5. SUMMARY OF MITIGATION MEASURES

Under the Proposed Action (Preferred Alternative), NASA would continue the good environmental practices employed at each of the NASA facilities that would support the Constellation Program. These practices are documented in various Federal, state, and local environmental permits; NASA practices and procedures; and best management practices. Since the proposed Constellation Program is built largely upon the ongoing Space Shuttle Program technologies and support facilities, continuing many of ongoing good environmental practices which support the Space Shuttle Program would mitigate potential environmental impacts associated with Constellation Program activities.

Activities associated with the Proposed Action that are expected to have potential environmental impacts include rocket engine tests, rocket launches and atmospheric entries, wind tunnel tests, and construction of new facilities. These activities, along with modifications of existing facilities, would be expected to utilize site-specific mitigation measures much like those employed for the Space Shuttle Program.

5.1 FACILITIES

5.1.1 John F. Kennedy Space Center

John F. Kennedy Space Center (KSC) employs an extensive system of mitigation measures to reduce the potential impacts of launches on the environment. All Federal launch complexes, including KSC, Cape Canaveral Air Force Station (CCAFS), and the U.S. Army's White Sands Missile Range (WSMR) have Range Safety processes that: 1) ensure that direct impacts are confined to the range and impacts outside of the range are appropriately managed and mitigated, and 2) ensure that the public is protected, both from direct effects such as falling debris after activation of commanded destruct systems and indirect effects such as exposure to high levels of burning propellant emissions in exhaust clouds.

In mitigation planning for modifications to Launch Complex (LC)-39 Pad B, NASA has considered three categories of potential impacts to biota that could arise from the modifications: 1) nighttime bird and bat strike risks due to tall structures and wires; 2) daytime bird strike risks from low-visibility structures and wires; and 3) sea turtle disorientation risks due to artificial lighting illuminating nesting beaches. NASA's *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* has addressed these concerns and provides mitigation and monitoring measures (KSC 2007f). Examples of these mitigation measures include reduction in the height of the lightning protection towers from that proposed originally; use of minimum number of grounding wires for lightning protection that are of non-coated stainless steel to retain the bright and reflective nature, largest diameter wire possible with markers on the wires for high visibility, and smallest possible angle between the wires and the towers; use of minimum number and intensities of lights requires with longest duration of dark between flashes; and use of low pressure sodium lights that are shielded. This Final Programmatic Environmental Impact Statement (PEIS) incorporates those measures by reference. It is expected that future modifications to LC-39 Pad A would be similar to those to be undertaken for LC-39 Pad B. Therefore, the mitigation and monitoring measures adopted for

the modifications to LC-39 Pad A would be expected to be similar to those incorporated for LC-39 Pad B.

5.1.2 John C. Stennis Space Center

At John C. Stennis Space Center (SSC), there is a perpetual restrictive easement on 506 square kilometers (195 square miles) (the "Buffer Zone") extends 9.7 kilometers (6 miles) in all directions from the perimeter of the Fee Area to ensure that the noise levels to which the public is exposed from engine tests are reduced (see Figure 3-4). Provisions of the restrictive easement prohibit maintenance or construction of dwellings and other buildings suitable for human habitation. The purpose of the Buffer Zone is to provide an acoustical and safety protection zone for NASA testing operations. Predominant land use in the Buffer Zone includes sand and gravel mining, timber production, and recreational activities. Urban areas interspersed with open space, such as coastal wetlands, adjoin the perimeter of the Buffer Zone.

NASA has addressed the environmental impacts of engine testing at both SSC and at George C. Marshall Space Flight Center (MSFC) in its *Final Environmental Impact Statement of Engine Technology Support for NASA Advanced Space Transportation Program* (MSFC 1997a). NASA committed in the Record of Decision (ROD) (MSFC 1998) for that EIS to take certain positive actions to mitigate the potential offsite noise impacts of testing large engines. The ROD indicated that:

> *NASA would make available, to the public through press releases, test firing schedules for medium, large, and multiple engine tests whose collective thrust level does not exceed that of one large engine. Off site noise levels would be projected using real time meteorological data. If acoustical focusing resulting in overall noise levels of 120 dB or greater is expected offsite, evaluation of potential impact will be made and the results presented to test managers. Engine tests will be delayed if substantial risk of structural damage to private property is determined to exist. However, NASA test management reserves the right to proceed with testing if atmospheric focusing conditions are expected to reasonably diminish as the day advances and meteorological conditions favorably improve. SSC would implement similar noise mitigation for single large engine tests or multiple engines whose thrust level exceed that of one large engine.*
>
> *To verify noise modeling software results, off-site noise monitoring would be conducted at MSFC for approximately six engine tests whose thrust level meets or exceeds that of one medium engine. Similar monitoring would be conducted at SSC for all engine tests whose thrust level equals or exceeds that of one large engine.*

These mitigation measures would be continued for Constellation Program activities at SSC and are incorporated in this Final PEIS by reference.

SSC manages wetlands within the facility in accordance with 14 CFR 1216.205, *Policies for evaluating NASA actions impacting floodplains and wetlands*. In planning mitigation activities addressed in the *Final Environmental Assessment for the Construction and Operation of the*

Constellation Program A-3 Test Stand (SSC 2007b), SSC has delineated 47.9 hectares (118.54 acres) wetlands credits (based on the U.S. Army Corps of Engineer's Charleston Method) which would be charged against its "Mitigation Bank." This information, along with an application form for authorization to disturb wetlands, associated maps, and other data were submitted to the U.S. Army Corps of Engineers on March 27, 2007.

5.1.3 George C. Marshall Space Flight Center

At MSFC, the physical separation between engine test facilities and public property by the U.S. Army's Redstone Arsenal mitigates or reduces the sound levels under normal atmospheric conditions (see Figure 3-10). As summarized in Section 5.1.2, NASA committed to monitor meteorological conditions prior to testing to determine if sounds waves would result in substantive risk of offsite structural damage (MSFC 1998). These safety procedures would continue to be utilized for Constellation Program testing activities. As with current practice, MSFC would make available test firing schedules for large engine testing via the Public Affairs Office press releases. This Final PEIS incorporates the applicable mitigation measures at MSFC by reference.

5.1.4 White Sands Missile Range

Detailed mitigation measures associated with the operation of WSMR are provided in the *White Sands Missile Range Range-Wide Environmental Impact Statement* (WSMR 1998). These measures include actions that would reduce the potential impacts from test launches in support of the Constellation Program. For example, noise impacts are mitigated by excluding the public from areas where they could be exposed to potentially harmful noise levels and by requiring WSMR personnel to use hearing protection devices when needed. In addition, WSMR has a Range Safety program similar to the KSC/CCAFS Range Safety program describe in Section 5.1.1 and elsewhere.

Mitigation measures associated with Constellation Program launch abort testing and construction activities at WSMR are described in the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b). All mitigation actions would be contained within WSMR. Three potential impacts from launch complex modifications are addressed: 1) nighttime migratory bird strike risk due to tall structures; 2) daytime bird strike risk due to low-visibility structures; and 3) the possibility of uncovering historical or archaeological sites during excavations. To address possible bird strikes, the proposed tower would contain the minimum number of lights at the lowest intensity required. Surveys would be conducted during mating season to ensure that no birds are found nesting in the towers; any nest material would be removed prior to egg deposition. There would also be open grates in the floors of the tower to discourage roosting. On-site personnel would be instructed to report dead birds and/or bats as soon as they are discovered. If a cultural site is discovered during excavations, the WSMR Historic Preservation Officer would be notified for action. WSMR also would employ dust control techniques during construction activities, vehicle controls on off-road traffic, soil remediation for hazardous and non-hazardous waste spills, and flight termination systems on launch vehicles to mitigate the impacts of anomalous launch events (WSTF 2007b). This Final PEIS incorporates these measures by reference.

5.1.5 Alliant Techsystems-Launch Systems at Promontory

The State of Utah Department of Environmental Quality air permit issues for the test stands at the Alliant Techsystems-Launch Systems Group (ATK) at Promontory, Utah facility imposes meteorological conditions under which test firings are permitted. These conditions ensure that the exhaust cloud from each test is highly diluted, thus reducing the potential for adverse concentrations, far from the test site. Daily limits on the quantities of hydrogen chloride (HCl) from open burning also are imposed by the State of Utah air permit (UDAQ 2006b).

5.2 REDUCTION IN USE OF OZONE DEPLETING SUBSTANCES

Since 1990, NASA has reduced overall annual ozone depleting substances (ODS) usage from approximately 1.6 million kilograms (kg) (3.5 million pounds [lb]) to less than 69,000 kg (150,000 lb), a reduction of more than 96 percent. NASA is committed to finding safe and technically acceptable substitutes for remaining ODS uses.

Under the Proposed Action, it is assumed that hydrochlorofluorocarbon (HCFC 141b) would not be used to produce foam insulation for the cryogenic LH/LOX tanks (cryoinsulation) for the Ares I and Ares V launch vehicles. To comply with EPA requirements to phase out ODS, and to reduce the long-term risk that ODS become unavailable for manufacturers, NASA intends to develop cryoinsulation replacements for use on the Ares I Upper Stage that do not contain HCFC 141b. Building on and drawing from work done in support of the Space Shuttle Program, NASA has begun planning a research and development program to identify and qualify substitute cryoinsulation materials that meet Ares I technical requirements and fulfill the non-ODS objective. This test program will require relatively small amounts of HCFC 141b-blown foam for use in comparative studies. These studies are required to ensure that replacement cryoinsulation materials have similar properties and perform at least as well as the current materials in the challenging environments of launch, ascent, and atmospheric entry. The performance profile of the current Space Shuttle Program foam has been designated as the "performance baseline" for materials developed under these renewed research efforts. Successful implementation and operational performance of these materials would enable the Ares I and other space vehicle programs to use non-ozone depleting cryoinsulation.

5.3 MEASURES TO REDUCE RISK TO PUBLIC FROM LAUNCH AND ENTRY ACCIDENTS

A NASA Range Safety process has been in effect for over 50 years and parallels similar processes by the U.S. Air Force for CCAFS and the U.S. Army for WSMR. NASA's Range Safety Policy (NASA 2005c) is designed to protect the public, employees, and high-value property during all phases of flight, including jettisoned Ares I and Ares V components and the Earth atmospheric entry of the Orion spacecraft, and is focused on the understanding and mitigation (as appropriate) of risk. The policy establishes individual and collective risk criteria for the general public (offsite public and onsite visitors) and onsite workforce for the risk of casualty from any means, including blast, debris, or toxics. Range Safety protects people, as well as the range, by understanding the potential impacts of a normal launch and debris as well as launch area and atmospheric entry accidents and establishing protection controls, including not launching when meteorological conditions do not warrant.

Range Safety addresses the measures taken by NASA to protect personnel and property during those portions of a mission (launch, atmospheric entry, and landing) that have the potential to place the general population at risk. The "range" is the land, sea, or airspace within or over which orbital, suborbital, or atmospheric vehicles are tested or flown. Range Safety addresses these areas and the potentially affected areas around the range. NASA's Range Safety policy is specifically defined in NASA Procedural Requirements (NPR) 8715.5 "Range Safety Program."

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

1. Preclude hazards, such as uncontrolled vehicles, debris, explosives, or toxics, from reaching the public, workforce, or property in the event of a vehicle failure or other mishap.

2. Apply a risk management process when the hazards associated with range operations cannot be fully contained.

In addition, launches and entries associated with the Constellation Program would be preceded by Notices to Airmen (NOTAM) and Notices to Mariners. These notices would provide information on temporary restrictions along the Ares I and Ares V launch and Orion entry corridors to prevent collisions with surface ships and aircraft.

5.4 CULTURAL RESOURCES MITIGATION

If the Proposed Action were implemented, a number of historic resources at various NASA facilities could be adversely affected. For example, the Rotating Service Structure and the Fixed Service Structures at both LC-39 Pads A and B at KSC would be expected to be dismantled as they would not be needed for the proposed new launch vehicles; at John H. Glenn Research Center's Plum Brook Station, modifications to the Spacecraft Propulsion Research Facility (B-2 Facility) (Building 3211) vacuum chamber would be undertaken in support of Ares Upper Stage structural testing; at Langley Research Center, modifications to the Impact Dynamics Facility (Gantry) (Building 1297) would be undertaken in support of Orion drop tests; and at MSFC, modifications to the Structural Dynamics Test Facility (Building 4550) would be undertaken in support of Ares launch stack dynamic testing.

Modifications to historic properties as identified in this Final PEIS (Table 2-10) could affect the character or historic integrity of such properties. NASA has a programmatic agreement with the Department of the Interior, National Park Service to mitigate adverse effects to National Historic Landmarks (NASA 1989). Modifications required for the Constellation Program at NASA facilities would be undertaken in consultation with the respective State Historic Preservation Officer (SHPO). The NASA Historic Preservation Officer at each NASA facility would, in consultation with the SHPO, determine if proposed modifications would be considered "adverse" under the National Historic Preservation Act and other applicable rules and regulations. For such situations, NASA and the SHPO would develop a mitigation strategy to ensure that important historic information is preserved. Such mitigation often includes documenting appropriate aspects of the historic resources before and after modification occur with

photographs or drawings, using specific protocols such as the Historic American Buildings Survey/Historic American Engineering Record and other documentation, as determined appropriate by NASA's Historic Preservation Officer and the SHPO.

6. LIST OF PREPARERS

The National Aeronautics and Space Administration's (NASA's) Constellation Program Office prepared this *Final Constellation Programmatic Environmental Impact Statement* (Final PEIS). NASA's Exploration Systems Directorate has approved the content of this Final PEIS. Individuals listed below contributed to the completion of this Final PEIS by writing basic components of the document, contributing significant background documents, or acting as a technical editor.

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		Exec Sum	1	2	3	4	5	6	7	8	9	10	App A	App B
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	John Connolly			√										
	Lara Kearny			√										
	Michael See	√		√		√								
	Richard Mrozinski	√		√		√								√
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	Mario Busacca	√		√	√	√	√		√					√
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	Bruce Vu					√								
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MAF	Francis Celino				√	√								
MSFC	Lewis Wooten	√		√										
	Donna Holland	√		√	√	√	√		√					
GRC	Trudy Kortes			√	√									
	Christie Myers				√	√			√					
	Robert Lallier, Jr.				√	√								
LaRC	Roger Ferguson				√	√			√					√
ARC	Ann Clarke				√	√			√					
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GSFC	Lizabeth Montgomery				√	√			√					
WSTF	Tim Davis				√	√			√					√

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		Exec Sum	1	2	3	4	5	6	7	8	9	10	App A	App B
HQ	David Stewart	√	√	√	√	√	√	√	√	√	√	√	√	√
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	Richard Wickman	√	√	√	√	√	√	√	√	√	√	√	√	√
	Frank Bellinger	√	√	√		√	√							
	Tina Norwood	√			√	√								
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	Kenneth Kumor		√	√		√	√		√					
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	Glen Curtis				√	√								
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	David Hughes			√										
UTC	David Williamson	√		√		√								
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	Suzanne Crede		√	√										√
	Daniel Gallagher	√	√	√										
	Daniel Czelusniak	√	√	√	√	√	√	√	√	√	√	√	√	√
	Douglas Outlaw	√		√		√	√							√
	Dennis Ford	√	√	√	√	√								
	Kenneth Walsh					√								
	Lorraine Gross					√								
	Jennifer O'Donnell					√								
	James Johnson				√	√	√	√	√	√	√		√	√
	Jorge McPherson					√							√	
	Charlotte Hadley		√		√									
	Richard Kalynchuk				√	√								

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7. AGENCIES, ORGANIZATIONS, AND INDIVIDUALS CONSULTED

In preparing this *Final Constellation Programmatic Environmental Statement* (Final PEIS), the National Aeronautics and Space Administration (NASA) has actively solicited and/or received comments from the following list of potentially interested Federal, state, and local agencies; organizations; and individuals:

FEDERAL AGENCIES

Executive Office of the President

Council on Environmental Quality
Office of Management and Budget
Office of Science and Technology Policy

National Science Foundation

U.S. Department of Agriculture

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

U.S. Department of Defense

Department of the Air Force
AFFTC Technical Library
Edwards Air Force Base Library
Department of the Army
Fort Irwin (National Training Center-Headquarters) Director of Public Works
Department of the Navy

U.S. Department of Homeland Security

Office of the Undersecretary of Management
U.S. Coast Guard

U.S. Department of the Interior

Bureau of Land Management
U.S. Fish and Wildlife Service
National Park Service

U.S. Department of State

U.S. Department of Transportation

Federal Aviation Administration

U.S. Environmental Protection Agency

Office of Federal Activities
Region 3 Office
Region 4 Office
Region 5 Office
Region 6 Office
Region 8 Office
Region 9 Office

STATE AGENCIES

State of Alabama

Alabama Department of Economic and Community Affairs
Alabama Department of Environmental Management
Alabama Historical Commission
State of Alabama, House of Representatives
State of Alabama, Office of Governor
State of Alabama, Senate

State of California

California Department of Fish and Game
California Department of Transportation
California State Clearinghouse
Native American Heritage Commission
State of California, Office of Governor

State of Florida

Florida Department of Environmental Protection
Florida State Clearinghouse
State of Florida, House of Representatives
State of Florida, Office of Governor
State of Florida, Senate

State of Louisiana

Louisiana Department of Environmental Quality
State of Louisiana, Office of Governor

State of Maryland

Maryland State Clearinghouse for Intergovernmental Assistance
Maryland Department of the Environment
Maryland Department of Planning
State of Maryland, Office of Governor

State of Mississippi

Mississippi Department of Environmental Quality
State of Mississippi, Office of Governor

State of New Mexico

New Mexico Department of Cultural Affairs
New Mexico Environment Department
New Mexico Game and Fish
New Mexico State Land Office
State of New Mexico, Office of Governor

State of Ohio

Ohio Environmental Protection Agency
State of Ohio, Office of Governor

State of Texas

Governor's Office of Budget, Planning, and Policy
State of Texas, Office of Governor

State of Utah

Public Lands and Coordination Office
State of Utah, Office of Governor

State of Virginia

State of Virginia, Office of Governor
Virginia Department of Environmental Quality
Virginia Department of Historic Resources

COUNTY AGENCIES

State of Alabama

Madison County
County Commissioner

State of California

Inyo County
Inyo County Free Library, Central Library
Inyo County Free Library, Lone Pine Branch
Inyo County Planning Department
Kern County
County Administrative Officer
Department of Planning and Development Services
Kern County Air Pollution Control District
Kern County Library, Beale Memorial Library
Kern County Library, Boron Branch
Kern County Library, California City Branch
Kern County Library, Mojave Branch
Kern County Library, Tehachapi Branch
Kern County Library, Wanda Kirk Branch
Los Angeles County
Chief Executive Officer
Los Angeles County Library, Lancaster Branch
Los Angeles County Library, Quartz Hill Branch
Los Angeles County Planning Department
San Bernardino County
Land Use Services Department, Planning Division
Santa Clara County
County Executive

State of Florida

Brevard County
County Manager
Development and Environmental Services
Emergency Operations Center
Natural Resources Management Office
Planning and Zoning Office
Public Safety Department
Lake County
County Manager

Orange County
County Administrator
Osceola County
County Manager
Seminole County
County Manager
Volusia County
County Manager

State of Louisiana

St. Tammany Parish
Parish President

State of Maryland

Prince George's County
Office of the County Executive

State of Mississippi

Hancock County
Board of Supervisors
Port and Harbor Commission
Pearl River County
Board of Supervisors

State of New Mexico

Doña Ana County
County Manager

State of Ohio

Cuyahoga County
County Administrator
Erie County
County Administrator

State of Texas

Harris County
Office of the Commissioner

State of Utah

Box Elder County
County Commissioner

State of Virginia

Accomack County
County Administrator
York County
County Administrator

LOCAL AGENCIES

State of Alabama

City of Huntsville
Office of the Mayor

City of Madison
Office of the Mayor
City of Triana
Office of the Mayor

State of California

California City
Office of the Mayor
City of Lake Isabella
Kern River Valley Library
City of Lancaster
Antelope Valley Air Pollution Control District
Office of the Mayor
Planning Commission
City of Los Angeles
Office of the Mayor
City of Mountain View
Office of the Mayor
City Manager's Office
City of Palmdale
Office of the Mayor
Palmdale City Library
Planning Department
City of Pasadena
Office of the Mayor
City of Sunnyvale
Office of the Mayor
City of Trona
Trona Library
City of Victorville
Lahonton Regional Water Quality Control Board
Mojave Desert Air Quality Management District

State of Florida

City of Cape Canaveral
Canaveral Port Authority, Chief Executive Officer
Office of the Mayor
City of Cocoa
Office of the Mayor
City of Cocoa Beach
Office of the Mayor
City of Melbourne
Office of the Mayor
City of New Smyrna Beach
Office of the Mayor
City of Orlando
Office of the Mayor
City of Rockledge
Office of the Mayor

City of Titusville
Office of the Mayor
Planning Department
City of West Melbourne
Office of the Mayor
Merritt Island
Commissioner's Office

State of Louisiana

City of New Orleans
Office of the Mayor
City of Slidell
Office of the Mayor

State of Maryland

City of Greenbelt
Office of the Mayor

State of Mississippi

City of Bay St. Louis
Office of the Mayor
City of Waveland
Office of the Mayor
City of Picayune
Office of the Mayor

State of New Mexico

City of Las Cruces
Bureau of Land Management, Las Cruces District Office
Office of the Mayor
White Sands Missile Range
Office of the Garrison Commander

State of Ohio

City of Brook Park
Brook Park Fire Department
City of Cleveland
Cleveland Hopkins International Airport
Department of Public Health, Division of Air Pollution Control
Office of the Mayor
City of Sandusky
City Manager

State of Texas

City of Houston
Office of the Mayor

State of Utah

City of Brigham
Office of the Mayor

State of Virginia

City of Hampton
City Manager
Office of the Mayor
City of Poquoson
City Manager
Hampton Roads Planning District Commission
Town of Chincoteague
Office of the Mayor

ORGANIZATIONS

Aerospace Industries Association
American Institute of Aeronautics and Astronautics
Diamondhead Property Owners Association
Economic Development Commission of Florida's Space Coast
Environmental Defense
Federation of American Scientists
Florida Coalition for Peace and Justice
Friends of the Earth
Global Network Against Weapons and Nuclear Power in Space
GlobalSecurity.org
Greenpeace International
National Audubon Society
National Congress of American Indians
National Fish and Wildlife Foundation
National Hispanic Environmental Council
National Society of Black Engineers
National Tribal Environmental Council
National Wildlife Federation
Natural Resources Defense Council
Partnership for a Sustainable Future, Inc.
Physicians for Social Responsibility
Sierra Club National Headquarters
Southwest Network for Environmental and Economic Justice
Space Florida
Space Frontier Foundation
The American Association for the Advancement of Science
The Mars Society
The National Space Society
The Nature Conservancy
The Planetary Society
The Space Foundation
The Wilderness Society
Union of Concerned Scientists

INDIVIDUALS

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Daum, Gerhard
DeCarlo, Michelle
DeJaeger, Erik
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Halvorson, Todd
Hellman, Robert
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Hockstra, Daniel
Karlen, Rosetta M.
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Lear, Robert
Lee, Alex
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Long, David G.
May, Jonathan
McColloch, Craig
McKenney, Brent
Murphy, Carl
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Sakala, Gregory
Saunders, Michael
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Showalter, Keith
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Skinner, Scott
Smith, Rebecca
Stribley, Todd
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Vergee
Winn, Oliver
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Yanagitani, Brian

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9. GLOSSARY OF TERMS

Abort – Action taken to terminate an anomalous launch. There are three different abort scenarios: pad abort, mid-ascent abort, and late-ascent abort. With respect to crewed missions, each scenario uses a different method to propel the **Crew Module** free from the launch vehicle and safely return the crew to the Earth.

Advanced Projects Office – NASA **Constellation Program** organization responsible for defining the requirements of future systems that would be needed for extended lunar missions and missions to Mars.

adverse effect – When used specifically with respect to the effects of an action upon historic properties listed or eligible for listing on the **National Register of Historic Places**. As defined by 36 CFR 800.5 "*Protection of Historic Properties*," an "adverse effect" is evident when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the **National Register** in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the **National Register**. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.

affected environment – A description of the existing environment that could be affected by the proposed action or alternatives.

air emissions – Gases or particles that are deposited in the atmosphere by various sources (*e.g.*, point sources, mobile sources, and biogenic sources).

ambient air – The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures.

ambient noise – Noise level measured under normal, everyday conditions.

anomalous launch – A rocket launch that deviates from predetermined conditions.

aquifer(s) – A geologic formation which contains and/or conducts groundwater.

Ares I – The name of the Crew Launch Vehicle (**CLV**), which would have a five-segment reusable solid rocket motor First Stage with a liquid oxygen/liquid hydrogen Upper Stage powered by a J-2X engine.

Ares V – The name of the Cargo Launch Vehicle (**CaLV**), which in its current planning configuration would have two five-segment reusable solid rocket boosters, a liquid oxygen/liquid hydrogen **Core Stage** powered by five RS-68 engines, and a liquid oxygen/liquid hydrogen Upper Stage (also called the **Earth Departure Stage**) powered by a J-2X engine.

artesian pressure – Pressure exerted on an underground aquifer that forces ground water to flow freely to the surface.

Atlas – A family of launch vehicles formerly manufactured by the Lockheed Martin Corporation. Currently, United Launch Alliance, a cooperative venture between Lockheed Martin Corporation and The Boeing Company, has assumed responsibility for providing Atlas rocket services to U.S. government customers.

atmospheric pollution – Pollution which is produced by either natural or man-made sources and disperses into the **ambient air**.

attainment – An area is designated as being in attainment by the U.S. Environmental Protection Agency if it meets the **National Ambient Air Quality Standards (NAAQS)** for a given **criteria pollutant**. Nonattainment areas are areas in which any one of the **NAAQS** have been exceeded. Areas previously designated nonattainment and subsequently redesignated as attainment are defined as maintenance areas. Areas that cannot be classified on the basis of available information as meeting or not meeting the **NAAQS** for any one criteria pollutant are defined as unclassifiable areas.

audiometric testing – Procedure that measures hearing ability. Could be used to mitigate noise effects on workers due to launches or engine ground tests.

biconic – a shape which resembles two cones attached together at the base; the cone sizes are not necessarily exact replicas.

buffer zone – A neutral zone which serves to separate one area from another, for any of multiple reasons (*e.g.*, environmental effects, greenways, hazardous areas, *etc.*).

CaLV – See **Ares V**.

carbon-fiber composite – Engineered material made from one or more constituent substances (one of which must be carbon) that exhibit different physical properties when combined, yet retain their individual chemical properties.

casualty – An injury requiring overnight hospitalization or worse, including death.

Categorical Exclusion (Cat-Ex) – Documents proposed actions or activities that a Federal agency has designated under 14 CFR 1216.305(d) as normally having no significant impact(s) on the human environment, individually or cumulatively.

CEV – Crew Exploration Vehicle. Renamed **Orion** following selection of the prime contractor. See **Orion.**

Clean Air Act – The national air pollution prevention standards for the United States. This Federal Regulation was originally passed in 1963 and has since been modified and amended several times (most recently with the 1990 Clean Air Act Amendments). Many states and localities have adopted their own air quality regulations which are more stringent than the **Clean Air Act**.

Clean Water Act – Similar in scope to the **Clean Air Act**, the **Clean Water Act** is the Federal legislation governing water quality in the United States. Its aim is to reduce toxic

releases into water systems as well as to maintain water quality suitable for human sports and recreation.

CLV – See **Ares I**.

Constellation Program – The NASA program which would provide the vehicles and the infrastructure to support the **International Space Station** and return humans to explore the Moon and eventually Mars and beyond.

Core Stage – As used in the **Ares V**, the launch vehicle stage that carries the majority of a vehicle's propulsive capability and LOX/LH propellants to which supplemental propulsive stages can be attached for added thrust.

crawler transporter – A tracked vehicle formerly used to move **Saturn V** and currently used to move Space Shuttle vehicles from the Vehicle Assembly Building to the launch pad at KSC. Currently, the **Mobile Launch Platform** is placed on top of the **crawler transporter** and the Space Shuttle is attached to the **Mobile Launch Platform**. The **crawler transporter** then moves both items to the launch pad.

Crew Module – Part of the **Orion** spacecraft; a capsule that would provide habitable volume for crew members or cargo room during uncrewed missions. It contains life support, intra-vehicular docking ability, and atmospheric entry and landing ability. There would be several **Orion Crew Module** configurations, which provide for varying crews/cargos configurations.

criteria pollutants – The **Clean Air Act** requires the U.S. Environmental Protection Agency to set air quality standards for common and widespread pollutants after preparing criteria documents summarizing scientific knowledge on their health effects. Currently, there are standards in effect for six criteria pollutants: sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter (PM_{10}) and particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb).

critical habitat – Areas of habitat, defined under the Endangered Species Act, which are believed to be essential for a threatened or endangered species' conservation.

cryogens – In terms of this document, cryogens refers to liquid oxygen/liquid hydrogen (LOX/LH) which are used as propellants.

cultural resources – The prehistoric and historic districts, sites, buildings, objects, or any other physical activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

cumulative impact – The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes other such actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

decibel (dB) – A logarithmic measurement unit that describes a particular sound pressure level compared to a standard reference value. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB. A-weighted decibels (dBA) refer to measured decibels whose frequencies have been adjusted to correspond to the highest sensitivity of human hearing, which is typically in the frequency range of 1,000 to 4,000 Hertz.

Delta – A family of launch vehicles formerly manufactured by The Boeing Corporation. Currently, United Launch Alliance, a cooperative venture between Lockheed Martin Corporation and The Boeing Company, has assumed responsibility for providing Delta rocket services to U.S. government customers.

deluge water – Water used during the launch of spacecraft to suppress vibrations, fire, and sound from igniting rocket engines and boosters.

deflagrate – To burn suddenly and/or violently.

Design Reference Mission – Fixed combinations of elements (launch vehicles, capsule sizes, rendezvous locations, number of launches, *etc.*) to deliver crew and/or cargo to a specific destination for a specific duration, used to define the requirements of each mission architecture element during the **ESAS** study.

Earth Departure Stage – The Upper Stage of the **Ares V** launch vehicle for lunar missions. It would be used to achieve Earth orbit and subsequently trans-lunar injection once docking with the **Orion** spacecraft is completed (also called Mars Transfer Stage for Mars missions).

endangered species – The classification provided under the Endangered Species Act of 1973 to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

environmental impacts – Adverse or beneficial effects that the proposed action or alternatives would have on both the human and natural environment. This includes direct, indirect and cumulative impacts.

essential fish habitat – Those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity for federally managed fish species. Promulgated under the Magnuson-Stevens Act of 1976 (and subsequent amendments) to protect and conserve domestic fisheries within U.S. territorial waters.

estuary – A semi-closed body of water characterized by an open mouth (usually leading to the ocean) and one or more tributaries. Usually, these areas are sites of high biologic activity. They may be known as bays, sounds and/or fjords.

exhaust cloud – Emissions from the launch or testing of a rocket.

exhaust velocity – The speed of emissions from a rocket engine nozzle.

Exploration Systems Architecture Study (ESAS) – A document prepared by NASA, which was used as a starting point for the Constellation Program. It is the result of an Agency-wide team activity to define the requirements for a new space transportation and

exploration infrastructure which meets the objectives of President George W. Bush's *Vision for Space Exploration*.

extravehicular activity(ies) (EVA) – Actions which include assembly, repair, or exploration outside of the pressurized environment of a space vehicle.

Extravehicular Activities Project – The NASA Project under the **Constellation Program** designated for modifying and/or developing new hardware to support **EVAs**.

Evolved Expendable Launch Vehicle (EELV) Program – A Department of Defense program to develop and build a family of launch vehicles for long-term military, civil, and commercial use.

Fairing/Payload Shroud – An ellipsoid shaped structure which covers cargo being launched into space. Principally designed to protect spacecraft from aerodynamic loads during ascent, it is jettisoned late in the ascent, after those loads diminish.

Federal Register (FR) – The official United States Government publication for rules, proposed rules, executive orders and other presidential documents, and notices of Federal agencies and organizations.

Fee Area – The area designated within the gated boundary of the John C. Stennis Space Center.

First Stage – The launch vehicle stage that provides thrust at liftoff.

fused silica – A type of glass containing silicon dioxide in a non-crystalline form. It is currently used in the windows on the Space Shuttle, and would likely be used in the windows on the **Orion Crew Module**.

General Conformity Rule – The General Conformity Rule is applicable to nonattainment or maintenance areas (see **attainment**) as designated by the U.S. Environmental Protection Agency (EPA), and ensures that Federal actions conform to each State Implementation Plan for air quality. These plans, approved by the EPA, are each State's individual plan to achieve the **NAAQS** as required by the **Clean Air Act**. The EPA is required to promulgate a Federal Implementation Plan if a State defaults on its implementation plan. A conformity requirement determination for a Federal action is made from influencing factors, including, but not limited to, nonattainment or maintenance status of the area, types of emissions and emission levels resulting from the action, and local impacts on air quality.

Gimbal – a mechanical device which allows a nozzle of a rocket engine to be moved in different axes

Ground Operations Project – The NASA Project under the **Constellation Program** responsible for ground processing and testing of the integrated launch vehicles, providing launch logistics and services, and post-landing recovery operations of the **Orion Crew Module** as well as the **Ares I First Stage** and the **Ares V solid rocket boosters**.

ground processing – Readying the **Orion** spacecraft and the **Ares** launch vehicles for stacking on the mobile launcher and later launch operations. This includes checking battery power, fueling operations, flight and environmental systems checks, loading of any

cargo, *etc.* It also refers to actions which involve refurbishing the **Crew Module** and **SRBs** after post-landing and recovery operations.

ground support equipment – Any piece of hardware necessary to support launch or recovery operations which is not to be launched itself.

ground track – An imaginary pathway on the surface of Earth that corresponds to the location of an in-flight object.

Halon – Compounds used as fire extinguishing agents which contain bromine, fluorine, and carbon. Some halon compounds cause ozone depletion and are banned under the *Montreal Protocol on Substances that Deplete the Ozone Layer*. See **Montreal Protocol**.

hazardous material (Hazmat) – Generally, a substance or a mixture of substances that has the capability of either causing or significantly contributing to an increase in serious irreversible or incapacitating reversible illness; or posing a substantial present or potential risk to human health or the environment. Use of these materials is regulated by several statutes (*e.g.*, the Resource Conservation Recovery Act).

Human-rated – A space system that incorporates those design features, operational procedures, and requirements necessary to transport humans.

Hypergolic fuel – Rocket fuel which spontaneously ignites when its two components are combined.

integrated launch vehicle(s) – The combination of all components in a launch system.

International Space Station – A multi-national research installation which is currently being assembled in Earth orbit.

in situ – A Latin phrase meaning *in the place*; under the **Constellation Program**, it refers to the use of prevalent existing resources on lunar missions which will be used to provide fuel, power, *etc.* for sustained human presence.

Ionosphere – The Earth's upper atmospheric region where ionization of atmospheric gases occurs

Launch Abort System – A propulsive stage of the **Orion** spacecraft which would provide a means of escape for crew members prior to **Ares I** ascent. The Launch Abort System will be similar in design to the Apollo Launch Escape System. It would be mounted on top of the **Crew Module**, and when ignited, would propel the **Crew Module** free of the **Ares I First Stage**.

launch azimuth – The initial angle, measured clockwise from North, which a launch vehicle's **ground track** makes as the vehicle begins to ascend.

lifting body – An aircraft that obtains lift from the airfoil shape of its fuselage.

liquefaction – The process of making or becoming a liquid; in geology, it is the process in which soil is converted into a suspension during events such as earthquakes. A term used to describe potential soil conditions in earthquake-prone regions.

low Earth orbit – An orbit generally between 200 to 2000 km (124 to 1,240 mi) above the Earth's surface.

Lunar Architecture Study – A NASA study which utilized inputs from government, academic, and private sources to determine a blueprint for a return of human presence on the lunar surface as well as the establishment of a lunar outpost. Robotic precursors to human missions were also integrated into the study.

Lunar Lander – The vehicle that would be used to transport crew and cargo from the **Orion** spacecraft in lunar orbit to the lunar surface and back.

Lunar Lander Project – The NASA Project under the **Constellation Program** responsible for the design, development, and construction of **Lunar Landers**.

Mach – The speed of sound. In general, it is approximately 1,238 km/h (769 mph) at sea level at a temperature of 70°F (21°C).

Main Propulsion Test Article (MPTA) – A full-scale, working prototype of an **Ares I** Upper Stage used for multiple ground tests including firing the J-2X engine at MSFC.

major source – A pollution source that emits more than a defined threshold level defined by the U.S. Environmental Protection Agency. These sources are required to put in place monitoring plans and obtain applicable state and Federal permits. See **Title V**.

meteorology – The scientific study of atmospheric phenomenon.

mitigation – A method or action to reduce or eliminate adverse impacts.

Mission Operations Project – The NASA Project under the **Constellation Program** that is responsible for astronaut training and planning for, and executing missions. They are also responsible for managing launch and entry Range Safety.

Mobile Launch Platform – A two story structure that rides on the **crawler transporter**, and has provided a mobile launch base for both the **Saturn V** and the Space Shuttle vehicles. The structure contains umbilicals which service the obiter as well as attach posts which hold the boosters and orbiter in place, keeping the entire structure upright before launch.

Montreal Protocol – Otherwise known as the *Montreal Protocol on Substances that Deplete the Ozone Layer*, this international treaty was originally enacted in 1987, and most recently amended in 1999, to protect the ozone layer through immediately banning some and ultimately phasing-out all ozone depleting substances.

National Ambient Air Quality Standards (NAAQS) – Section 109 of the **Clean Air Act** requires the U.S. Environmental Protection Agency to set nationwide standards, the **NAAQS**, for widespread air pollutants. Currently, six pollutants are regulated by primary and secondary **NAAQS** (see **criteria pollutants**).

National Estuary Program – A program, directed by Section 320 of the **Clean Water Act,** which is responsible for improving and protecting the quality of estuaries of national importance.

National Historic Landmark – A building site, structure, district, or object that is deemed to be of rich historic or cultural value to the United States of America. See **National Historic Preservation Act**.

National Historic Preservation Act (NHPA) – Legislation which created the **National Register of Historic Places** and the list of **National Historic Landmarks** in order to preserve historical and archaeological sites in the United States. Section 106 of the NHPA pertains to the "*Protection of Historic Properties*."

National Register of Historic Places (National Register) – A register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2(b) of the Historic Sites Act of 1935 and Section 101(a)(1) of the **National Historic Preservation Act** of 1966, as amended.

Notice of Intent (NOI) – The first formal step in the environmental impact statement process, consisting of a notice in the ***Federal Register*** with the following information: a description of the proposed Federal action and alternatives; a description of the agency's proposed scoping process, including scoping meetings; and the name and address of the person(s) to contact within the lead agency regarding the environmental impact statement.

ordnance – Military materials; explosives, ammunition, or other combat vehicles and equipment.

Orion – Formerly the **Crew Exploration Vehicle (CEV)**; refers to the vehicle which would incorporate a **Crew Module**, **Service Module**, **Launch Abort System**, and **spacecraft adapter**. This vehicle would be used (along with the **Ares I** launch vehicle) as a replacement for the Space Shuttle to transport crew and cargo between the Earth and the International Space Station, provide crew transport (along with the **Ares I** and **Ares V** launch vehicles) for lunar and Martian exploration missions, and return crew and cargo to the surface of the Earth. See also **CEV.**

overall sound pressure level – A sound level averaged over the entire audio spectrum; used to measure rocket launch noise and engine testing noise propagation from the source.

oxides of nitrogen (NO_X) – Gases formed primarily by fuel combustion, which contribute to the formation of acid rain. Hydrocarbons and oxides of nitrogen combine in the presence of sunlight to form ground-level ozone, a major constituent of smog.

oxides of sulfur (SO_X) – A family of gasses which result from the burning of fuels that contain sulfur. These gasses are precursors of sulfuric acid which may precipitate out of the atmosphere in the form of acid rain.

ozone layer – A portion of the Earth's **stratosphere** which contains a high concentration of ozone (O_3). It is very important in filtering out ultra-violet rays produced by the sun.

ozone hole(s) – Areas in the **ozone layer** noted for significant seasonal depletion of stratospheric ozone.

payload(s) – The element(s) that a launch vehicle or spacecraft carries over and above what is necessary for its operation. For a launch vehicle, the spacecraft being launched is the payload; for a scientific spacecraft, the suite of science instruments is the payload.

Phenolic impregnated carbon ablation (PICA) – A candidate material for use in the heat shield of the **Orion Crew Module**.

polybutadiene acrylonitrile (PBAN) –An elastomer used to bind the constituents of solid rocket fuel together; also known as Polybutadiene – Acrylic acid – Acrylonitrile.

Prevention of Significant Deterioration (PSD) – A standard that applies to new **major sources** or major modifications at existing sources for pollutants where the source is located in an area defined as in attainment or unclassifiable for the **NAAQS**.

Project Ares – The program that is responsible for the development of the **Ares I** and **Ares V** launch vehicles. It is also responsible for the testing of the launch vehicles as well as their delivery to John F. Kennedy Space Center for use in missions.

Project Orion – Is responsible for building and delivering the **Orion** spacecraft to the **Ground Operations Project** at John F. Kennedy Space Center. **Project Orion** would lead the development of the **Orion** spacecraft.

range – Permanent or temporary area or volume of land, sea, or airspace within or over which orbital, suborbital, or atmospheric vehicles are tested or flown. This includes the operation of launch vehicles from a launch site to the point where orbit is achieved or final landing or impact of suborbital vehicle components. This also includes the atmospheric entry of space vehicles from the point that the commit to de-orbit is initiated to (for normal atmospheric entries) the point of intact vehicle impact, landing, or the impact of all associated debris.

remediation – The long term, permanent clean up of CERCLA or other environmentally contaminated sites.

restrictive easement – A condition placed on land by its owner or by Federal, state, or local government that in some way limits its use, usually regarding the types of structures which may be built there or what may be done with the ground itself.

risk – The combination of (1) the probability (qualitative or quantitative), including associated uncertainty, that a system will experience an undesired event (or sequences of events) such as internal system or component failure and (2) the magnitude of the consequences (to the public , personnel, mission, and vehicle) and associated uncertainties given that the undesired event(s) occur(s).

rookery – Colony of breeding birds.

safing activities – Refers to venting excessive fuels or disarming ordnance.

Saturn V – A member of the Saturn family of rockets designed to launch heavy payloads into space. It was an expendable, liquid-fueled launch vehicle was used to launch the Apollo and Skylab missions.

seismology – The study of earthquakes, their sources and after-effects, and the propagation of elastic waves through the Earth.

Service Module – A cylindrical structure that would attach to the bottom of the **Crew Module** and provide propulsion and power for the **Orion** spacecraft. The **Service Module** includes radiator panels to dissipate heat, solar arrays to contribute electric power, as well as a platform to attach communications devices such as antennas. It is also used for the final injection burn to get into low Earth orbit, as well as for the deorbit burn during missions to the **International Space Station**.

Solid Rocket Booster (SRB) – A rocket that provides additional boost to the main propulsion system used to launch a spacecraft. It consists of a solid rocket motor plus additional assemblies, attach rings, and other electronic avionic systems. It may be expendable (*e.g.*, Atlas and Delta) or reusable (*e.g.*, Space Shuttle).

Solid Rocket Motor (SRM) – A rocket motor with a solid propellant consisting of fuel and oxidizer combined in compact grain. The SRM used for the Space Shuttle is a multi-segmented, reusable motor.

spacecraft adapter – The connecting structural hardware between the launch vehicle and the **Orion** spacecraft.

Specific Impulse (Isp) – describes the efficiency of a rocket engine in terms of the relationship between the change in momentum and the amount of propellant. An engine with a higher specific impulse is considered to be more efficient

Species of Concern – Species that are declining or might be in need of conservation actions.

Superfund site – Any land in the United States which has been contaminated by hazardous waste and identified by the U.S. Environmental Protection Agency as a candidate for cleanup because it poses a risk to human health and/or the environment.

stratigraphy – A branch of geology which studies rock layers and layering.

stratosphere – An upper portion of the Earth's atmosphere above the **troposphere**, reaching a maximum height of 50 km (31 mi) above the Earth's surface. The temperature is relatively constant in the lower **stratosphere** and gradually increases with altitude. The stratosphere is the Earth's main ozone producing region.

superalloy – A ductile metal alloy able to maintain excellent mechanical strength at extreme temperatures. Superalloys are also able to withstand corrosion and oxidation; typically the base element is nickel, cobalt, or nickel-iron.

tackifying – To make sticky. The Ares solid rocket motors would use a solvent to emulsify or partially dissolve the surface of the rubber insulation making it sticky so that layers of rubber can be bonded together.

Threatened Species – The classification assigned to an animal or plant likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Title V – Section of the 1990 Clean Air Act Amendments which require permit programs for large sources of air pollution. Permits are regulated under the **Clean Air Act**, but are issued by the state in which a source is located. Permits are available for viewing by all interests (government, general public, and industry).

topography – The study of Earth's physical features (natural and man made) as well as the physical features of other planets and moons.

total maximum daily load (TMDL) – Calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

tropopause – The boundary between the **troposphere** and **stratosphere**, usually characterized by an abrupt change of the relationship between temperature and altitude; the change is in the direction of increased atmospheric stability from regions below to regions above the tropopause; its height varies seasonally, from 15 to 17 km (9 to 11 mi) in the tropics to approximately 10 km (6 mi) in polar regions.

troposphere – The portion of the atmosphere next to the Earth's surface in which the temperature rapidly decreases with altitude, clouds form, and convection is active. The **troposphere** begins at ground level and extends to an altitude of 10 to 12 km (6 to 8 mi) above the Earth's surface.

umbilicals – Connections that supply necessary support material to a launch vehicle while on the launch pad. They can supply, but are not limited to electricity, air, water and fuels.

vadose – Found or located above the water table.

Warmwater Habitats – A phrase designated by the Ohio Environmental Protection Agency to describe an aquatic life use categorization.

wetlands – Areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil. This classification includes swamps, marshes, bogs, and similar areas.

Wetland Mitigation Bank – A site where wetlands and/or other aquatic resources are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources.

Wild and Scenic Rivers Act – Legislation enacted in 1968 which created the National Wild and Scenic Rivers System and Nationwide Rivers Inventory. The purpose of the act is to preserve certain rivers which exhibit outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values from damming or other alteration.

Wildlife Management Area(s) – Designated areas which allow for a wide range of public use such as hunting, fishing, camping, and other outdoor recreation activities.

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