containment
1244	AVGAS	400	Stainless Steel	2011	Portable Tank
1244	jet fuel	800	Stainless Steel	2011	Portable Tank
1244A	ULSD	1,000	ConVault	1999	For fire pumps
1244A	ULSD	100	Steel - Double wall	2006	Day Tank - Inside
1248	ULSD	137	Steel – Double wall	2001	Generator Base Tank
1248	ULSD	660	Steel – Double Wall	2014	Generator Base Tank
1250	ULSD	300	Steel – Double wall	1999	Generator Base Tank
1258	Empty	1,000	ConVault	1999	Cleaned & closed with VDEQ in 2017.
1265	RP-2 or JP-10	6,000	Steel – Double wall	2004	Storage Tank
1265	RP-2 or JP-10	1,000	Steel – Double wall	2017	Fuel Transfer Tank
1265	RP-2 or JP-10	750	Steel - Single wall	2004	Fuel Transfer Tank w/containment dike
1265	RP-2 or JP-10	300	Steel - Single wall	2004	Run Tank w/containment dike
1265	RP-2 or JP-10	85	Steel - Single wall Fuel-draulic tanks (bundle of 3 tanks)	2004	Spill containment dike built around Run Tank and Fuel-draulic Tanks
1265	RP-2 or JP-10	300	Steel – Double wall	2009	Fuel-draulics Fuel Transfer Tank

TABLE 11-1
LARC ABOVEGROUND STORAGE TANKS

Building	Type of Material Stored	Capacity (Gallons)	Construction Material	Year Installed	Comments
1265	Used Oil	300	Steel – Double wall	2009	Collects oil from oil/water separator
1268	ULSD	1,025	Steel – Double wall	2012	Generator Base Tank
1268A	ULSD	145	Steel – Double wall	2004	Generator Base Tank
1268A	ULSD	350	Steel – Double wall	2009	Generator Base Tank
1268B	ULSD	308	Steel – Double wall	2008	Generator Base Tank
1268Lab	ULSD	308	Steel – Double wall	2008	Generator Base Tank
1268C	ULSD	2,000	Steel – Double wall	1998	Generator Base Tank; retired in place, tank drained but not cleaned
1285	Gasoline	500	Steel - Double wall	2003	grounds maintenance
1285	ULSD	500	Steel - Double wall	2003	grounds maintenance
1297	Diesel	1,000	ConVault	1999	Building heat
1297G	ULSD	190	Steel – Double wall	2009	Generator Base Tank
1297C	Diesel	500	ConVault	1999	Building heat
1299	Empty	350	generator tank from B1213	2009	inactive & empty
2101	ULSD	472	Steel – Double wall	2010	Generator Base Tank
2102	ULSD	416	Steel – Double wall	2013	Generator Base Tank
2102	Used Cooking Oil	312	Steel - Double wall	2014	Room 142
2103	ULSD	6,160	Steel - Double wall	2017	Generator Base Tank- A
2103	ULSD	6,160	Steel - Double wall	2017	Generator Base Tank- B
2103	ULSD	6,160	Steel - Double wall	2017	Generator Base Tank- C

TABLE 11-2
NASA LARC UNDERGROUND STORAGE TANKS

Building	Type of Material Stored	Capacity (Gallons)	Construction Material	Year Installed	Status/Plan
1199	Gasoline	8,000	Double-wall Fiberglass	1992	Active
1199	Gasoline	8,000	Double-wall Fiberglass	1992	Active
1199	Diesel	6,000	Double-wall Fiberglass	1992	Active
1215 UST 1	Ultra-Low Sulfur Diesel	50,000	Double-wall Steel with Fiberglass reinforced plastic (FRP) coating	1993	Active
1215 UST 2	Ultra-Low Sulfur Diesel	50,000	Double-wall Steel with Fiberglass reinforced plastic (FRP) coating	1993	Active
1215 UST 3	Ultra-Low Sulfur Diesel	50,000	Double-wall Steel with Fiberglass reinforced plastic (FRP) coating	1993	Active

An engineering investigation carried out by NASA LaRC in 1992 evaluated potential releases to soil and groundwater from 19 UST sites (Ebasco, 1994a). These included 18 inactive tanks and the 500-gallon gasoline tanks at Building 1244 which have since been removed. The study concluded that there were possible petroleum releases at 14 of the 19 UST sites. In accordance with Virginia regulations, an additional site characterization was made and corrective actions completed, where required (Ebasco, 1994a, 1994b). Table 11-3 lists the tanks that have been removed from the Center and if any remediation was required. The EMO maintains records of tank removal remediation activities.

TABLE 11-3
NASA LARC REMOVED UNDERGROUND STORAGE TANKS

Building	Type of Material Stored	Capacity (Gallons)	Year Removed	Soil Remediation Required
643	Gasoline	1,000	1995	No
1172	Varsol	550	1995	No
1172	Kerosene	1,000	1995	No
1172	Waste Oil	2,000	1995	No
1154	No. 2 Fuel Oil	5,000	1995	No
1154	No. 2 Fuel Oil	4,000	1995	No
1206	No. 2 Fuel Oil	4,000	1995	Yes
1228	No. 2 Fuel Oil	550	1999	No
1236	Diesel	1,000	1999	No
1244	Avgas	10,000	1995	Yes
1244	Gasoline	550	1995	Yes
1244	Gasoline	2,000	1995	Yes
1244	JP-5	10,000	1995	Yes
1244	JP-5	10,000	1995	Yes
1244	Waste Oil	1,000	1995	Yes
1244A	Diesel	1,000	1999	No
1247D	Gasoline	1,500	1995	No
1247 D	Gasoline	1,500	1995	No
1247D	No. 2 Fuel Oil	10,000	1980	Abandoned/filled with sand (partially below electrical substation; not removed)
1247 D	No. 2 Fuel Oil	10,000	1980	Abandoned/filled with sand (partially below electrical substation; not removed)
1249	Gasoline	4,000	1995	No
1258	No. 2 Fuel Oil	1,000	1999	No
1256	No. 2 Fuel Oil	6,000	1995	Yes
1260	No. 2 Fuel Oil	1,000	1999	No
1272	No. 2 Fuel Oil	10,000	1995	Yes
1297	No. 2 Fuel Oil	550	1999	No
1300	No. 2 Fuel Oil	2,000	1999	No

11.2.1 Monitoring of Tank Systems

All USTs at LaRC are equipped with electronic leak-detection systems. In addition, product inventory records are maintained by operating personnel at each facility where USTs are located. Facilities maintenance support contractors visually inspect the ASTs each time they are filled with product. In addition, documented AST inspections are performed in accordance with Virginia AST and EPA SPCC regulations. Records of AST inspections are kept in the EMO files.

11.3 REFERENCES AND RESOURCES

Ebasco, 1994a. Underground Storage Tank Site Characterization, NASA Langley Research Center, Hampton, Virginia. Ebasco Services Incorporated.

Ebasco, 1994b. Final Corrective Action Plan, Underground Storage Tank Sites, NASA Langley Research Center, Hampton, Virginia. Ebasco Services Incorporated.

NASA LaRC Integrated Spill Contingency Plan (LPR 8715.12), NASA Langley Research Center, Hampton, Virginia.

Virginia Department of Environmental Quality, Website Information on Storage Tanks, https://www.deq.virginia.gov/Programs/LandProtectionRevitalization/PetroleumProgram.aspx

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12.0 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

12.1 REGULATORY OVERVIEW

The National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to establish cultural resource preservation programs and to consider the effects of their actions on cultural resources that are listed or are eligible for listing in the National Register of Historic Places (NRHP). To evaluate the possible effects of proposed actions, Section 106 of the NHPA requires an agency to identify and evaluate historic properties, assess the effects of the project on the properties, consult with the State Historic Preservation Office (SHPO), and in some cases, solicit comments from the Advisory Council on Historic Preservation (ACHP). Section 110 of the NHPA requires that all Federal agencies inventory cultural resources under their jurisdiction that meet the criteria for listing in the NRHP.

Executive Order 11593, "*Protection and Enhancement of the Cultural Environment*," directs Federal agencies to identify cultural resources, nominate qualifying resources to the National Register, and avoid damaging resources that might be eligible for the National Register. It also mandates that Federal agencies comply with the requirements of the NHPA.

Executive Order 13287, "*Preserve America*," directs Federal agencies to actively advance the protection, enhancement, and contemporary use of the historic properties owned by the Federal Government, and to promote intergovernmental cooperation and partnerships for the preservation and use of historic properties.

The Archaeological Resources Protection Act of 1979 protects archaeological sites on Federal land and the Archaeological and Historic Preservation Act requires the preservation of data with respect to historic properties.

36 CFR Part 60, "*National Register of Historic Places*," sets forth the criteria for evaluating the significance of resources and their eligibility to the National Register.

36 CFR Part 800, "*Protection of Historic Properties*," includes procedures for Federal agencies to meet their obligations under the NHPA and Executive Order 11593. The regulations define the requirements of the Section 106 process and establish procedures for determining the eligibility of a resource and defining possible adverse effects.

12.1.1 NASA Requirements

NASA LaRC has a 2010 Programmatic Agreement (PA) among the VA SHPO and the ACHP for management of buildings, infrastructure and sites at the Center. The PA provides for standard mitigation and documentation processes, as well as a list of activities that are excluded from review under the PA. The PA identifies the LaRC Cultural Resources Manager (CRM) [previously Historic Preservation Officer (HPO)] as having primary responsibility for consulting and ensuring LaRC complies with the PA. In 2019, the PA was extended to January 2025.

NASA also has a 1989 PA among the National Conference of State Historic Preservation Officers (NCSHPO) and the ACHP, which addresses agency consultation and mitigation for projects impacting NASA's National Historic Landmark (NHL) properties. The LaRC CRM maintains copies of both PAs.

NASA Procedural Requirements (NPR) 8500.1, "*NASA Cultural Resource Management*," provides the policies and procedures for all NASA Centers to follow in order to ensure compliance with the NHPA and applicable historic preservation regulations and requirements.

NPR 4310.1, "*Identification and Disposition of NASA Artifacts*," provides procedures and guidance for the identification, reporting, transfer, or disposal of NASA articles, equipment, and hardware of historical interest. It specifies that the Smithsonian Institution's National Air and Space Museum (NASM) shall be responsible for the custody, protection, preservation, exhibition, and loan of artifacts received from NASA.

12.2 NASA LANGLEY OPERATIONS

12.2.1 LaRC's Cultural Resource Surveys and Resources

Since the early 1970's, LaRC has completed numerous cultural resource surveys. A brief description of the surveys is included in Table 12-1. The survey reports and more detailed information related to each of the surveys are maintained by the LaRC CRM.

TABLE 12-1
CULTURAL RESOURCE SURVEYS COMPLETED AT
NASA LANGLEY RESEARCH CENTER

Survey Type	Surveyor Name	Date Complete	Description	Reference
Archaeological: Phase I	LRCHAS	Mid 1970's	Survey identified the location of the King's Highway Site 44HT82 (shell-paved road bed).	Parker n.d.
Archaeological: Phase I	LRCHAS, Hudgins and Luccketti	1978	Refuse-fired steam plant. Excavation of 336 shovel tests. No cultural resources identified.	Hudgins and Lucketti 1978
Architectural: Phase I/II	National Park Service	1984	"Man in space" theme study. Resulted in five LaRC properties being designated as NHL's.	Butowsky 1984
Archaeological: Phase I	MAAR	1992	Four-acre survey of the proposed OSD Industrial Complex. Identified Site 44HT43 (Ross Site).	Traver and Hoffman 1992
Archaeological: Phase I/II	KAS	1992	Identified disturbed portions of Site 44HT43; not eligible for NR.	Traver 1992
Archaeological: Phase II	MAAR	1992	To assess NR eligibility of Site 44HT43. Identified features and discrete cultural deposits.	Traver 1992
Archaeological: Phase I	Gray & Pape	1994-1995	Shovel test survey of selected "proposed construction sites". Identified 12 sites, recommended 11 as possibly NR eligible.	Cassebeer et al. 1995
Archaeological: Phase I	Gray & Pape	1995	Shovel test survey of selected locations. No archaeological resources identified.	Clarke et al. 1995
Archaeological Phase II	JRIA	2002	Phase II evaluation of Site 44HT48; recommended no further work.	Tyrer et. al. 2002
Archaeological Phase I and II	JRIA	2004	Phase I and II evaluation of Sites 44HT45 and 44HT76; 44HT45 recommended eligible for the NR.	Tyrer et al. 2005
Architectural	NASA/SAIC	2007	SSP Survey; ALDF found eligible	SAIC 2007
Archaeological	JRIA	2008	Treatment Plan and Technical Report for Picnic Shelter expansion at 44HT0045	Laird et al. 2008
Architectural Phase I	Dutton & Associates	2009	Phase I reconnaissance level survey of 271 buildings	Dutton et al. 2009
Archaeological	DATA Investigations	2011	Archaeological Field School survey of 44HT001	Harpole et al. 2011
Archaeological Phase I	Dutton & Associates	2011	Phase I shovel testing for parking lot behind Building 1229	Dutton et al. 2011
Archaeological Phase I	Dutton & Associates	2016	Phase I shovel testing of Flight Dynamics Research Facility site	Dutton et al. 2016

TABLE 12-1
CULTURAL RESOURCE SURVEYS COMPLETED AT
NASA LANGLEY RESEARCH CENTER

Survey Type	Surveyor Name	Date Complete	Description	Reference
Architectural Phase I Addendum	Dutton & Associates	2018	Update to the 2009 Phase I survey of 271 buildings at LaRC	Dutton et al. 2018

Surveyor Full Names: Langley Research Center Historical and Archaeological Society; Mid-Atlantic Archaeological Research Associates, Inc., Williamsburg; Karell Archaeological Services, Washington, D.C.; Gray & Pape, Inc., Richmond; James River Institute for Archaeology, Inc.; Dutton & Associates, LLC, Richmond; DATA Investigations, LLC, Gloucester

12.2.1.1 Architectural Resources

Architectural resources at LaRC have been documented in several surveys. In 1985, the National Park Service (NPS) performed a survey as part of the "Man in Space" theme study which identified resources that significantly contributed to the Apollo Program. This project encompassed multiple NASA Centers located throughout the U.S. and resulted in twenty resources being designated as NHLs with five of those located at LaRC. Two of the NHL properties, the 8-Foot High Speed Tunnel and the 30 by 60-Foot Full Scale Tunnel, are no longer extant. A description of the NHL properties is available at: https://www.nasa.gov/centers/langley/news/factsheets/Landmarks.html.

In 2007, NASA completed an agency-wide survey of facilities and assets that supported the Space Shuttle Program (similar to the "Man in Space" theme study). Several facilities at NASA LaRC were evaluated as part of this survey and the Aircraft Landing Dynamics Facility (ALDF) complex was determined to be potentially eligible for the National Register within the context of the Space Shuttle Program. Following the closeout of the Space Shuttle Program, and due to no future mission need for the ALDF testing capabilities, the complex was demolished in 2015.

In 2009, LaRC completed a reconnaissance level architectural survey of 271 buildings and structures located throughout the Center. The Phase I Survey evaluated the potential National Register eligibility of each property and it also identified the NASA LaRC Historic District as being potentially eligible for the National Register. Results of the survey were incorporated into the 2010 PA for management of facilities, infrastructure and sites at NASA LaRC, and the Center's Cultural Resource Management Plan (CRMP). The LaRC CRM maintains the complete inventory of buildings and maps showing their location.

In June 2012, the NASA LaRC Historic District was listed on the NRHP. In 2018, LaRC completed an update to the Phase I survey of 271 architectural resources at the Center. The update was performed to comply with stipulations in the Centerwide PA in advance of extending the PA.

12.2.1.2 Archaeological Resources

NASA LaRC has performed numerous archaeological surveys throughout the Center. The first excavations were performed in the early 1970's by the Langley Research Center Historical and Archaeological Society (LRCHAS) which was a group of NASA employees and their families who had a common interest in archaeology and history. In 1971, following excavations at the Chesterville plantation, the birthplace and home of George Wythe (located on the northern portion of NASA LaRC property), the LRCHAS prepared the documentation that resulted in the site being listed in the National Register (#144-0098, Site 44HT1). The LRCHAS performed additional excavations around LaRC prior to disbanding in the early 1980's.

In the mid-1990's, Phase I and II archaeological surveys were performed throughout NASA LaRC by qualified archaeological firms. The surveys were performed to generate historic contexts for archaeological resources at the Center, to characterize the Center's archaeological resource potential, and to locate and record historic and prehistoric sites. More recently, surveys have been performed in association with construction and development activities. The LaRC CRM maintains a complete inventory and maps of LaRC's archaeological sites.

12.2.2 Cultural Resource Management Plan

NASA LaRC's Cultural Resource Management Plan (CRMP) includes a detailed historic context of the Center and provides information on completed cultural resource surveys and investigations that have been performed at the Center, as well as the types of LaRC activities that may affect cultural resources. The CRMP incorporates the requirements of the PA and provides information and guidelines necessary for proper preservation and management of LaRC's cultural resources and historic properties. The LaRC CRM ensures the CRMP is updated at least every 5 years and is available on LaRC's Environmental website.

12.2.3 Cultural and Recreational Facilities

Cultural and large-scale recreational facilities are not provided on the Center since these additional activities are plentiful on the Virginia Peninsula. Various parks, playgrounds, gymnasiums, theaters, and museums provide LaRC personnel with abundant off-Center facilities for entertainment and recreation.

The Virginia Air and Space Center (VASC), located in downtown Hampton, serves as LaRC's official Visitors' Center (https://www.vasc.org/). Under a Memorandum of Agreement with NASA, the VASC has permanent exhibits that include the Adventures in Flight Gallery, Air and Spacecraft, and the Space Gallery, all of which showcase LaRC's contributions to aeronautics and the space program. NASA provides annual funding and grants to the VASC for permanent exhibits, educational resources, and traveling displays (e.g., the Virginia State Fair) to allow for public involvement in and interpretation of NASA's history and legacy. Over the years, NASA's partnership with the VASC has been extremely successful and operation of the visitors' center remotely from LaRC property allows the public a much greater opportunity to appreciate NASA's

history. The VASC is the top attraction in Hampton, and the second most-visited science museum in Virginia.

In addition, the area around NASA LaRC also has many historical and contemporary points of interest. Among these are Joint Base Langley Eustis (Langley Air Force Base and Ft. Eustis); Fort Monroe; Yorktown Battlefield; Saint John's Church; Fort Eustis' Transportation Museum; Mariner's Museum; Virginia Living Museum; Peninsula Fine Arts Center; War Memorial Museum; Air Power Park; Hampton Carousel; and Harbor Cruises.

The Center has four tennis courts, an indoor and outdoor basketball court, one softball diamonds, and the Conference Center at Building 2102. The Langley Exchange Activities (LEA) provides social options for NASA families, including club meeting facilities, food service, and organized sports leagues (volleyball, softball, golf, running, tennis, etc.). A picnic area and playground are located adjacent to the former site of Building 1222.

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13.0 COMMUNITY RELATIONS AND LOCAL ECONOMY

13.1 REGULATORY OVERVIEW

To comply with Federal, State and local environmental laws, NASA LaRC has developed and implemented an environmental compliance, restoration, and pollution prevention program to address LaRC's operations that could affect human health or the environment. LaRC has also developed an Emergency Management Plan (EMP) (LPR 1046.1, revised October 2015) to ensure coordination with local governments, police, and fire departments when responding to any emergency situations arising from Center operations.

Executive Order 12898 dated February 11, 1994 requires that each Federal agency make achieving environmental justice part of its mission. This involves identifying and addressing the adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. NASA Headquarters published the agency environmental justice strategy in March 1995. Individual centers, including NASA LaRC, published their environmental justice implementation plans in March 1996.

13.2 NASA LANGLEY OPERATIONS

LaRC's everyday operations require the use of hazardous chemicals which could result in the inadvertent small-scale release of chemicals to the environment through air emissions or spill/leakage/discharge on land or to water bodies. LaRC utilizes pollution prevention strategies and best management practices to minimize the potential for releasing a hazardous material to the environment. The Center uses an Environmental Management System (EMS) to continually review and improve environmental initiatives. Prior to the passage of NEPA in 1969, RCRA in 1976, and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in the early 1980s, the release and disposal of hazardous substances were not strictly regulated.

LaRC is currently listed on the Superfund National Priorities List as a result of contamination caused by past activities at the Center. Soils at former landfills were contaminated with waste solvents and paints, used batteries, scrap metals, pesticides, municipal wastes, chemicals, sanitary refuse, photo finishing wastes, medical wastes and laboratory wastes. Groundwater was contaminated with metals and volatile organic compounds (VOCs). Sediments and biota in the Back River and Tabbs Creek were contaminated with polychlorinated biphenyls (PCBs) and polychlorinated terphenyls. Information on preliminary assessments, investigations, studies and remedial actions of contaminated LaRC sites can be found in Chapter 16 (EPCRA/CERCLA) of this document.

NASA LaRC has developed a comprehensive community relations program under the Center's Superfund program. Since 1993, NASA LaRC has conducted a number of outreach activities designed to inform the public about cleanup of contaminated areas at the Center and create avenues for citizen input into the decision-making process. NASA LaRC's Superfund program and related outreach activities are described in the NASA LaRC Community Relations Plan. In addition, NASA LaRC has developed an Environmental Justice Implementation Plan. Both plans outline the Center's community outreach strategies, which help to ensure that outreach efforts continue to target groups that constitute a representative cross-section of the local population.

13.2.1 Local Community Factors

The cities of Hampton and Poquoson and York County are directly adjacent to NASA LaRC's perimeter. Poquoson is located to the north and is primarily a residential community. The City of Poquoson covers 41 square kilometers (km²) or 16 square miles (mi²) and includes 1,780 hectares (4,398 acres) of salt marsh wetlands and 135 km (84 mi) of shoreline. The 2010 census recorded Poquoson's population at 12,150 with a racial makeup of 95 percent white residents. The median household income in Poquoson is $84,347, with a poverty rate of 4.9 percent.

York County (273 km² or 105.5 mi²) lies to the northwest of NASA LaRC. York County has a population of 65,464, with a median household income of $77,662. The County's poverty rate is at 4.7 percent and the population is approximately 76.4 percent white, 13.4 percent African American, 4.4 percent Hispanic or Latino, and 6.9 percent Asian and other minorities.

The City of Hampton (134.7 km² or 52 mi²) lies to the south and southwest of NASA LaRC and has a large residential community (137,436 in the 2010 census). The median household income is $46,175 and the poverty rate is 14.8 percent. Hampton's population is 42.7 percent white, 49.6 percent African American, 4.5 percent Hispanic or Latino, and 4 percent Asian and other minorities.

The area to the west of NASA LaRC is one of the least developed areas of the City of Hampton. Development immediately outside the western/southwestern NASA LaRC boundary consists of a residential mobile home park, an apartment complex, and an auto race track (Langley Speedway). There also are a number of small commercial businesses, convenience stores, fast food restaurants, and a hotel along the NASA LaRC western border. The buildings within a 3.2 km (2 mi) radius are primarily residential and commercial, although office buildings are located in the Hampton Roads Center and some laboratories are found in the Langley Research and Development Park located nearby.

13.2.2 Local Population Factors

The economic study area addressed in this ERD is within a one-hour commuting radius (80 km or 50 mi) from NASA LaRC. The area includes the portions of the Norfolk-Virginia Beach-Newport News, VA-NC Metropolitan Statistical Area (MSA) known as Hampton Roads. The area includes the cities of Hampton, Poquoson, Newport News, Williamsburg; and James City County and York County. The MSA also includes five other cities and another five counties. NASA LaRC is located in the northern portion of the City of Hampton.

13.2.2.1 Population

The total population of the Hampton Roads MSA for 2010 was 1,671,683. Table 13-1 lists the 1980, 1990, 2000, and 2010 Census populations for each major area of the Peninsula. As the table shows, the Peninsula area experienced significant growth over the 30-year period from 1980 to 2010.

Table 13-1 U.S. CENSUS POPULATIONS						
Year	**Hampton**	**Newport News**	**York County**	**James City County**	**Williamsburg**	**Poquoson**
1980	122,617	144,903	35,463	22,339	10,294	8,726
1990	133,773	171,477	42,434	34,779	11,600	11,005
2000	146,437	180,150	56,297	48,102	11,998	11,566
2010	137,436	180,719	65,464	67,009	14,068	12,150
Source: 2010 U.S. Census						

13.2.2.2 Employment

Total employment for the Hampton Roads MSA in 2016 was 1,037,720. Government workers comprised 23.7 percent of the MSA's workers in 2016 and private wage and salary workers made up for 80.2 percent (Hampton Roads Planning District Commission, 2016). Table 13-2 lists the occupational profile for the MSA.

Table 13-2 HAMPTON ROADS MSA EMPLOYMENT FOR 2016		
Occupation	**Annual Average Employment**	**Percentage**
Farm	2,253	0.2
Manufacturing	53,524	4.0
Retail Trade	105,469	7.7
Information	13,325	1.0
Professional and Technical Services	66,174	4.9
Educational Services	19,657	1.4
Health Care and Social Assistance	105,388	7.7
Other Services, except public admin.	58,188	4.3
Government, Total	246,174	18.0
Federal, Civilian	57,619	4.2
Military	84,089	6.2
State and Local	104,466	7.7
Other (individual breakdown not provided in Source data - See Note 1)	162,287	11.9
Total Employment	**1,037,720**	
Note 1: Employment categories include: Forestry, Fishing, Utilities, Wholesale Trade, Transportation & Warehousing, Arts, Entertainment, Recreation, Food Services. Source: Hampton Roads Data Book (June 2016); Hampton Roads Planning District Commission. www.hrdpva.gov		

NASA LaRC forms an important part of the City of Hampton's economy and the MSA. Langley's facilities, covering 764 acres, represent a $2.8 billion impact nationally. Current and future

infrastructure investments are likely to generate additional economic benefits. About 3,700 people work at the Center, including 1,940 civil service and 1,750 contract employees. According to the NASA LaRC 2017 Annual Report, the Center's economic impact includes the following: Hampton Roads area, 1.1 billion supporting 6,474 jobs; Virginia, 1.3 billion supporting 7,597 jobs; and nationwide, 2.8 billion supporting 14,785 jobs.

13.2.2.3 Income

In 2016, the per capita income of the MSA was $47,019 which was approximately 95 percent of the average U.S. per capita income. The Peninsula per capita income varies, from $47,019 in the City of Hampton to $54,592 in the City of Poquoson (Hampton Roads Data Book, 2018). According to the U.S. Census' American Community Survey 5-year estimates, the number of families below the poverty level income in the MSA was 7.5 percent compared to 9.1 percent in the City of Hampton. The City of Poquoson and York County, which are relatively affluent, had about 3 percent of their families with income below the poverty level.

13.2.2.4 Housing

The 2010 U.S. Census data indicate that the total number of occupied housing units in the Hampton Roads MSA was 628,572. A majority of the units (427,810) were single-family units. Total inhabited units numbered 55,031 in the City of Hampton, 4,525 in the city of Poquoson and 24,006 in York County. In the period 2000 to 2010, all three local jurisdictions have seen growth in housing construction. Housing growth in the Hampton Roads area is shown in Table 13-3 and is based on 2000 and 2010 U.S. Census data.

Table 13-3
Housing Growth in Hampton Roads, 2000 - 2010

Location	Housing Units		Change (2000-2010)	
	2000	2010	Number	Percent
James City County	20,772	29,797	9,025	43.4
Newport News	77,426	76,198	-1128	-1.5
Poquoson	4,300	4,726	426	9.9
Hampton	58,810	59,566	756	1.3
Williamsburg	3,880	5,176	1296	33.4
York County	20,701	26,849	6148	29.7
Peninsula Totals	185,889	202,312	16,423	8.8

Source: U.S. Census, 2000 and 2010

13.2.3 Security and Law Enforcement

The City of Hampton police force employs 287 sworn officers, and has 103 civilian positions, comprised of telecommunications, administrative and school crossing guard personnel. (Hampton Police Division, May 2016 Staffing Report).

Access to NASA LaRC is controlled on a 24-hour, year-round schedule at access gates by uniformed security support contractor officers. Security officer responsibilities consist of on-foot and motorized patrols.

13.2.4 Fire Protection

The LaRC Fire Department (Hampton Fire Department Station No. 8) was built in the mid-1960s and is strategically located on the Center at 10 Langley Blvd. The Fire Department provides coverage for all the acres that comprise LaRC as well as areas within the City of Hampton adjacent to the Center. All fire apparatus and the Fire Station are owned by NASA. All emergency response personnel are employees of the City of Hampton Fire Department and compensation is provided annually by NASA via a Space Act Agreement with the City of Hampton for staffing of the station.

The LaRC Fire Department is responsible for fire suppression, hazardous materials response, emergency medical response, and special rescue support activities. They are on duty 24-hours a day, 7-days a week and use a 3-platoon work schedule whereby one platoon is on duty for 24-hours at a time. One fire officer (captain or lieutenant), three advanced life support-qualified (ALS) firefighters (Medics), plus three additional technical rescue staff are on each platoon. The LaRC Fire Department maintains a total of three emergency response vehicles, including a ladder truck, brush truck and an ambulance. Some emergency trailers are specially equipped to control situations unique to LaRC (LPR 1046.1 J-1, 2015).

13.2.5 Schools

The City of Hampton public school system includes 29 schools with a total enrollment of over 20,618 students in elementary, middle school, and high school. The Poquoson school district has 4 public schools with a total enrollment of approximately 2,137 students. The following table shows enrollment and available pupil/teacher ratios for area schools.

Table 13-4
Area Public Schools Enrollment and Pupil/Teacher Ratios

School District	Number of Schools	2019-20 Total Enrollment	Ratio of Pupils to Classroom Teaching Positions (2014-15)	
			Grades K-7	Grades 8-12
Hampton	29	19.590	13:1	12:1
Poquoson	4	2,137	13:1	13:1
York	12	13,184	15:1	13:1
Newport News	37	28,655	15:1	12:1

Source: Virginia Department of Education, (http://www.doe.virginia.gov/statistics_reports/index.shtml)

Higher education programs serving the area include the following:

- Old Dominion University (satellite campus in Hampton)
- Hampton University and Thomas Nelson Community College in Hampton
- College of William and Mary in Williamsburg

- Virginia Institute of Marine Science at Gloucester Point
- Old Dominion University, and Norfolk State University in Norfolk
- Christopher Newport University in Newport News
- Other institutions serving Hampton Roads: George Washington University Hampton Roads Center, Virginia Tech Hampton Roads Center, St. Leo's College, Regent University, Eastern Virginia Medical School, Rappahannock Community College, and Tidewater Community College

13.2.6 Health Care Facilities

The peninsula has full-service acute health care services available through Eastern State Hospital (Williamsburg), Mary Immaculate Hospital (Newport News), Port Warwick Medical Arts (Newport News), Riverside Behavioral Health Center (Hampton), Riverside Rehabilitation Institute (Newport News), Riverside Regional Medical Center (Newport News), Sentara CarePlex Hospital (Hampton), Sentara Williamsburg Regional Medical Center, and Veterans Affairs Medical Center (Hampton).

The NASA LaRC occupational medicine program incorporates both an onsite health clinic and an employee fitness center. The clinic staff includes a physician, a physician assistant, two registered nurses, one nurse practitioner, a radiation technologist, and a medical assistant. Services provided by the health clinic include: urgent care, immunizations and injections, blood pressure screenings, voluntary health exams, travel health information, and optician services. The Fitness Center offers personalized fitness and conditioning programs, including aerobics classes. An on-site Employee Assistance Program (EAP) is also provided for both civil servants and contractor personnel.

13.2.7 Telecommunications

The IT Infrastructure Branch in LaRC's Office of the Chief Information Officer manages and operates the Langley Telephone System (LaTS), which provides landline call and voicemail services. Telephone service is delivered to desktops, conference rooms, hallways, and emergency stations across the center. LaTS features include caller ID, call logging, various voicemail options, and reverse 911 notification. LaTS also employs a voice firewall that blocks unwanted or harassing calls.

The NASA Langley Research Center data network (LaRCNet) services over 100 buildings and physically connects over 9,000 research, support, and infrastructure devices and allows them to communicate with each other and the rest of the world. LaRCNet consists of Ethernet technology based on four high performance data switches. The core switches connect to building switches that, in turn, connect end user devices to LaRCNet. LaRCNet's Wireless and Guest Network, WaGN, supports guest user network access to the Internet. NASA employees and contractors who are telecommuting or who are on travel can access LaRCNet through the Langley VPN system. VPN service is supported through the IT Security services group.

13.2.8 Transportation

Highways and Roads

The primary freeway through the city of Hampton is Interstate 64 (I-64) which connects with Interstate 664 and Interstate 264. The I-64/664/264 system provides quick access from Hampton to Newport News, Virginia Beach, Chesapeake, Suffolk and the Williamsburg area. Two bridge-tunnels, one on I-64 and the other on I-664, link Hampton to the Southside of the Hampton Roads metropolitan area. I-64 continues west where it links with I-95, I-295, and I-81, which provides access to major east-west and north-south interstate systems.

Several U.S. highways serve Hampton Roads. U.S. Route 17 connects with Fredericksburg, Virginia at I-95 and leads south along the coast through the Carolinas. U.S. Routes 258/58 reach west along the Virginia/North Carolina border with interchanges at I-95, I-85 and I-81. U.S. Route 60 leads north to Richmond and then through central Virginia. U.S. Route 13 connects Hampton Roads with the Eastern Shore of Virginia and Maryland. Approximately 50 motor carrier companies operate terminals in Hampton Roads for freight handling and load consolidation.

Mass transit bus service is provided by Hampton Roads Transit. Hampton Roads Transit buses operate seven days a week and provide service on a network of routes throughout Hampton, Newport News, Norfolk, Virginia Beach, Portsmouth, Chesapeake and Suffolk, as well as bus service between the Southside and the Peninsula. Transit buses are lift equipped for persons with disabilities, and curb-to-curb service for physically and mentally disabled individuals is available. There is no transit service provided to NASA LaRC.

The Virginia Department of Transportation maintains a number of “Park & Ride" commuter parking lots throughout the area to encourage ridesharing. Taxi services are provided by more than 20 taxicab companies located on the Peninsula.

Airports

Two major airports are within a 30-minute drive from NASA LaRC. The Newport News-Williamsburg International Airport is located in Newport News approximately 16.1 km (10 mi) from LaRC. This airport is served by four carriers with nonstop airline service to several eastern hubs including Atlanta and New York. The Norfolk International Airport is located about 35.4 km (22 mi) from LaRC in Norfolk. This airport is southeastern Virginia's primary airport serving the greater Hampton Roads area and northeastern North Carolina. Norfolk International airport has nearly 200 arrivals and departures daily with almost 4 million passengers a year.

Railways

Two major railroads, Norfolk Southern and CSX Corporation, provide cargo services in the Hampton Roads area. Norfolk Southern operates approximately 21,500 route miles in 22 eastern states, the District of Columbia and Ontario. CSX provides rail freight transportation over a network of approximately 21,000 route miles in 23 states, the District of Columbia, and the Canadian provinces of Ontario and Quebec.

Passenger rail service is provided by Amtrak from their passenger station located in Newport News. Amtrak provides daily service to Washington, D.C., Baltimore, Philadelphia, New York, and Boston.

Waterways

The Port of Hampton Roads provides the best natural deep water harbor on the east coast. Its strategic mid-Atlantic location and well-developed transportation infrastructure attract many steamship lines and shippers. It has more than 75 international shipping lines and one of the most frequent direct sailing schedules of any port. Fifty-foot-deep, unobstructed channels provide easy access and maneuvering room for large container ships. The ice-free harbor provides year-round access to the open sea. One of the largest port facilities on the east coast, Hampton Roads offers six direct-service trains to 28 major cities each day. More than 50 motor-carrier companies offer full freight-handling and load-consolidation services. A modern network of interstate and local highways permits fast, direct inland motor-freight transportation to any point in the United States.

14.0 NOISE

14.1 REGULATORY OVERVIEW

The Federal Noise Control Act of 1972 (42 USC §4901 et. seq.) was enacted by Congress to promote an environment that is free from noise that jeopardizes the health and welfare of the nation. The Act was established to provide a means for coordinating federal research and activities in noise control, to authorize the establishment of noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products. The Quiet Communities Act of 1978 (42 USC §4913) directed the federal government to develop and disseminate noise control information and educational materials to the public, conduct research into the effects of noise on humans, animals, wildlife, and property, and investigate the economic impact of noise on property and human activities.

Federal regulations that have been promulgated as a result of the Noise Control Act generally regulate the noise produced by transportation related equipment such as locomotives, trucks, and construction equipment (40 CFR 201-211). In addition, requirements are given for product noise labeling and hearing protection standards. Federal regulations governing low noise emission requirements for products exclude any rockets or equipment which are designed for research, experimental, or developmental work to be performed by NASA (40 CFR 203.1). However, NASA LaRC's policy is to minimize noise generated by LaRC operations, prevent occupational noise-related hearing loss among employees, provide a work environment free from hazardous noise, and give priority to engineering procedures to eliminate, control, or isolate sources of hazardous noise (LPR 2710.1).

The Noise Control Act directed EPA to publish information about the effects of different qualities and quantities of noise and to define acceptable levels of noise under various conditions that would protect public health and welfare with an adequate margin of safety. The noise guidelines published by EPA identify a 24-hour exposure level of 70 decibels (dBA) as the level of environmental noise which will prevent any measurable hearing loss over a lifetime. They identify a day/night sound level (Ldn)[1] of less than 55 dBA outdoors and 45 dBA indoors as adequate to protect activities against interference and annoyance due to noise (EPA, 1974).

The Commonwealth of Virginia has not enacted noise control regulations. However, the City of Hampton has enacted a Noise Ordinance (Hampton City Code, Section 22 - Noise) which prohibits creating any unreasonably loud or disturbing noise of such character, intensity, or duration that may be detrimental to the life or health of any individual or which disturbs the public peace and welfare. The City has defined a Noise District which includes all lands within the 65 dBA Ldn contour of the Noise Contour Map of Langley Air Force Base (LAFB), Air Installations Compatible Use Zone (AICUZ) report. The LAFB AICUZ report is an extensive analysis of the effects of noise, aircraft

[1] The Ldn parameter is preferred by the EPA for assessing environmental noise impacts (EPA, 1974). It is the energy average of all the noise occurring throughout the 24-hour day but with a 10-decibel penalty added to the nighttime hours between 10 p.m. and 7 a.m. to account for the greater sensitivity of people to noise at night. This guideline level is commonly used as a basis for judging the acceptability of facility noise at residential and other sensitive receptors. Other governmental agencies such as the Department of Housing and Urban Development (HUD) and the Department of Defense (DOD) define outdoor Ldn Levels up to 65 dBA as acceptable for residences.

accident potential, land use, and development, upon neighboring communities (LAFB 2007). The LaRC Noise Contour Map, shown in Figure 14-1, was derived from this report. The Hampton City Code requires residences within the Noise District have adequate acoustical insulation to achieve a maximum interior noise level of 45 dBA to guard against any adverse human health effects or disturbances due to excessive noise.

14.2 NASA LANGLEY OPERATIONS

NASA conducts its research and testing operations with great caution and awareness to restrict noise within the guidelines established by the Occupational Safety and Health Act of 1970 (29 CFR 1910 et. seq.) and minimizes environmental noise impacts to the extent possible. LaRC maintains a Noise Control and Hearing Conservation Program, which is described in LPR 2710.1.

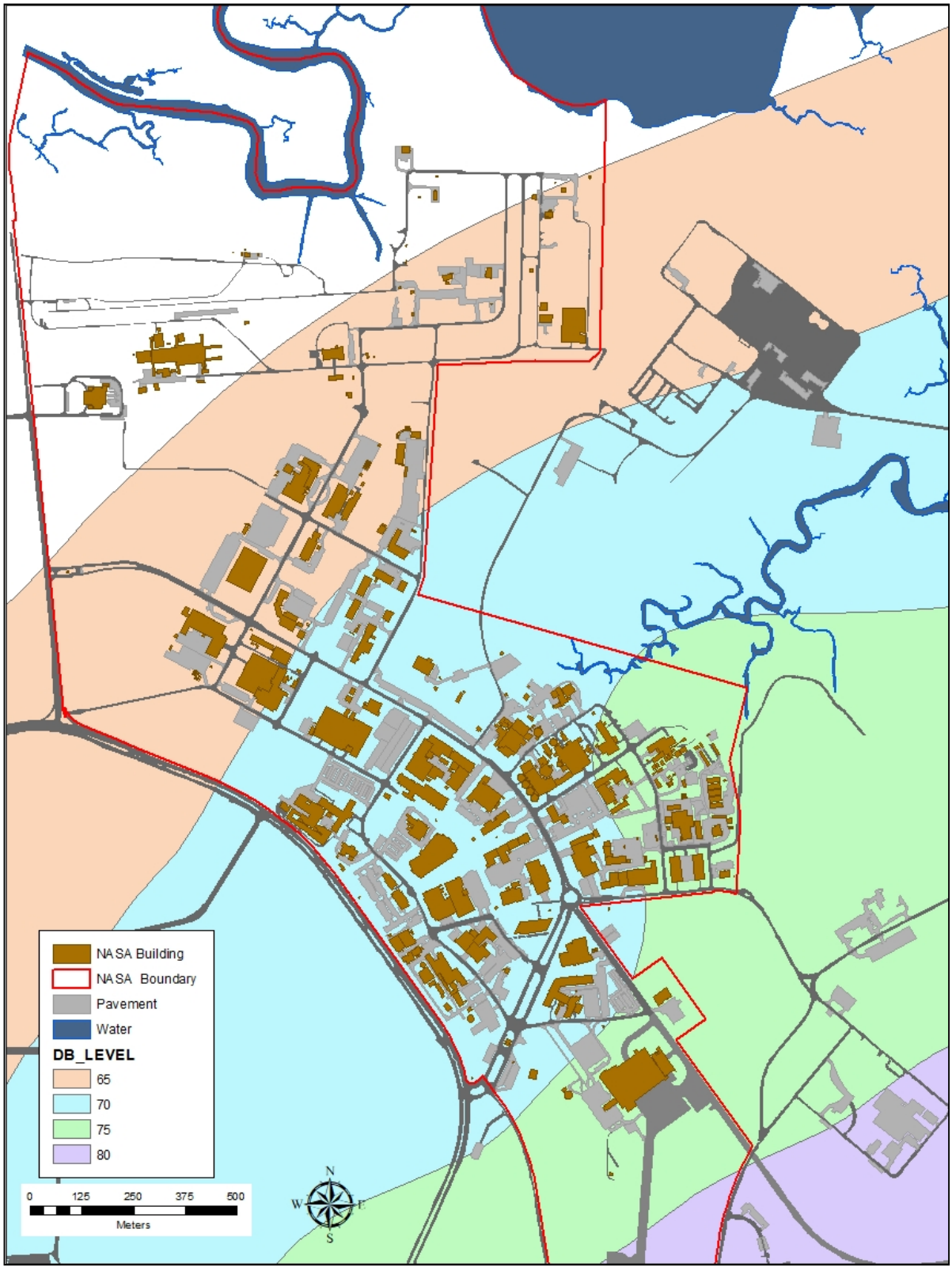
Primary noise sources at NASA LaRC include the wind tunnels, the compressor stations, and the substations. Most of the wind tunnels are closed-loop tunnels in which the test gas medium is recirculated and the noise generated by the tunnel is contained largely within the building. In addition, many of the laboratories and shops have equipment that produces high interior noise levels within the buildings.

Sound intensity attenuates with distance from the source, so the impact of sound generated is greatly affected by the distance from the source to the receptor. Since the land surrounding NASA LaRC is basically flat, the effects of terrain on propagating sound waves have been ignored in sound analyses performed at NASA LaRC. Meteorological conditions, however, can have a great effect on sound wave intensity. Acoustic focusing can be caused when the speed of sound increases with altitude due to certain wind speeds and temperature profiles. When this occurs, sound waves are refracted and combine with the sound wave traveling along the ground, causing higher noise levels at any given distance than would normally be expected. Many of the facilities operate intermittently, often for periods of ten minutes or less.

Although the fighter aircraft operating from Langley Air Force Base are by far the dominant and most wide spread noise source in the area, several NASA LaRC facilities located close to the NASA LaRC property line produce noise levels higher than ambient levels outside the property line. Several of the tunnels operate for extended hours during nighttime due to large electrical power requirements. The major noise sources at NASA Langley Research Center include:

- National Transonic Facility (Building 1236)
- 8-Foot High Temperature Tunnel (Building 1265A-E)
- 14x22-Foot Subsonic Tunnel (Building 1212C)
- Transonic Dynamics Tunnel (Building 648)

FIGURE 14-1
NASA LaRC NOISE CONTOURS



Several wind tunnel operations at NASA LaRC, such as the 8-Foot High Temperature Tunnel, produce noticeable sound outside NASA LaRC property, and as such there is a possibility of impact to surrounding communities from these noise levels, particularly during adverse atmospheric conditions.

Due partly to the uniqueness of the NASA LaRC tunnels, a lack of major residential development within the Hampton Noise District, and the fact that NASA LaRC and LAFB have preceded most residential developments in the area, there have not been significant complaints regarding noise from NASA LaRC operations.

NASA LaRC conducted a comprehensive environmental noise survey (Ebasco, 1995) of its major noise producing sources during 1994 to establish noise levels resulting from Center operations, to determine the acceptability of the noise by the local community, and to develop appropriate mitigative measures as required. The survey used the Botsford procedure to rate the noise from each source and to determine the potential of community annoyance from these noise sources. Table 14-1 lists the facilities and their operating noise levels measured at five off-site properties in the nearby community around NASA Langley Research Center.

Table 14-1
FACILITY OPERATING NOISE LEVELS AND POTENTIAL FOR COMMUNITY ANNOYANCE

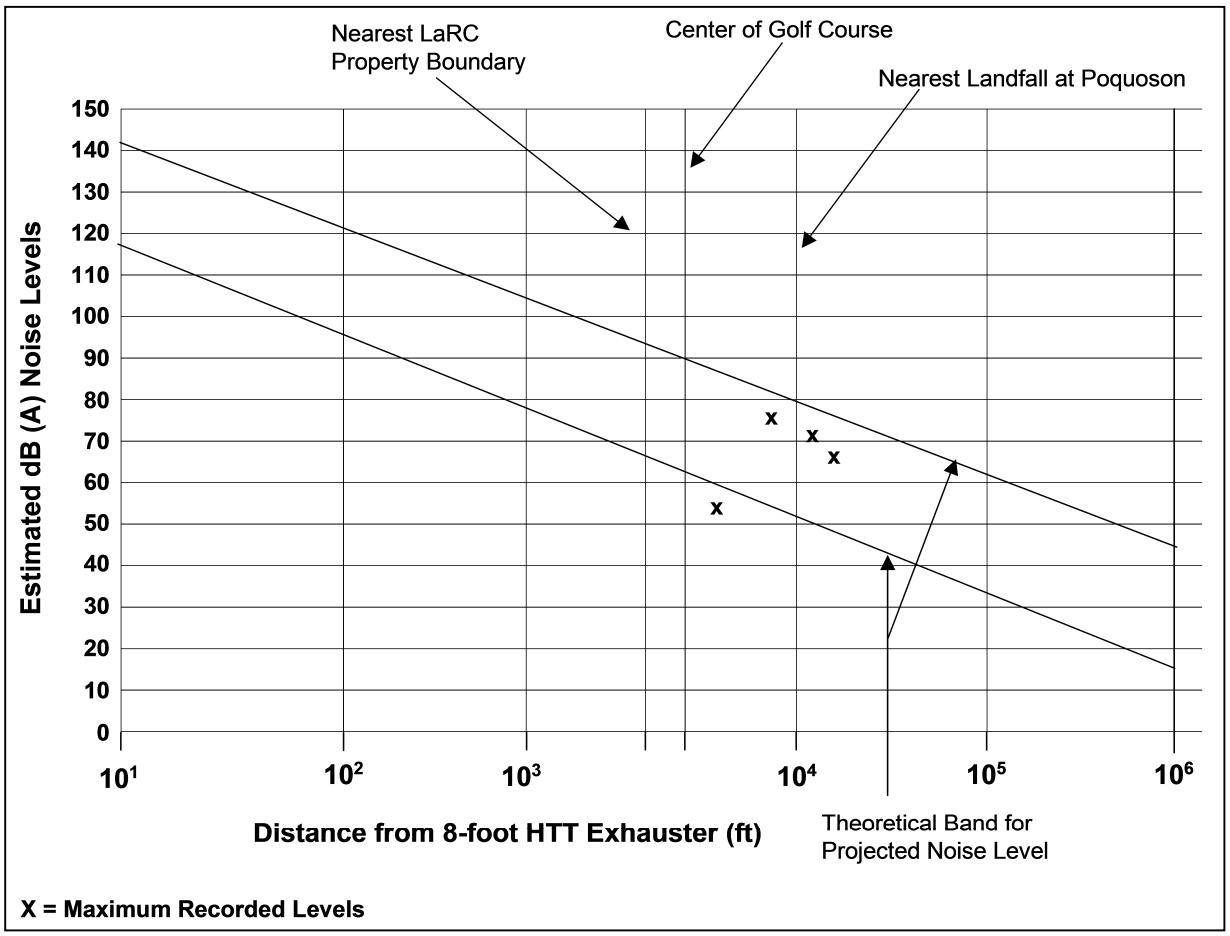
Building No.	Noise Source	Date Measured	Highest Operating Noise Level dBA	Botsford Potential for Community Noise Annoyance
648	Trans Dynamic Tunnel	7/14/94	47	None
1212C	14x22-Foot Subsonic Tunnel	7/24/94	56	None
1236	National Transonic Facility	12/8/94	69	Few
1244	Hangar/Run-up Pad with NASA Use	7/18/94	57	None
1244	Run-up Pad with LAFB Use	7/18/96	81	Few
1265	8-Foot High Temperature Tunnel	7/18/94	79	None

The survey indicates the National Transonic Facility produces noise levels with the potential to generate a "few" noise complaints from the adjacent community. Although noise levels from NASA aircraft using the Run-up pad were determined to have no potential for community annoyance, noise levels during the use of the Run-up pad by Air Force fighter jets were determined to have a potential for community annoyance. The noise level measured from the 8-Foot High Temperature Tunnel was similar to the noise level generated by Air Force fighter jets using the Run-up pad, although the Botsford potential for community annoyance was "none" from the 8-Foot High Temperature Tunnel operation. The reported difference in the Botsford potential between this Tunnel operation and the jet operations is the large low frequency of the sound from the Tunnel, and the relatively short duration (less than 100 seconds per test run) and infrequency of Tunnel operations (approximately twice a week). Jet noise from the Run-up pad extends for a much longer duration (14 minutes) than noise from the 8-Foot High Temperature Tunnel. Figure 14-2 shows theoretical calculations for likely noise levels from this tunnel operation. These calculations

indicate that noise levels between 55 dBA and 82 dBA may be possible near the City of Poquoson. These are comparable to actual measurements of 51 dBA to 79 dBA taken at Poquoson sound monitor locations in 1994 (Ebasco, 1995).

The Center's Industrial Hygiene staff in the Safety and Facility Assurance Branch monitors noise levels at NASA Langley Research Center facilities. They survey and monitor noise levels periodically, during annual audits of facilities, and in response to NASA LaRC employee complaints. The Industrial Hygiene staff ensures proper controls are in place to protect Center personnel from exposure to excessive noise levels in accordance with OSHA requirements.

FIGURE 14-2
8-FOOT HIGH TEMPERATURE TUNNEL (HTT) NOISE LEVELS



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15.0 ENERGY AND UTILITIES

15.1 REGULATORY OVERVIEW

The Center's energy conservation goals and objectives are consistent with Agency federal requirements including the Energy Policy Act of 2005 (EPACT), the Energy Independence and Security Act of 2007, and Executive Order 13834. The primary goals for LaRC include:

- Facility Energy Efficiency - Achieve 30% reduction in BTU/GSF relative to fiscal year (FY) 2003 and 0.5% reduction in FY 2019 relative to FY 2018.

- Efficiency Measures, Investment, and Performance Contracting - Utilize performance contracting to achieve energy, water, building modernization, infrastructure goals.

- Renewable Energy - At least 7.5% of total electricity consumed from renewable sources.

- Water Efficiency - Achieve 20% reduction in gal/GSF relative to FY 2007 and 0.5% reduction in FY 2019 relative to FY 2018.

- High Performance Sustainable Buildings - At least 15% of agency owned buildings or GSF qualify as sustainable and demonstrate annual progress.

15.2 NASA LANGLEY OPERATIONS

15.2.1 Energy Consumption

NASA LaRC used approximately 121 million kilowatt-hours (kWh) of electricity in FY 2016 and approximately 136 million kilowatt-hours (kWh) of electricity in FY 2017. NASA LaRC uses natural gas and distillate oil (#2 Fuel Oil, Diesel Fuel) to provide for heating and research needs, and distillate oil is also used in the diesel-fueled emergency generators that are used to provide backup power to certain facilities in the event of a power outage. In FY 2017, NASA LaRC facilities used approximately 1 million cubic feet of natural gas and 18,000 gallons of distillate oil. NASA LaRC received 272 million pounds of steam from the City of Hampton Refuse-Fired Steam Generating Facility (RFSGF) in FY 2017 and the Center's Steam Plant at Building 1215 produced 80 million pounds of steam.

In FY 2017, NASA LaRC produced approximately 69 MWh of renewable electricity through its three solar photovoltaic systems. The Center also "produced" renewable thermal energy through its use of ground source heat pumps in B2101, the first newly constructed building in the Center's 20-year revitalization plan, but no value has been calculated for this energy production. Energy program staff are looking into the verification needed to obtain credit for this renewable source of energy.

In FY 2017, the Center used approximately 47,710 gallons of jet fuel and 9,787 gallons of aviation gasoline for its planes. The Center also used approximately 32,868 gallons of gasoline, 11,378 gallons of diesel fuel, and 6,213 gallons of E85 for its on-site fleet of vehicles. Due to significant maintenance problems and costs, the use of B20 biodiesel for vehicular use was discontinued at LaRC in late 2009. The Center returned to using regular petroleum diesel for its diesel fueled vehicles.

15.2.2 Energy Management and Conservation

Historical Program

A comprehensive energy conservation and management program has been in operation since the early 1970's at the Center. An assortment of programs, controls, hardware systems, and management policies are in place to facilitate energy monitoring and conservation. The salient features of the program include the following:

- Refused-Fired Steam Generating Facility (RFSGF, B1288) jointly funded by NASA and the City of Hampton which typically provides about 85 percent of the Center's annual steam requirements;
- Energy Management Control System (EMCS) for automated monitoring and on/off control of the heating, ventilating, and air conditioning (HVAC) systems in major facilities;
- Radio control system for automated on/off control of smaller HVAC systems and hot water heaters;
- Electronic monitoring and reporting system of electrical and thermal energy usage;
- Benchmarking and tracking of energy use, power demand, and energy use intensity in individual buildings;
- Ongoing commissioning and re-commissioning/retro-commissioning of buildings;

- Investment in energy efficiency projects; and
- Outreach to promote energy efficiency to LaRC personnel.

Current System and Future Plans

Data from the energy management program is managed through three segregated elements - the Energy Management System (EMS), the Facilities and Related Services database (F&RSA), and the EMCS (managed through the LaRC Integrated Operations Center in Building 1215). EMS, which pulls data from the Center's Schneider Electric Struxureware electricity metering data historian, provides electrical power usage monitoring and reporting on current usage, comparisons of actual and planned usage, accumulated totals, and excessive power usage. The F&RSA database tracks water, sewer, steam, natural gas and fuel oil cost and consumption. The EMCS implements energy control by on/off actions using strategies based on day/night cycles, weekday/weekend cycles, and outside temperature thresholds for HVAC systems. The NASA LaRC Utilities and Energy Managers oversee the program.

In FY16 and FY17, significant focus was placed on the electrical metering system and monitoring tools available to make energy management decisions. The energy management program implemented a new energy information system using the existing OSIsoft PI process management server and infrastructure that was put in place for the Center's Condition-Based Maintenance (CBM) program. This system allows for electrical, steam, and sanitary metering measurements to be reported on a real-time basis to the OSI PI data archive. The system also allows for real time monitoring and analysis of energy and water data which also improved visibility and correction of meter data quality problems.

In addition to these systems, LaRC also utilizes ad hoc information and control systems for energy management on Center, such as electricity submetering and lighting controls in certain facilities.

The Center is aggressively developing strategies to meet the challenges of Federal energy mandates without unduly compromising research productivity or employee comfort. The Center's 10-year Energy Conservation Performance Plan (ECPP) is the primary planning document for the program and should be referenced for more detailed information. The ECPP is reviewed annually with updates every two (2) years, at a minimum, and signed by the Center Director every four (4) years.

15.2.3 Utilities

15.2.3.1 Electrical Power

Electrical power is supplied throughout the Peninsula by Dominion Energy Power, and NASA LaRC is one of the largest single customers connected to its system. The Center is served from Virginia Power's Peninsula Substation by two 115 kV overhead lines. Each line is protected by a circuit breaker at Virginia Power's Peninsula Substation. The present transmission system at NASA LaRC consists of cables and overhead lines operating at voltages from 115 kV down to 2.3 kV.

Power usage is maintained within the following in-house and contracted agreements:

- During "on-peak" hours, Monday through Friday, 7:00 a.m. to 10:00 p.m., 24 megawatt (MW) firm “on peak” plus 126 MW excess (interruptible) “on peak”. Operations above 150 MW can be allowed with prior approval from the electricity provider.
- All other hours (off-peak), the power is limited to 245 MW.
- Non-emergency rate of change of power in excess of 100 MW per minute has special contracted limitations.

NASA LaRC has advanced metering on all applicable buildings on Center, thus meeting the Federal mandate to install advanced metering by October 1, 2012.

15.2.3.2 Water Supply

NASA LaRC does not operate a public water system. Potable water is supplied by the Newport News Waterworks (NNW). The primary sources of raw water to the NNWW are the Chickahominy River and the Diascund Reservoir. Raw water from these sources is pumped approximately 48 km (30 miles) to the City of Newport News treatment plants located at the Lee Hall and the Harwood's Mill reservoirs. These two plants combined can treat 85 million gallons of water per day. The NASA LaRC East Area is served by the LAFB water system which also purchases its water from Newport News Waterworks.

The West Area of NASA LaRC is connected to the City of Newport News water distribution system via an 8" meter and 8" service line located at Armistead Avenue directly behind Building 1146E. The NASA LaRC main service line then connects to a backflow preventer located in Building 1146E before continuing to the main potable water pumps located at Building 1215. The potable water pumps are controlled by the level of the LaRC Water Tower (Building 1186) and maintain the level of the tower between 72% and 92% which have a corresponding pressure of between 72 and 76 psig to insure adequate pressure for fire protection. The water is distributed through 8” and 10” headers in a loop configuration with service lines to the individual facilities, ensuring that the major facilities have more than one source of water to avoid major outages. A 400,000 gallon reserve is maintained in the water tower.

NASA LaRC also provides water to the LAFB Munitions Area. This connection consists of a loop tied into the 8" service line at the former B1275 site and at the base of the elevated storage tank. The service line is metered at both connections.

15.2.3.3 Sanitary Sewer System

Sanitary sewage disposal is provided by the Hampton Roads Sanitation District (HRSD). Wastewater discharges from NASA LaRC to the sanitary sewer system are regulated under a permit issued by HRSD. NASA LaRC has an 8" PVC force main which is connected to the HRSD system. The sewage pumps and sewage effluent meter are located at Building 1223B. The force main exits near the Wythe Creek Road side of Building 1212 and connects to the HRSD system.

15.2.3.4 Stormwater System

NASA LaRC has a network of man-made stormwater conveyances including separate storm sewers, ditches, drainage channels, swales, and pipes which discharge into surface water bodies adjacent to the Center. This system is considered a Phase II Municipal Separate Storm Sewer System (MS4). NASA LaRC has sixteen permitted outfalls which are regulated by VDEQ under a VPDES Permit. The MS4 is also permitted by the VDEQ and provides general stormwater permit coverage for the Center. Additional information on the LaRC Water Permits can be found in Chapter 3, Section 3.2.4 of this Environmental Resources Document.

15.2.3.5 Central Heating/Steam System

NASA LaRC's West Area has a network of steam lines laid in underground tunnels or subsurface trenches that provide steam for both institutional and research demands. The LaRC West Area total steam demand is provided by both the West Area Steam Plant (Building 1215) and the RFSGF (Building 1288). Typically, approximately 85 percent of the NASA LaRC West Area annual steam demand is supplied by the RFSGF and 15 percent by the West Area Steam Plant.

Oversight of the RFSGF is performed by a Joint Board of Oversight consisting of representatives from the City of Hampton and NASA LaRC. The City of Hampton operates and maintains the facility and monitors emissions as required by the Title V air permit. NASA LaRC's responsibility involves providing engineering support and active involvement with the Joint Board of Oversight.

NASA LaRC has fulfilled the Federal mandate to install advanced steam metering on all applicable buildings.

15.2.3.6 Natural Gas

Natural gas service at LaRC is provided by Virginia Natural Gas (VNG). Gas is delivered to a regulating station in company mains and distributed within the Center by Virginia Natural Gas-owned lines. In 2014, the Center had installed advanced natural gas meters for all applicable buildings, thus meeting the federal mandate for installing natural gas metering by October 1, 2016.

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16.0 RELEASE REPORTING UNDER THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA) AND COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA)

16.1 REGULATIONS

16.1.1 Emergency Planning and Community Right-to-Know Act (EPCRA)

The Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 was enacted in response to a growing concern about the effect of chemical releases on communities.

Although enacted as part of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III), EPCRA is a free-standing law. It is intended to encourage and support emergency planning efforts at the state and local level and provide citizens and local governments with information concerning potential chemical hazards present in their communities.

16.1.2 CERCLA

CERCLA provides the EPA with the authority to respond to releases or threatened releases of hazardous substances, pollutants, or contaminants that may endanger human health or the environment. CERCLA also requires that EPA maintain the National Priorities List (NPL), a list of sites across the United States that require remedial action due to releases or threatened releases of hazardous substances. Finally, CERCLA requires reporting of releases, establishes the liability of persons responsible for releases of hazardous substances, and establishes a trust fund to provide for cleanup when no responsible party can be identified.

16.2 REPORTING REQUIREMENTS

Reporting requirements for EPCRA and CERCLA are extensive. The requirements for each regulation are summarized below.

16.2.1 EPCRA Reporting

16.2.1.1 Emergency Planning Notification

EPCRA (SARA Sections 302 and 303) requires that facility owners or operators notify the Local Emergency Planning Committee (LEPC) and State Emergency Response Commission (SERC) if their facility qualifies as an Emergency Planning Facility. The criteria for qualification is any facility that has on site, at any given time, a quantity of an Extremely Hazardous Substance (EHS) that is equal to or greater than its threshold planning quantity (TPQ). The facility must notify the LEPC and SERC within 60 days of first meeting this qualification.

An Emergency Planning Facility must designate a Facility Emergency Coordinator and provide the name of that individual to the LEPC or the SERC if there is no established LEPC. Upon request from the LEPC or SERC, the facility shall promptly provide information necessary for emergency

planning. NASA LaRC is designated as an Emergency Planning Facility and complies with all emergency planning reporting requirements.

16.2.1.2 Spill Reporting

EPCRA (SARA Section 304) and CERCLA (Section 103) require that the owner or operator of a facility must notify the appropriate authorities in the case of an accidental release of an EHS or CERCLA-defined hazardous substance equal to or greater than its reportable quantity. This notification must be made immediately by the owner or designated representative to the National Response Center, SERC and LEPC for any area likely to be affected by the release. See Chapter 14 of the Environmental and Energy Program Manual (LPR 8500.1) for procedure information on spills and reporting.

As soon as possible after the release, EPCRA requires a written follow-up report for any release that requires immediate notification to the SERC and LEPC.

16.2.1.3 Inventory Reporting

Facilities that have hazardous chemicals are required by OSHA to maintain Safety Data Sheets (SDSs) for the hazardous chemicals. EPCRA (SARA Sections 311 and 312) requires the owner or operator of these facilities to:

- Submit SDSs or a list of SDS chemicals within 90 days from the day the facility first has on-hand the threshold quantities, and
- Submit annually (by March 1) a hazardous chemical inventory form to the SERC, the LEPC, and the local fire department that has jurisdiction over the facility.

NASA LaRC complies with the reporting requirements of EPCRA and submits the information to the Virginia Emergency Response Council in a Tier II format. Additional information is provided when requested by State or Federal agencies. While the specific number and types of hazardous materials reported may vary year to year, materials reported in recent years include fuels (diesel, unleaded gasoline, E-85, jet fuel, AVGAS 100LL, RP-2), gases (propane, methane, nitrogen, oxygen), liquids (oils, dielectric fluids, sulfuric acid, HCFC 134a, and 3D TRASAR 3DT230), and solids (lead-acid batteries, sodium chloride, garnet abrasive).

16.2.1.4 Hazardous Materials

NASA LaRC personnel use various hazardous materials to support the Center's mission. Center personnel are required to track hazardous materials used or stored in their facility using the Chemical Material Tracking System (CMTS) as stated in NASA LaRC policy in LPR 8500.1 and LPR 1710.12.

When facility staff purchase chemical items to use onsite, the item must be entered into CMTS. Tracking begins with the approval of a Form 44, a hazardous material purchase request form, which informs the facility inventory manager (CMTS user) that the product has been approved for purchase. Before Form 44 approval, the CMTS user must send the product's SDS to the CMTS administrator so that it can be entered into the system. The CMTS user is then responsible for maintaining and tracking the chemical inventory in the facility and updating the inventory

quarterly via CMTS. Using CMTS information, the EMO can obtain data for environmental reporting.

All chemicals are stored in accordance with OSHA requirements.

16.2.1.5 Toxics Release Inventory

EPCRA (SARA Section 313) also requires a report of releases of toxic chemicals from facilities that manufacture, process, import, or otherwise use a listed toxic chemical in excess of specific threshold quantities. Facilities must report the quantities of both routine and accidental releases of listed chemicals, as well as the maximum amount of the listed chemical onsite during the calendar year and the amount transferred offsite. This information is used to provide the public with information on the release of toxic substances to the environment during the reporting year. The EMO compiles data annually to determine if NASA LaRC is required to report a listed chemical under SARA Section 313. Data sources include CMTS, LaRC stock-issued supply reports, metals issue and recycling data, personnel interviews, data collected for air and water permit compliance, materials usage tracking spreadsheets collected from temporary onsite projects, and various other sources.

LaRC submitted toxic chemical release information on EPA Form R for the first time July 1, 1995. The only chemicals that have required reporting by NASA LaRC have been dichlorodifluoromethane, polycyclic aromatic compounds (PACs) and lead. Lead was first reported on EPA Form R in reporting year (RY) 2000. Further, lower reporting threshold requirements for lead enacted in 1999 has resulted in Form Rs from RY2000 to RY2010.

Table 16-1
TOXIC CHEMICAL RELEASES REPORTED BY NASA LaRC

Chemical	CAS #	Years Reported
Lead	7439-92-1	2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010
Polycyclic Aromatic Compounds (PACs)	N590	2009
Dichlorodifluoromethane	75-71-8	1994, 1995, 1996

16.2.2 CERCLA Reporting

Reporting the release of toxic chemicals is required for NASA and its contractors at NASA LaRC under CERCLA. This law and implementing regulations (40 CFR 355.10 et seq.; 40 CFR 372.1 et seq.) establish a list of hazardous substances and a reporting quantity as well as reporting requirements for release of toxic chemicals. Under CERCLA, facility personnel and contractors are responsible for reporting releases of reportable quantities (RQ) of hazardous substances to the EMO who reports to the National Response Center within 24 hours. Reportable quantities are specified on a constituent-by-constituent basis in 40 CFR Table 302.4.

16.2.2.3 CERCLA Reports

Preliminary Assessments/Site Inspections Under CERCLA

The EMO manages the investigation, response, and remedial activities of historically contaminated NASA sites at LaRC. EMO's Restoration Program Manager maintains copies of investigation and remediation reports.

In 1988, NASA LaRC conducted a Preliminary Assessment (PA) as required under Section 120(d) of CERCLA at the Center (Ebasco, 1988). The PA identified seven potentially contaminated sites. Of these sites, three were identified for further investigation. These sites included the Pyrotechnics Area (now known as the Chemical Waste Pit), Construction Debris Landfill, and the Area E Warehouse. A Site Inspection (SI) was carried out and used to develop preliminary Hazard Ranking System (HRS) scores as defined by the EPA (Ebasco, 1989). Three other sites (Tabbs Creek, Stratton Substation, and a portion of the East and West area stormwater system) were identified for further study as a result of other Center investigations. In 1991, the EPA conducted a site analysis of NASA LaRC and LAFB and identified 32 potentially contaminated sites at the two installations. From the Site Analysis, seven additional sites were identified at NASA LaRC. Sites identified during CERCLA investigations at NASA Langley are listed in Table 16-2.

In April 1993, the EPA approved and released the HRS scoring package for the NASA LaRC/LAFB site. Based on final scoring of the sites, NASA LaRC was jointly listed with LAFB on the NPL on April 1, 1994. Cleanup of the storm drain system, covered under a 1990 Federal Facilities Compliance agreement, was completed in July 1996 for West area facilities and December 1996 for East area facilities on LAFB, with approved EPA close-outs. NASA LaRC has studied five of the sites (Chemical Waste Pit, Construction Debris Landfill, Stratton Road Substation, Area E Warehouse, and Tabbs Creek) under a 1993 NPL Federal Facilities Agreement (NASA LaRC, 1993b). NASA LaRC has signed Records of Decision (ROD) for the Area E Warehouse area, Stratton Substation and Tabbs Creek. It has been determined that no further action is necessary at the Chemical Waste Pit. Remedial investigation of the Construction Debris Landfill site has been completed and the feasibility study was finalized in April 2009. The implementation of the soil cover remedy was completed in May 2010. An Interim Measures ROD was completed in 2010 for the chlorinated solvent contaminated groundwater at the CDL. The remedy was implemented in June 2011. Monitoring of this remedy is ongoing. A Remedial Investigation Addendum was completed in 2016 to evaluate potential risks not already addressed, including human health and ecological risks from groundwater. A ROD is expected in 2021.

The remaining seven sites (Dump near Building 1156, Dump near Building 1250, Open Storage Area, Buildings 1164 and 1199, the Treatment Facility, and the Fill Area) have been studied under the NASA LaRC NPL Facility Management Plan. Decision documents for all seven sites have been completed, signed, and implemented. All known petroleum-contaminated sites have been remediated as part of the underground storage tank (UST) work conducted at the Center (Ebasco, 1994b). A release from a previously existing tank at Building 1152 was discovered in 2011 and investigated. A Site Characterization Report was completed and the site was closed via the VDEQ Leaking UST program. Most contaminated soil was removed and disposed of during the construction of a new building in the area. The NASA LaRC Master Plan has noted the area as an "Environmental Hazard" area. Another tank at Building 583 was discovered in 2014 after

demolition activities damaged the fill port and supply-return lines which resulted in a release. A Site Characterization Report was completed and the site was closed via the VDEQ Leaking UST program after removal of the tank and contaminated soil in 2015.

TABLE 16-2
NASA LaRC CERCLA SITES

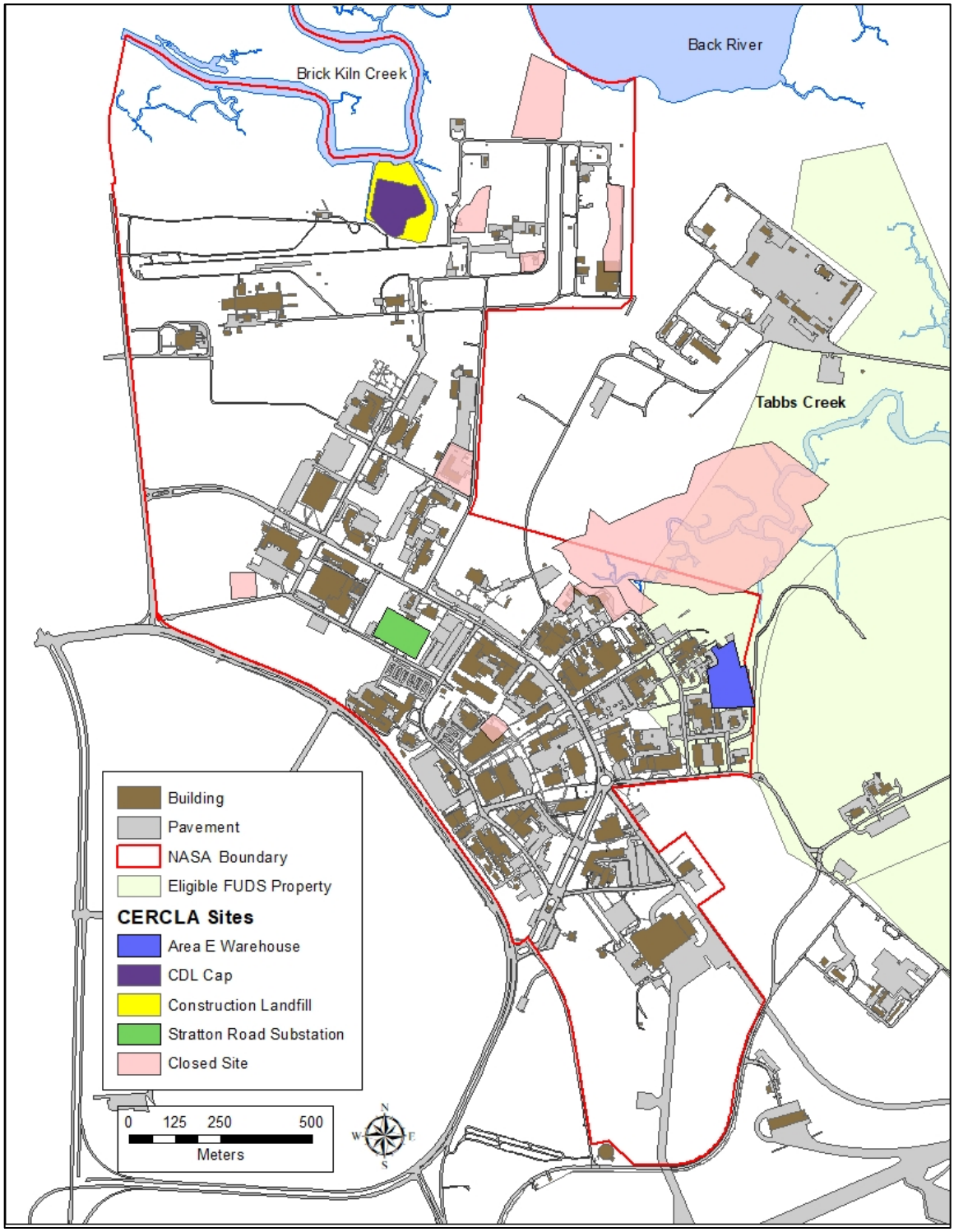
Site Description	Status
Area E Warehouse	LUC in place
Stratton Substation	Residual PCB-contaminated soil; Groundwater monitoring required; LUC in place
Construction Debris Landfill (CDL)	RI complete/FS complete; Environmental monitoring ongoing; LUC in place
Treatment Facility	Complete
Chemical Waste Pit	Complete
Stormwater System*	Complete
Tabbs Creek	Complete
Dump (Building 1156)	Complete
Dump (Building 1250)	Complete
Open Storage Area	Complete
Building 1164	Complete
Building 1199	Complete
Fill Area	Complete

* Federal Facilities Compliance Agreement, II-FF-CWA-003

Note: LUC Land Use Control (industrial use only). LUCs at CDL include bans on installation of drinking water wells and digging through the soil cover.
RI/FS Remedial Investigation/Feasibility Study.

Approximately 14.5 hectares (36 acres) of land along LaRC's east boundary was previously owned by the Department of Defense and as such, is eligible for the Formerly Used Defense Site (FUDS) Program. LaRC is currently investigating the area to determine if any Department of Defense activities may have contaminated the property. Preliminary information received from the Remediation Program Manager at LAFB indicates that no activities have occurred that would have contaminated the site, with the exception of pesticides, since the land is adjacent to the LAFB golf course. Figure 16-1 shows the location of the potential FUDS property, as well as the CERCLA sites undergoing restoration activities and those that have been closed.

Figure 16-1



CERCLA Sites at NASA LaRC

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17.0 SPECIAL LAND USES IN THE VICINITY OF NASA LaRC

17.1 PARKS AND WILDLIFE REFUGES

17.1.1 Nature Preserves and Wildlife Refuges

LaRC is located 11.3 km (7 miles) from Grandview Nature Preserve, which is located at the northeast corner of the City of Hampton. This nature preserve covers over 192 hectares (475 acres) of salt marsh, tidal creeks, and Chesapeake Bay beachfront. LaRC is located approximately 61.2 km (38 miles) from Hog Island State Wildlife Management area. Hog Island is 1,582 hectares (3,908 acres) consisting of three tracts of land. This area attracts waterfowl to forage and rest on the tidal marshes, diked impoundments and planted fields. Visitors have an opportunity to see eagles, a wide variety of shorebirds, and even upland wildlife species on some parts of the area. Approximately 64.3 km (40 miles) away is the Great Dismal Swamp National Wildlife Refuge. The Great Dismal Swamp, located in southeastern Virginia and Northeastern North Carolina, consists of over 45,325 hectares (112,000 acres) of forested wetlands. Lake Drummond, the largest natural lake in Virginia (1,255 hectares) is located in the Great Dismal Swamp. The Great Dismal Swamp is known for a wide variety of activities including hiking, biking, nature photography, wildlife observation, hunting, fishing and boating. The refuge was established for the purpose of protecting and managing the swamp's unique ecosystem which includes wildlife and habitat.

17.1.2 State and National Parks

In addition to being located near several major nature preserves and wildlife refuges, LaRC is also located near several city, national and state parks. LaRC is located near the city of Hampton's Sandy Bottom Nature Park. Sandy Bottom park is a 185 hectare (456 acre) recreational facility featuring two lakes, wetlands areas, trails for hiking and biking, fishing, non-motorized boating, picnic areas, children's playground, a campground and a beautiful nature. This park was developed from reclaimed borrow pits and garbage dumps. Approximately 27.4 km (17 miles) away is the Colonial National Historic Park. This park is comprised of 3 main features: Yorktown Battlefield, Historic Jamestowne, and the Colonial Parkway. The Colonial Parkway joins Yorktown, Jamestowne and Colonial Williamsburg to form what is referred to as the Historic Triangle. Newport News Park, located 24.1 km (15 miles) west of LaRC, is one of the nation's largest municipal parks. It is over 3,237 hectares (8,000 acres) in size and has a wide variety of native wildlife, found in a natural setting of woodlands, meadows and lakes. Approximately 40.2 km (25 miles) east of LaRC is First Landing State Park. This 1,169 hectare (2,888 acre) park, located on the Chesapeake Bay is the most visited state park in Virginia. First Landing offers boating, swimming, nature and history programs, hiking, biking, picnicking, a boat launch, and cabins.

17.2 HOSPITALS

LaRC is located within close proximity to a major hospital complex in Hampton. The Sentara CarePlex Hospital is a technologically advanced, acute care hospital, and Certified Primary

Stroke Center located three miles southwest of LaRC. The hospital provides care through advanced surgical programs, emergency cardiac intervention and fellowship-trained physicians.

17.3 WATER BODIES

LaRC is located within close proximity to several surface water bodies within the tidal zone of the Chesapeake Bay. It is located approximately 1.6 km (1 mile) from the Northwest Branch of the Back River which empties into the Chesapeake Bay. The Bay is protected by federal and state regulations. LaRC is located approximately 16 km (10 miles) from the York River, a protected waterway by the State of Virginia.

17.4 REFERENCES

City of Hampton, Virginia Website,
https://hampton.gov/1187/Parks-Recreation

Virginia Department of Game and Inland Fisheries Website,
https://www.dgif.virginia.gov/wma/?pid=4

U.S. Fish and Wildlife Service Website, https://www.fws.gov/refuge/great_dismal_swamp/

City of Hampton, Virginia Website,
https://hampton.gov/142/Sandy-Bottom-Nature-Park

Newport News Department of Parks, Recreation and Tourism Website,
http://www.nnparks.com/parks_nn.php

Virginia Department of Conservation,
http://www.dcr.virginia.gov/state-parks/first-landing#general_information

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https://www.deq.virginia.gov/Programs/Air.aspx

18.0 GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

18.1 REGULATORY OVERVIEW

At the agency level, NASA has established a goal of reducing NASA's Scope 1 and 2 GHG emissions by 47% and Scope 3 (indirect) emissions by 32% compared to a FY 2008 baseline by FY 2025. NASA's ongoing efforts to reduce GHG emissions rely on maintaining databases to collect Center-specific data on energy and related activities; promoting the use of energy-efficient infrastructure and renewable energy; and identifying new strategies to minimize GHG emissions across operations.

Also in response to previous Executive Order 13514, NASA formed the Climate Adaptation Science Investigators (CASI) Workgroup in 2009 to provide tools (data, projections, models and other tools), processes and relevant expertise to help NASA and its field Centers to manage climate risks and enable them to develop local adaptation strategies. CASI has compiled historic climate and climate projections with associated uncertainties for each Center, assessed adaptation approaches and Center-level planning strategies and recommended future research initiatives that fill gaps.

A presidential order was issued in January 2015 to amend Executive Order 11988 (1977) and directing the Federal Emergency Management Agency (FEMA) to develop Floodplain Management Guidelines for Implementing Executive Order 11988. The guidelines established a process for agencies to follow when evaluating projects with impacts to or within floodplain areas, and included clarification of the EO with respect to development within the floodplain. The Executive Order and Guidelines essentially direct agencies to cite new federal development outside of floodplain areas. These requirements have been included in site planning for redevelopment at LaRC, given the amount of LaRC property within or adjacent to floodplain areas.

18.2 NASA LANGLEY OPERATIONS

18.2.1 GHG Emissions

The bulk of LaRC's Scope 1 and Scope 2 GHG emissions are tied to energy use, especially the use of electricity, steam and fuels to operate the Center and heat and cool buildings. Per Agency policy, LaRC does not track all GHG emissions at the Center level. Rather, the Agency compiles energy data from all Centers and performs Agency-wide calculations to determine GHG emission levels for all Scopes.

An evaluation of LaRC's GHG emissions from stationary fuel combustion sources was performed in 2009 to determine if the Center was subject to the Mandatory GHG Reporting Rule (40 CFR Part 98). Annual GHG emissions were calculated, using the EPA protocol, for years 2003 through 2008. The evaluation determined that LaRC's annual emissions are well below the 25,000 metric ton of Carbon Dioxide equivalent (CO2e) per year reporting trigger.

Table 18-1
ANNUAL GREENHOUSE GAS EMISSIONS FROM STATIONARY FUEL COMBUSTION SOURCES AT NASA LARC

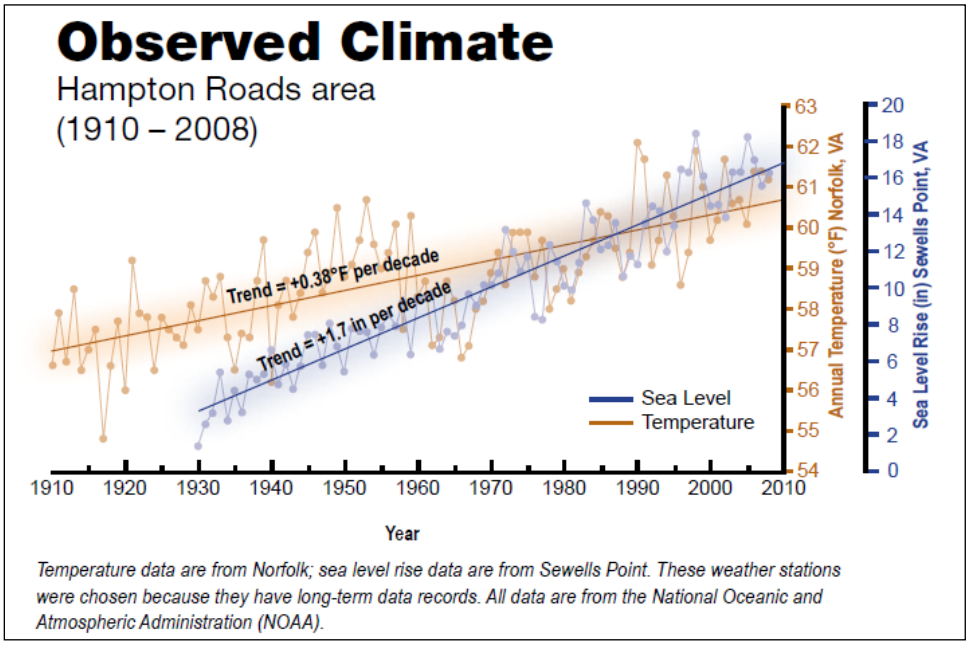
Calendar Year	CO_2 Emissions (Metric Tons)
2006	16,730
2007	11,284
2008	9,332
2009	8,820
2010	9,779
2011	5,489
2012	5,301
2013	4,287
2014	6,920
2015	18,406*
2016	10,135*
2017	6,280
2018	6,733
2019	6,862

*CY 2015 and 2016 (Jan-March) saw exceptionally high natural gas consumption as a steam transmission line outage from the RFSGF forced the Building 1215 Steam Plant to operate redundantly for most of 2015 to meet Center steam demand

18.2.2 Climate Change

Because of its location on the Back River/Chesapeake Bay, sea level rise and storm surge are expected to be the biggest climate threats to LaRC. Climate data collected in the Hampton Roads area over the past century clearly show a long-term pattern of sea level and temperature rise, accompanied by periods of shorter term variability.

Figure 18-1
SEA LEVEL RISE BY 2050 WITH STORM SURGE



Temperature data are from Norfolk; sea level rise data are from Sewells Point. These weather stations were chosen because they have long-term data records. All data are from the National Oceanic and Atmospheric Administration (NOAA).

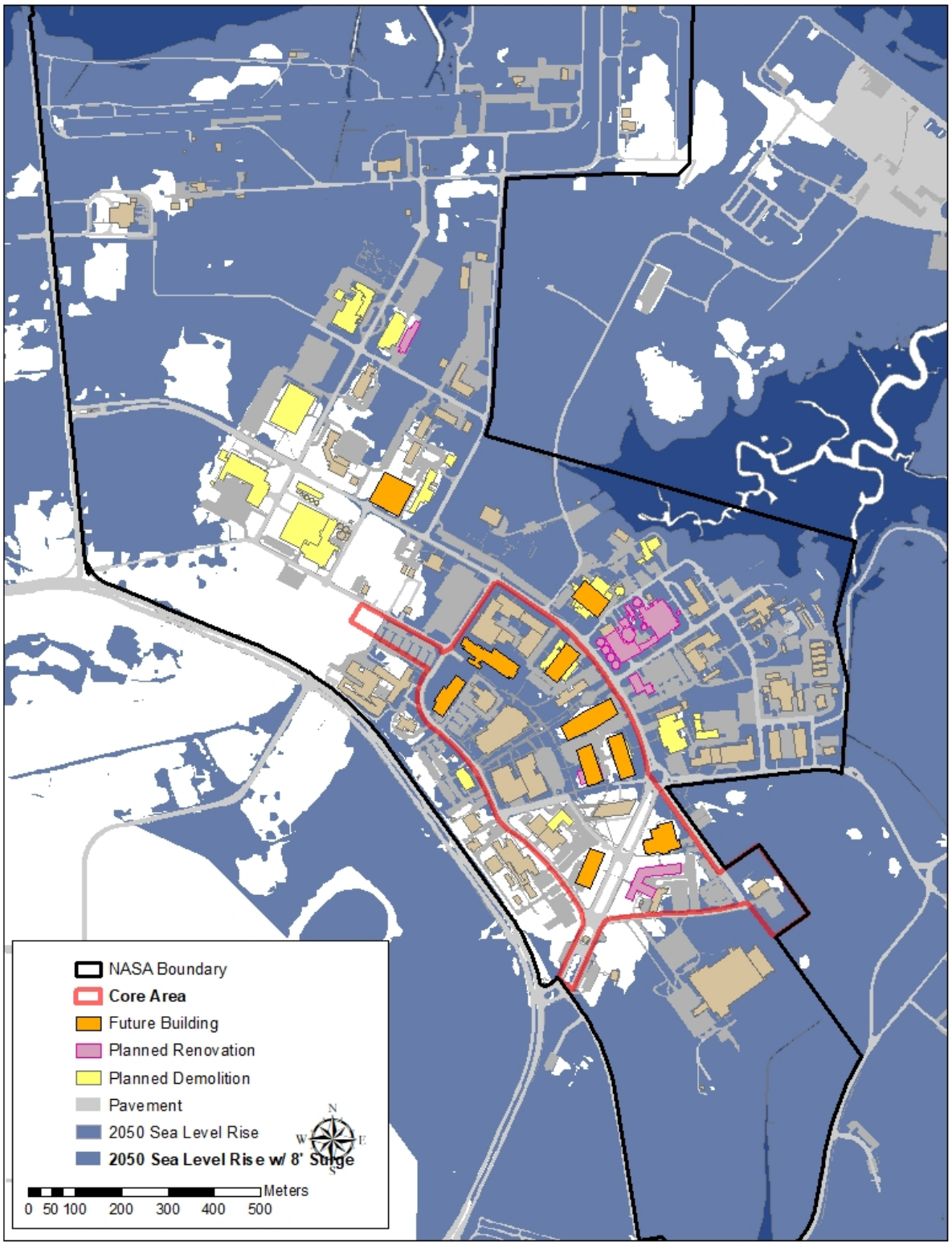
NASA's Goddard Institute for Space Studies used site-specific climate data (temperature and precipitation) from the Langley Air Force Base and Norfolk International Airport stations and Sewells Point (sea level rise) combined with climate model outputs to generate climate change projections specific to the Hampton Roads area. Overall, the projections for Hampton Roads indicate higher mean temperatures and rising mean sea levels, with little change expected in annual precipitation.

Figure 18-2
CLIMATE VARIABLES

Climate Variables				
Variable	**Baseline**	**2020s**	**2050s**	**2080s**
Average Temperature	59.9°F	+1.5 to 2.5°F	+2.5 to 4.5°F	+3.5 to 6.5°F
Annual Precipitation	46.8 in	0 to +10%	0 to +10%	0 to +15%
Sea Level Rise	NA	+2 to 5 in	+7 to 11 in	+12 to 21 in
Sea Level Rise – Rapid Ice Melt Scenario (See Rapid Ice Melt text box for more detail)	NA	~5 to 10 in	~19 to 28 in	~41 to 53 in

Temperature and precipitation projections reflect a 30-year average centered on the specified decade; sea levels are averages for the specified decade. The baseline for temperature and precipitation is the most complete 30-year data period centered around the 1980s; the baseline for sea level is 2000-2004. The baseline temperature and precipitation is an average of baseline data from the Langley Air Force Base and Norfolk International Airport stations. Sea level rise projections are for Sewells Point, Virginia, and include the impacts of subsidence in the area. Temperatures are rounded to the nearest half degree, precipitation projections to the nearest 5%, and sea level rise to the nearest inch. Data are from the NOAA National Climatic Data Center.

Figure 18-3



SEA LEVEL RISE BY 2050 WITH STORM SURGE

In addition to these changes, extreme weather events, such as intense rainfall and coastal flooding are also projected to change in their frequency and/or intensity. Hurricanes may shift to more intense storms causing increased coastal damage.

LaRC currently addresses climate change through its Center Master Plan, including the Revitalization Program; through the NEPA planning process; and through the GIS Flood Impact Analysis Tool. LaRC's 20-Year Revitalization Plan accounts for the impact of sea-level rise over the next few decades with the incorporation of the predicted coastal flooding models. The plan includes a consolidation of infrastructure into the Core Area campus, which is the high ground of the West Area. Climate change effects and adaptations are included in the NEPA planning process and in NEPA documents such as the 2013 *Environmental Assessment for LaRC's Master Plan.* LaRC's GIS Team developed a Flood Impact Analysis Tool that enables LaRC to evaluate climate change risks and vulnerabilities and to manage the effects of climate change on the Center's operations and mission in both the short and long term.

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19.0 AIRSPACE MANAGEMENT

19.1 REGULATORY OVERVIEW

19.1.1 Federal Aviation Administration Requirements

The Federal Aviation Act of 1958 established the Federal Aviation Administration (FAA) and made it responsible for the control and use of navigable airspace within the United States. The FAA created the National Airspace System (NAS) to protect persons and property on the ground, and to establish a safe and efficient airspace environment for civil, commercial, and military aviation. The FAA regulations that govern airspace are contained in 14 CFR Parts 71-77.

14 CFR Part 71 designates six classes of airspace. Class A, B, C, D, or E is controlled airspace, Class F is not used in the U.S., and Class G is uncontrolled. Brief descriptions are provided below:

Class A - Airspace from 5,846 m (18,000 ft) above mean sea level (MSL) to 18,288 m (60,000 ft) MSL.

Class B - Airspace from the surface up to 3,048 m (10,000 ft) MSL.

Class C - Generally, airspace from the surface up to 1,219 m (4,000 ft) above the airport elevation.

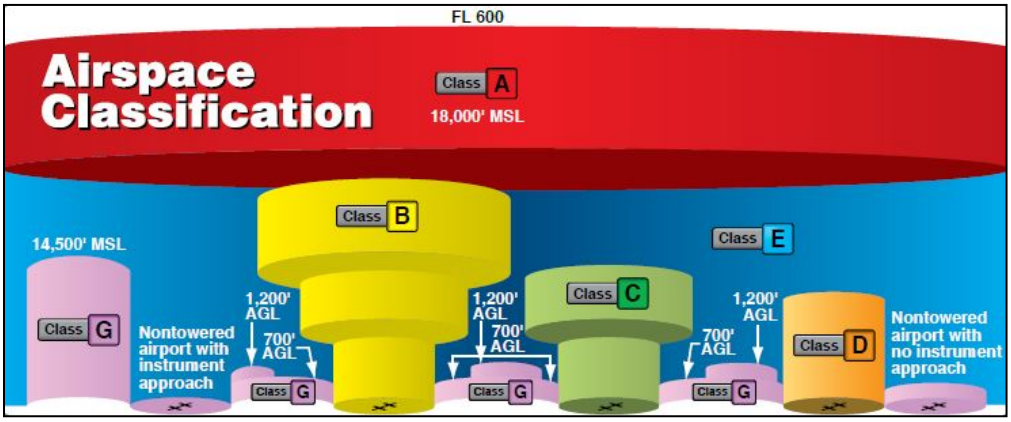
Class D - Generally, airspace from the surface up to 762 m (2,500 ft) above the airport elevation.

Class E - Class E airspace can be described as general controlled airspace. The majority of Class E airspace is where more stringent airspace control has not been established.

Class G - Uncontrolled airspace that is the portion of the airspace that has not been designated as Class A, B, C, D, or E, and extends from the surface to the base of the overlying Class E airspace. Although air traffic control (ATC) has no authority or responsibility to control air traffic in Class G airspace, there are visual flight rules (VFR) minimums that apply.

Figure 19-1 presents a profile view of the dimensions of the airspace classes. More detailed information on airspace classifications can be found here.

Figure 19-1
AIRSPACE PROFILE (FAA 2013)



14 CFR Part 77 designates airspace control surfaces to address objects potentially affecting navigable airspace and establishes a structure of imaginary surfaces which are three-dimensional sloping surfaces intended to protect operations within navigable airspace. The FAA considers these imaginary surfaces when evaluating the height of structures and other objects in the vicinity of airports that may be obstructions to air navigation. The following provides general characteristics of the imaginary surfaces:

Primary - A surface located on the ground or water longitudinally centered on each runway with the same length as the runway. The width of the primary surface for runways is 610 m (2,000 ft). However, at established bases where substantial construction has taken place in accordance with a previous lateral clearance criteria, the 610 m (2,000 ft) width may be reduced to the former criteria.

Approach – Longitudinally centered with the runway and generally extending to the runway end. Consists of a vertical slope of 50:1 for a horizontal distance of 3,048 m (10,000 ft) from the end of the runway, and a slope of 40:1 for an additional 12,192 m (40,000 ft).

Horizontal – Horizontal plane 46 m (150 ft) above the established airport elevation. Constructed of swinging arcs ranging from 1,524 m (5,000 ft) to 3,048 m (10,000 ft) from the runway centerline.

Conical – Extends outward and upward 1,219 m (4,000 ft) beyond the horizontal surface with a vertical slope of 20:1.

Transitional – Constructed to join the approach and horizontal surfaces. Extends outward and upward at right angles to the runway centerline from the approach surface. Consists of a 7:1 vertical slope which extends until reaching the horizontal surface.

14 CFR Part 77 also establishes obstruction standards for objects potentially impacting navigable airspace. An object constitutes an obstruction to navigation if it satisfies one or more of the following:

(a) An existing object, including a mobile object, is, and a future object would be an obstruction to air navigation if it is of greater height than any of the following heights or surfaces:

(1) A height of 152 m (499 ft) above ground level (AGL) at the site of the object;
(2) A height that is 61 m (200 ft) AGL, or above the established airport elevation, whichever is higher, within 5.5 km (3 nautical miles) of the established reference point of an airport, excluding heliports, with its longest runway more than 975 m (3,200 ft) in actual length, and that height increases in the proportion of 30.5 m (100 ft) for each additional nautical mile from the airport up to a maximum of 152 m (499 ft);
(3) A height within a terminal obstacle clearance area, including an initial approach segment, a departure area, and a circling approach area, which would result in the vertical distance between any point on the object and an established minimum instrument flight altitude within that area or segment to be less than the required obstacle clearance;
(4) A height within an en route obstacle clearance area, including turn and termination areas, of a Federal Airway or approved off-airway route, that would increase the minimum obstacle clearance altitude;
(5) The surface of a takeoff and landing area of an airport or any imaginary surface established under §77.19, 77.21, or 77.23. However, no part of the takeoff or landing area itself will be considered an obstruction.

(b) Except for traverse ways on or near an airport with an operative ground traffic control service furnished by an ATC tower or by the airport management and coordinated with the ATC service, the standards of section (a) apply to traverse ways used or to be used for the passage of mobile objects only after the heights of these traverse ways are increased by:

(1) 5 m (17 ft) for an Interstate Highway that is part of the National System of Military and Interstate Highways where overcrossings are designed for a minimum of 5 m (17 ft) vertical distance;
(2) 4.6 m (15 ft) for any other public roadway;
(3) 3 m (10 ft) or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road;
(4) 7 m (23 ft) for a railroad;
(5) For a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it.

14 CFR 77.9 states that notice must be filed with the FAA if requested by the FAA or when anyone proposes any of the following types of construction or alteration:

(a) Any construction or alteration exceeding 61 m (200 ft) above ground level.

(b) Any construction or alteration that exceeds an imaginary surface extending outward and upward at any of the following slopes:

(1) 100 to 1 for a horizontal distance of 610 m (20,000 ft) from the nearest point of the nearest runway of each airport described in 14 CFR 77.9(d) with its longest runway more than 975 m (3,200 ft) in actual length, excluding heliports;
(2) 50 to 1 for a horizontal distance of 3,048 m (10,000 ft) from the nearest point of the nearest runway of each airport described in 14 CFR 77.9(d) with its longest runway no more than 975 m (3,200 ft) in actual length, excluding heliports;
(3) 25 to 1 for a horizontal distance of 1,524 m (5,000 ft) from the nearest point of the nearest landing and takeoff area of each heliport described in 14 CFR 77.9(d);
(4) Any highway, railroad or other traverse way for mobile objects, of a height which, if adjusted upward as defined in 14 CFR 77.9(c) would exceed a standard of 14 CFR 77.9(a) or (b);
(5) Any construction or alteration located on an airport described in 14 CFR 77.9(d).

If one of the above criteria is met, project proponents are required to notify the FAA by filing FAA Form 7460-1 at least 45 days prior to project start. The FAA's Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) website (https://oeaaa.faa.gov) provides information on ways to determine if notification is required, including a Notice Criteria Tool that project proponents can use to determine the need for FAA notification.

The FAA Advisory Circular (AC) 70/7460-1L, *Obstruction Marking and Lighting with Change 1*, dated October 2016, sets forth standards for marking and lighting obstructions that have been deemed to be a hazard to navigable airspace.

More detailed information on imaginary surfaces, and airspace obstruction and notification requirements can be found here.

19.1.2 NASA Langley and U.S. Air Force Requirements

Langley Procedural Requirement (LPR) 1710.16, Aircraft Operations and Safety Manual, sets forth the guidelines and requirements for management and operation of aircraft (manned and unmanned) in the airspace at LaRC.

The Letter of Procedure (LOP) for Unmanned Aircraft Systems (UAS) Operations and Testing within Langley Air Force Base's (LAFB's) Class D Airspace, dated February 17, 2017, establishes guidelines and identifies responsibilities for the safe, orderly and expeditious operation of UAS in LAFB's Class D airspace, as well as provides instructions for operations of UAS if/when LAFB's ATC Tower is closed (e.g. generally weekends, holidays, after hours).

The Memorandum of Agreement (MOA) between NASA and the FAA Regarding Operation of Small Unmanned Aircraft Systems in Class G Airspace and associated NASA policy guidance was developed to ensure NASA small UAS operations conducted under the MOA receive the proper oversight from NASA Center flight operations.

The Airfield Operations Procedures and Programs Air Force Instruction (AFI) 13-204v3 provides guidance on managing and operating airfield operation facilities and training of airfield operations personnel.

The Langley Air Force Base Airfield Operations and Base Flying Procedures 11-250 establishes operational procedures, administrative procedures and standards for base ATC services, airspace management, operation of the airfield and associated equipment, local flying, emergency and special procedures.

19.2 NASA LANGLEY OPERATIONS

19.2.1 Aircraft Operations

All aircraft operations at LaRC are bound by FAA regulations, NASA and LAFB requirements. During business hours when the LAFB ATC is open, LaRC operates under LAFB's controlled Class D airspace which extends from the surface vertically to 760 m (2,500 ft) in an 8 km (5 mi) radius around the center of the airfield. When the tower is closed (e.g., generally after hours, weekends, holidays) the airspace at LaRC reverts to uncontrolled Class G which extends from the surface to the base of the overlying Class E airspace (Jordan, 2017).

Manned aircraft can only be operated in Class D airspace at LARC (when the LAFB ATC is operational) and pilots are required to maintain two-way radio communications with the tower (USAF, 2017b).

UAS can be operated in Class D and Class G airspace at LaRC in accordance with the requirements set forth in the LOP for UAS Operations and Testing at the Center (NASA, 2017). For UAS flights in Class D airspace, the Langley Airfield Management Operations (AMOPS) must be notified to publish a Notice to Airmen (NOTAM) before each flight (NASA, 2016b).

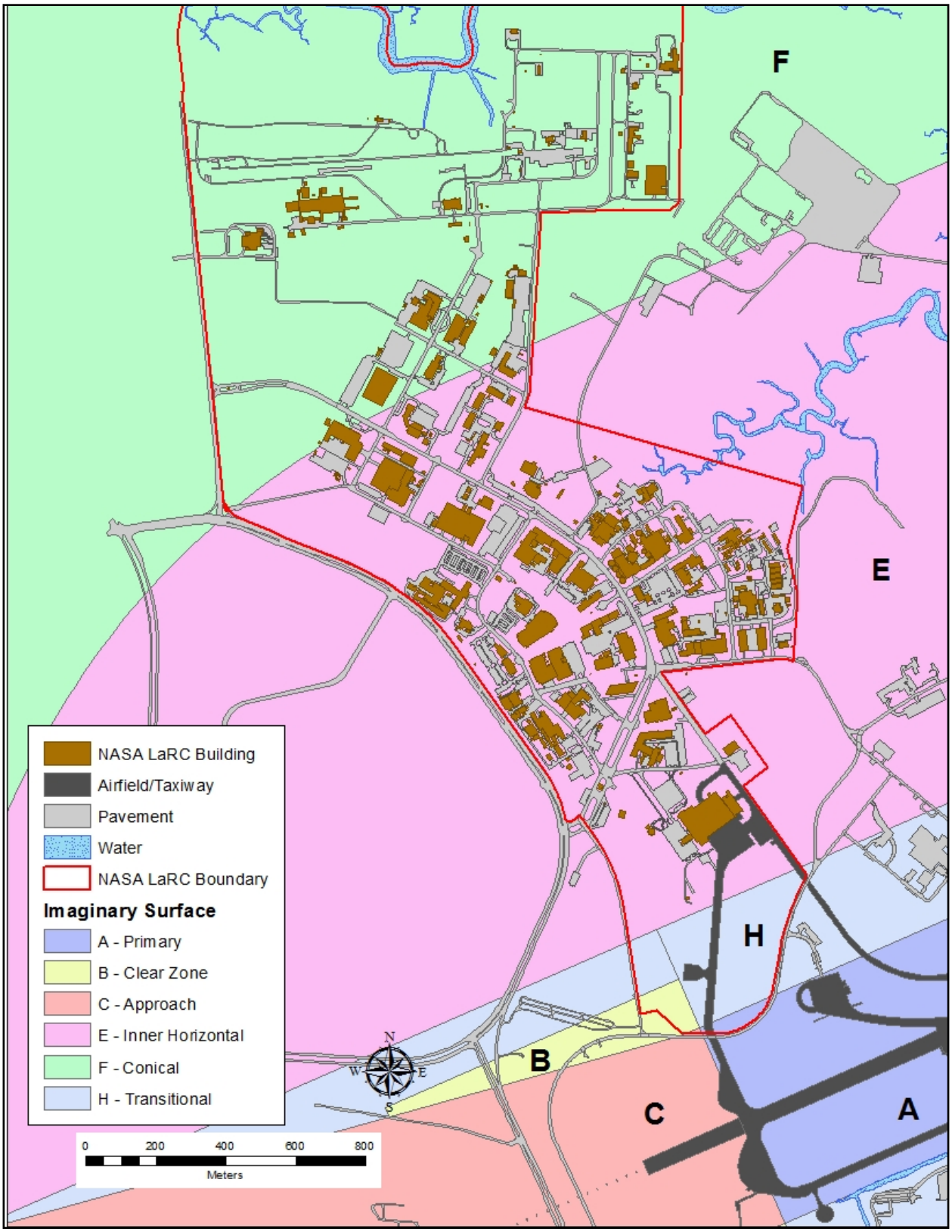
For UAS flights in Class G airspace, LaRC operates under the authority of the NASA/FAA MOA for operation of small UAS in Class G airspace. The Flight Standards District Office (FSDO; Washington, D.C.) must be notified to publish a NOTAM before each flight (NASA, 2016a).

19.2.2 Obstructions and Notifications

Activities and projects at LaRC that have the potential to meet the obstruction standards and/or penetrate an imaginary surface must comply with the FAA notification, obstruction marking, and lighting requirements. Figure 19-2 shows the imaginary surfaces at and around LaRC.

Examples of activities and projects at LaRC requiring notification, marking, and lighting due to height include the temporary use of tower cranes during construction activities, and temporary or permanent installation, construction, and operation of tall equipment and infrastructure, such as meteorology towers, the Gantry, and the Water Tower. In addition to FAA notification, activities and projects that pose potential airspace obstructions must be coordinated with the LAFB Civil Engineering Squadron.

Figure 19-2
IMAGINARY SURFACES AT AND AROUND LARC



19.3 REFERENCES AND RESOURCES

Advisory Circular (AC) 70/7460-1L, 2016. Obstruction Marking and Lighting with Change 1. U.S. Department of Transportation, Federal Aviation Administration, Washington D.C.

FAA Obstruction Evaluation/Airport Airspace Analysis (OE/AAA): https://oeaaa.faa.gov

Jordan, Thomas L. "Re: airspace." Email message to Diehl, Caroline A. on May 9, 2017.

NASA, 2017. Letter of Procedure (LOP) for Unmanned Aircraft Systems (UAS) Operations and Testing within Langley Air Force Base's (LAFB's) Class D Airspace, dated February 17, 2017. NASA Langley Research Center, Hampton, Virginia.

NASA, 2016a. Memorandum of Agreement (MOA) between NASA and the FAA Regarding Operation of Small Unmanned Aircraft Systems in Class G Airspace and associated NASA policy guidance. NASA HQ, Washington D.C.

NASA, 2016b. Langley Procedural Requirement (LPR) 1710.16, Aircraft Operations and Safety Manual. NASA Langley Research Center, Hampton, Virginia. Temporarily extended in 2016.

USAF, 2017a. Airfield Operations Procedures and Programs Air Force Instruction (AFI) 13-204v3. HQ USAF, Washington, D.C.

USAF, 2017b. Langley Air Force Base Instruction (LAFBI), Airfield Operations and Base Flying Procedures 11-250. Langley Air Force Base, Hampton, Virginia.

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APPENDIX 6-1

PARTIAL LIST OF WILDLIFE OCCURING AT LANGLEY RESEARCH CENTER

I. INTRODUCTION

The following lists detail the wildlife found on NASA Langley Research Center. They are based on the 2009 "NASA Langley Research Center Habitat Classification and Wildlife Survey Report" by Science Applications International Corporation (SAIC) and the 1995 "Baseline Biological Survey of Terrestrial and Aquatic Habitats at NASA Langley Research Center, With Special Emphasis on Endangered and Threatened Flora and Fauna" by Old Dominion University (ODU).

Amphibians	
Species	**Common Name**
Ambystoma opacum *	Marbled salamander
Plethedon cinereus +*	Red-backed salamander
Gastrophryne carolinensis *	Eastern narrow-mouth toad
Hyla cinerea +*	Green treefrog
Pseudacris triseriata *	Upland chorus frog
Rana utricularia +*	Southern leopard frog
+ Note: These species were identified/observed at LaRC during the 2009 SAIC Survey * Note: These species were identified/observed at LaRC during the 1995 ODU Survey	

Reptiles	
Species	**Common Name**
Chelydra serpentine +*	Snapping turtle
Kinosternon subrubrum *	Eastern mud turtle
Terrapene Carolina +*	Eastern box turtle
Malaclemys terrapin *	Northern diamondback terrapin
Eumeces fasciatus +	Five-lined skink
Sceloporus undulates *	Northern fence lizard
Lygosoma laterale *	Ground skink
Opheodrys aestivus +*	Rough green snake
Coluber constrictor *	Black racer
Elaphe obsolete *	Black rat snake
Nerodia spp. *	Water snake
+ Note: These species were identified/observed at LaRC during the 2009 SAIC Survey * Note: These species were identified/observed at LaRC during the 1995 ODU Survey	

BIRDS	
Species	**Common Name**
Cygnus columbianus *	Tundra swan
Branta canadensis +*	Canadian goose
Anas rubripes *	Black duck
Aix sponsa *	Wood duck
Oxyura jamaicensis *	Ruddy duck
Anas platyrhynchos *	Mallard
Anas discors *	Blue-winged teal
Podilymbus podiceps *	Pied-billed grebe
Phalacrocorax auritus +*	Double-crested cormorant
Ardea herodias *	Great blue heron
Casmerodius albus +*	Great egret
Leucophoxy thula *	Snowy egret
Bucephala albeola *	Bufflehead
Lophodytes cucullatus *	Hooded merganser
Cathartes aura +*	Turkey vulture
Coragyps atratus *	Black vulture
Accipiter striatus *	Sharp-shinned hawk
Buteo jamaicensis +*	Red-tailed hawk
Rallus longirostris *	Clapper rail
Porzana carolina *	Sora
Charadrius vociferous *	Killdeer
Scolopax minor *	American woodcock
Tringa solitaria *	Solitary sandpiper
Catoptrophorus semipalmatus *	Willet
Totanus melanoleucus *	Greater yellowlegs
Totanus flavipes *	Lesser yellowlegs
Larus Philadelphia +	Bonaparte's gull
Larus marinus *	Great black-backed gull
Larus argentatus *	Herring gull
Larus delawarensis +*	Ring-billed gull
Larus atricilla +*	Laughing gull
Sterna nilotica *«	Gull-billed tern
Sterna hirundo +*	Common tern
Sterna albifrons *	Least tern
Zenaidura macroura +*	Mourning dove
Columba livia *	Rock dove
Bubo virginianus *	Great horned owl
Strix varia *	Barred owl
Chaetura pelagic *	Chimney swift
Archilochus colubris *	Ruby-throated hummingbird
Megaceryle alcyon *	Belted kingfisher
Colaptes auratus *	Northern Flicker
Dryocopus pileatus *	Pileated woodpecker
*Melanerpes carolinus**	Red-bellied woodpecker
Dendrocopus villosus *	Hairy woodpecker
Dendrocopus pubescens *	Downy woodpecker
Sphyrapicus varius *	Yellow-bellied sapsucker
Tyrannus tyrannus *	Eastern kingbird
Myiarchus crinitus *	Great crested flycatcher
Contopus virens *	Eastern wood pewee

BIRDS	
Species	**Common Name**
Iridoprocne bicolor *	Tree swallow
Hirundo rustica *	Barn swallow
Cyanocitta cristata +*	Blue jay
Corvus brachyrhynchos +*	American crow
Corvus ossifragus +*	Fish crow
Parus carolinensis +*	Carolina chickadee
Parus bicolor *	Tufted titmouse
Certhia familiaris *	Brown creeper
Cistothorus palustris *	Marsh wren
Troglodytes troglodytes *	Winter wren
Thryothorus ludovicianus *	Carolina wren
Mimus polyglottus +*	Northern Mockingbird
Dumetella carolinensis *	Gray Catbird
Toxostoma rufum *	Brown thrasher
Turdus migratorius +*	American Robin
Hylocichla mustelina *	Wood thrush
Catharus guttatus *	Hermit thrush
Seiurus noveboracensis *	Northern waterthrush
Catharus fuscescens *	Veery
Sialia sialis +*	Eastern bluebird
Polioptila caerulea *	Blue-gray gnatcatcher
Regulus calendula *	Ruby-crowned kinglet
Bombycilla cedrorum *	Cedar waxwing
Sturnus vulgaris +*	European starling
Vireo griseus *	White-eyed vireo
Passer domesticus *	House sparrow
Vireo flavifrons *	Yellow-throated vireo
Vireo olivaceus *	Red-eyed vireo
Vireo philadelphicus *	Philadelphia vireo
Mniotilta varia *	Black and white warbler
Parula americana *	Northern Parula warbler
Dendroica petechia *	Yellow warbler
Dendroica caerulescens *	Black-throated blue warbler
Dendroica coronate *	Yellow-rumped/Myrtle warbler
Dendroica virens *	Black-throated green warbler
Dendroica striata *	Blackpoll warbler
Dendroica pinus *	Pine warbler
Dendroica discolor *	Prairie warbler
Dendroica palmarum *	Palm warbler
Protonotaria citrea *	Prothonotary warbler
Vermivora pinus *	Blue-winged warbler
Helmitheros vermivorus *	Worm-eating warbler
Vermivora ruficapilla *	Nashville warbler
Wislonia citrine *	Hooded warbler
Seiurus aurocapillus *	Ovenbird
Geothlypis trichas *	Common Yellowthroat
Setophaga ruticilla *	American redstart
Sturnella magna *	Eastern meadowlark
Agelaius phoeniceus *	Red-winged blackbird
Quiscalus quiscula *	Common grackle

BIRDS	
Species	**Common Name**
Molothrus ater +*	Brown-headed cowbird
Cardinalis cardinalis +*	Northern cardinal
Carpodacus purpureus *	Purple finch
Carpodacus mexicanus +*	House finch
Carduelis tristis *	American goldfinch
Sitta canadensis +	Red-breasted nuthatch
Pipilo erythrophthalmus *	Rufous-sided towhee
Ammodramus savannarum *	Grasshopper sparrow
Ammodramus henslowii *«	Henslow's sparrow
Spizella passerine *	Chipping sparrow
Zonotrichia albicollis *	White-throated sparrow
Melospiza melodia *	Song sparrow
Junco hyemalis *	Dark-eyed junco
Haliaeetus leucocephalus *«	Bald eagle
Pandion haliaetus +*	Osprey
Falco sparverius +*	American kestrel
Pelicanus occidentalis *	Brown pelican
Phasianus colchicus *	Ring-necked pheasant
Colinus virginianus *	Common bobwhite
Meleagris gallopavo +	Wild turkey
+ Note: These species were identified/observed at LaRC during the 2009 SAIC Survey * Note: These species were identified/observed at LaRC during the 1995 ODU Survey « Note: These species are either Federal- or State-listed as endangered or threatened, 2009.	

MAMMALS	
Species	**Common Name**
Didelphis virginiana *	Opossum
Blarina brevicanda *	Northern short-tailed shrew
Scalopus aquaticus *	Eastern mole
Procyon lotor +*	Raccoon
Lutra canadensis *	River otter
Sciurus carolinensis +*	Gray squirrel
Glaucomys volans *	Southern flying squirrel
Peromyscus leucopus *	White-footed mouse
Oryzomys palustris *	Marsh rice rat
Microtus pennsylvanicus *	Meadow vole
Ondatra zibethicus *	Muskrat
Mus musculus *	House mouse
Sylvilagus floridanus *	Eastern cottontail
Odocoileus virginianus +*	White-tailed deer
+ Note: These species were identified/observed at LaRC during the 2009 SAIC Survey * Note: These species were identified/observed at LaRC during the 1995 ODU Survey	

APPENDIX 6-2

AQUATIC SPECIES COLLECTED IN THE NASA LANGLEY RESEARCH CENTER AREA (ODU, 1995)

Notes:

Collection sites
- a - Mouth of Brick Kiln Creek
- b - Cedar Point area
- c - Tabbs Creek mouth
- d - Back River channel
- e - Channel between Tabbs Point and Tin Steel Point
- f - Area adjacent to the stave south of Tabbs Point
- g - Shallows between Stoney point and Mears
- h - Back Landing

Months
- A - April sample
- J - June sample
- S - September sample

1. Species caught within the Northwest Branch of the Back River and its contiguous creeks (ODU, 1995).

Species	Common Name	Site							
		a	b	c	d	e	f	g	h
Chasmodes bosquianus	Striped blenny					A			
Trinectes maculatus	Hogchoker	A, J, S	A	A, J, S	A, S	A, J, S	A	A, J	A, J
Cynoscion regalis	Weakfish	J, S		J, S		A, S		A	
Opsanus tau	Oyster toadfish	A		A, J, S	A, S	A		J	
Bairdiella chrysoura	Silver perch	A, J, S	A, S	A, S		A, J			
Urophycis regia	Spotted hake					A			
Leiostomus xanthurus	Spot	A, J, S	A, S	A, J, S	A, S	A, J, S	A, S	A, S	A, S
Micropogonias undulatus	Atlantic croaker	A	A	A	A	A, J	A, S	A	A
Paralichthys dentatus	Summer flounder			A		A, J			
Morone saxatilis	Striped bass	A, J	A	J	S				
Anchoa mitchelli	Bay anchovy	A, J, S	A, J, S	A, J, S	A, S	A, J, S	A, S	A, J, S	A, J, S
Microgobius thalassinus	Green goby					A			
Gobiosoma bosc	Naked goby					A, S			
Caranx hippos	Crevalle jack				S				J
Lagodon rhomboides	Pinfish							J	
Menidia menidia	Atlantic silverside		A, J	A, J	A, J				
Tautoga onitis	Tautog				S		A		
Orthopristis chrysoptera	Pigfish		S	S	S	S		J, S	
Sygnathus fuscus	Northern pipefish							J	
Pomatomas	Bluefish						J, S		

1. Species caught within the Northwest Branch of the Back River and its contiguous creeks (ODU, 1995).

Species	Common Name	Site							
		a	b	c	d	e	f	g	h
saltarix									
Peprilus triacanthus	Butterfish			J					
Prionotus carolinus	Northern sea robin						S		
Chaetodipterus faber	Atlantic spadefish	S	S						
Menticirrhus americanus	Southern kingfish	S	S						
Selene vomer	Lookdown	S	S						
Anguilla rostrata	American eel			J					
Brevoortia tyrannus	Menhaden			J					

***Notes*: <u>Drainages, Marshes, and Ponds associated with Brick Kiln Creek</u>**

1 - Pond: permanent pond in northwest corner of LaRC property
2 - Marsh: brackish tidal marsh surrounding Site 1
3 - Marsh Creek: natural tidal creek draining portions of Site 2
4 - Marsh: south of 12 Wythe Landing Loop (WLL), adjacent to Bldg 1258 (WLL)
5 - Pond: semi-permanent pond east of Garrett-Winder Cemetary
6 - Drainage: drainage ditch system originating in the forest on the west side of LaRC, emptying into Brick Kiln Creek
7 - Drainage: brackish tidal creeks emptying into Brick Kiln Creek behind Bldg 1157
8 - Drainage: small drainage area west of 20 Hunsaker Loop

<u>Tabbs Creek Feeder Drainage</u>

9 - Drainage: large freshwater drainage ditch east of Doolittle Rd, north of softball fields

<u>Drainage Stream</u>

10 - Stream: intermittent stream crossing the tract of pine woods in the southeast corner of LaRC property

2. Species caught within the fresh and brackish drainages and ponds on NASA/LAFB property (ODU, 1995).

Species	Common Name	Site									
		1	2	3	4	5	6	7	8	9	10
Fundulus heteroclitus	Mummichog							A, J, S			
Fundulus majalis	Striped killifish	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S		A, J, S	
Lucanis parva	Rainwater killifish	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S		A, J, S	
Gambusia affinis	Mosquitofish	A, J, S	A, J, S	A, J, S			A, J, S			A, J, S	
Anguilla rostrata	American eel						A				
Menidia beryllina	Inland silverside	A, J, S									
Lepomis macrochirus	Bluegill	A									

3. Benthic invertebrate species collected at NASA LaRC during October 1994 (ODU, 1995).

Phylum	Tabbs Creek	Back River	Brick Kiln Creek
Annelida	Class Polychaeta *Nereis spp.* Class Oligochaeta *Oligochaeta spp.*	Class Polychaeta *Glycinde solitaria* *Haploscolopus fragilis* *Heteromastus filiformis* *Nereis succinea* *Spiochaetopterus oculatus* Class Oligochaeta *Oligochaeta spp.*	Class Polychaeta *Nereis succinea*
Arthropoda	Class Crustacea *Cyathura polita*	Class Crustacea *Corophium spp.* *Lepthocheirus plumulosus* *Leptalpheus forceps*	Class Crustacea *Uca minax*
Nemertina		Class Nemertina *Nemertina spp.*	

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APPENDIX 6-3

PARTIAL LIST OF PLANT SPECIES OCCURRING AT LANGLEY RESEARCH CENTER (SAIC, 2009 AND ODU, 1995)

Trees

Scientific Name	**Common Name**
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Ailanthus altissima	Tree of Heaven
Albizia julibrissin	Silktree
Carya glabra	Sweet pignut hickory
Carya ovata	Shagbark hickory
Carya spp	Hickory
Celtis laevigata	Sugarberry
Cornus florida	Flowering dogwood
Crataegus viridis	Green hawthorn
Diospyros virginiana	Persimmon
Fraxinus pennsylvanica	Green ash
Juglans nigra	Black walnut
Juniperus virginiana	Eastern red cedar
Lagerstroemia spp.	Crapemyrtle
Ligustrum spp.	Privet
Liqiudambar styraciflua	Sweetgum
Liriodendron tulipifera	Tuliptree
Maclura pomifera	Osage orange
Morus rubra	Red mulberry
Nyssa sylvatica	Marsh blackgum
Paulownia tomentosa	Princess tree
Persea borbonia	Redbay
Persea palustris	Swamp bay
Pinus echinata	Short needle pine
Pinus taeda	Loblolly pine
Platanus occidentalis	Sycamore
Populus alba	White poplar
Prunus angustifolia	Chickasaw plum
Prunus serotina	Black cherry
Quercus alba	White oak
Quercus laurifolia	Laurel oak
Quercus michauxii	Swamp chestnut oak
Quercus nigra	Water oak
Quercus pagoda	Cherrybark oak
Quercus palustris	Pin oak
Quercus phellos	Willow oak
Quercus stellata	Post oak
Salix nigra	Black willow
Sassafras albidum	Sassafras
Ulmus americana	American elm
Ulmus rubra	Slippery elm

Shrubs

Scientific Name	**Common Name**
Amelanchier arborea	Common serviceberry
Aralia spinosa	Devil's walkingstick
Asimina triloba	Common paw paw
Baccharis halimifolia	Eastern false-willow
Callicarpa americana	American beautyberry
Carpinus caroliniana	American hornbeam
Cornus amomum	Silky dogwood
Euonymus americana	American Strawberrybush
Hibiscus moscheutos	Crimsoneyed rosemallow
Ilex opaca	American holly
Ilex verticillata	Gray common winterberry
Itea virginica	Virginia sweetspire
Iva frutescens	bigleaf sumpweed
Leucothoe racemosa	Gray swamp doghobble
Ligustrum sinense	Chinese privet
Lindera benzoin	Northern spicebush
Myrica cerfiera	Wax myrtle
Nandina domestica	Sacred bamboo
Persea borbonia	Redbay
Phragmites communis	Common reed
Rhus copallinum	Winged sumac
Rubus occidentalis	Black raspberry
Rubus spp.	Blackberry and Dewberry species
Sambucus canadensis	Elderberry
Viburnum prunifolium	Blackhaw

Woody Vines

Scientific Name	**Common Name**
Berchemia scandens	Alabama supplejack
Campsis radicans	Trumpet creeper
Lonicera japonica	Japanese honeysuckle
Lonicera sempervirens	Trumpet honeysuckle
Parthenocissus quinquefolia	Virginia creeper
Smilax bona-nox	Saw greenbrier
Smilax glauca	Cat greenbrier
Smilax rotundifolia	Roundleaf greenbrier
Toxicodendron radicans	Eastern poison ivy
Vitis labrusca	Fox grape
Vitis palmata	Catbird grape
Vitis rotundifolia	Muscadine

Herbs/Grasses

Scientific Name	**Common Name**
Acalypha virginica	Virginia threeseed mercury
Agrimonia spp.	Agrimony species
Allium canadense	Meadow garlic
Ambrosia artensisifolia	Ragweed
Apios americana	Groundnut
Apocynum cannibinum	Indian hemp
Scientific Name	**Common Name**
Arthraxon hispidus	Small carpgrass

Asclepias syriaca	Common milkweed
Asplenium platyneuron	Ebony spleenwort
Aster spp.	Aster species
Athyrium asplenioides	Asplenium ladyfern
Atriplex patula	Spear saltbush
Bidens cernua	Nodding beggartick
Boehmeria cylindrica	Smallspike false nettle
Botrychium dissectum	Cutleaf grapefern
Carex comosa	Longhair sedge
Carex digitalis	Slender woodland sedge
Carex hyalinolepis	Shoreline sedge
Carex lurida	Shallow sedge
Carex squarrosa	Squarrose sedge
Cicuta maculata	Spotted water hemlock
Commelina virginica	Virginia dayflower
Cryptotaenia canadense	Canadian honewort
Cyperus atrovirens	
Cyperus spp.	Sedge
Datura stramonium	Jjimsonweed
Desmodium glutinosum	Pointedleaf ticktrefoil
Desmodium paniculatum	Panicledleaf ticktrefoil
Distichlis spicata	Coastal saltgrass
Dryopteris spinulosa	Spinulose woodfern
Elephantopus tomentosus	Devil's grandmother
Elymus virginicus	Virginia wildrye
Elytrigia repens	Quack grass
Erechtites hieracifolia	Burnweed
Erianthus strictus	Narrow plumegrass
Eupatorium capillifolium	Dogfennel
Eupatorium coelestinum	Blue mistflower
Eupatorium fistulosum	Trumpetweed
Eupatorium perfoliatum	Common boneset
Eupatorium rotundifolium	Roundleaf thoroughwort
Eupatorium spp.	Joepyeweeds
Fimbristylis spadicea	Hhot springs fimbry
Galium aparine	Catchweed bedstraw
Galium circaezans	Licorice bedstraw
Geum spp.	Avens species
Goodyera pubescens	Downy rattlesnake plantain
Hydrocotyle spp.	Hydrocotyle species
Hypericum hypericoides	St. Andrew's cross
Impatiens capensis	Jewelweed
Iris virginica	Virginia iris
Juncus coriaceus	Leathery rush
Juncus effusus	Common rush
Juncus roemerianus	Needlegrass rush
Juncus spp.	Rush species
Lobelia siphilitica	Great blue lobelia
Lycopus virginicus	Virginia waterhorehound
Matelea carolinensis	Maroon Carolina milkvine
Menispermum canadense	Common moonseed
Microstegium vimineum	Nepalese browntop
Mikania scandens	Climbing hempvine
Scientific Name	**Common Name**

Mitchella repens	Partridgeberry
Narcissus jonquilla	Jonquil
Onoclea sensibilis	Sensitive fern
Ophioglossum vulgatum	Southern adder's tongue
Osmunda cinnomomea	Cinnamon fern
Osmunda regalis	Royal fern
Panicum spp.	Signalgrass species
Panicum virgatum	Switchgrass
Paspalum spp.	Paspalum grass
Peltandra virginica	Green arrow arum
Phytolacca americana	American pokeweed
Podophyllum peltatum	May apple
Polygonatum pubescens	Hairy Solomon's seal
Polygonum cespitosum	Oriental ladysthumb
Polygonum persicaria	Spotted ladysthumb
Polymnia uvedalia	Hairy leafcup
Polystichum acrostichoides	Christmas fern
Prenanthes spp.	Rattlesnakeroot species
Pteridium aquilinum	Bracken fern
Rumex crispus	Curly dock
Rumex verticillatus	Swamp dock
Sagittaria graminea	Grassleaf arrowhead
Sanicula gregaria	Clustered blacksnakeroot
Saururus cernuus	Lizard's tail
Scirpus americanus	American bulrush
Scirpus robustus	Alkali bulrush
Scleria minor	Nutrush
Scutellaria integrifolia	Helmet flower
Senecio aureus	Golden ragwort
Sisyrinchium mucronatum	Needletip blueeyed grass
Smilacina racemosa	Feathery false lily of the valley
Solidago altissima	Canada goldenrod
Solidago puberula	Downy goldenrod
Solidago rugosa	Wrinkledleaf goldenrod
Solidago sempervirens	Seaside goldenrod
Spartina alterniflora	Smooth cordgrass
Spartina cynosuroides	Big cordgrass
Spartina patens	Saltmeadow cordgrass
Specularia perfoliata	Clasping Venus' lookingglass
Sporobolus spp.	Dropseed
Stellaria media	Common chickweed
Thelypteris palustris	Eastern marsh fern
Tipularia discolor	Crippled cranefly
Uniola laxa	Slender woodoats
Verbascum blattaria	Moth mullein
Verbena urticifolia	White vervain
Verbesina occidentalis	Yellow crownbeard
Woodwardia areolata	Netted chainfern
Woodwardia virginica	Virginia chainfern