FY 2022 Budget Request
Deep Space Exploration Systems
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Deep Space Exploration Systems	**5,959.8**	**6,517.4**	**6,880.4**	**7,014.1**	**7,263.7**	**7,514.9**	**7,772.8**
Exploration Systems Development			**4,483.7**				
Exploration Ground Systems			590.0				
Orion Program			1,406.7				
Space Launch System			2,487.0				
Exploration Research & Development			**2,396.7**				
Adv Cislunar and Surface Capabilities			91.5				
Advanced Exploration Systems			195.0				
Gateway			785.0				
Human Landing System			1,195.0				
Human Research Program			130.2				
Grand Total			**6,880.4**				

The FY 2022 Budget for the Deep Space Exploration Systems account consists of two areas, Exploration Systems Development (ESD) and Exploration Research and Development (ERD), which provide for the development of systems and capabilities needed for the human exploration of the Moon and Mars.

Exploration Systems Development (ESD)

- ESD programs work together to build many of the key space transportation systems that will enable the Agency's Artemis Program to land the first woman and first person of color on the Moon and extend human presence into the solar system. The systems include the Orion crew vehicle, Space Launch System (SLS) launch vehicle, and Exploration Ground Systems (EGS). The first uncrewed launch of the SLS and Orion will occur no earlier than (NET) November 2021 and the first crewed launch date is NET September 2023.
- The Orion program will finalize assembling and testing the first crewed vehicle and deliver the system to EGS at KSC. The program will start installing, assembling, and testing the second crewed vehicle and continue hardware production for the third.
- The SLS launch vehicle production and certification for flight will continue at Michoud Assembly Facility and Marshall Space Flight Center along with engine and core stage testing at Stennis Space Center. Key launch vehicle components will be delivered to EGS at Kennedy Space Center for integration into the final flight launch vehicle with the Orion crew vehicle. The Budget provides funding for development of the Block 1B upgrade to the SLS.
- EGS will continue to prepare launch infrastructure and operations requirements in support of the SLS and Orion programs. Modifications to existing facility and command and control systems will be ongoing, including continued construction of Mobile Launcher 2 and modifications for the Block 1B launch vehicle
- NASA will explore approaches for reducing the costs of future exploration missions to enable a more sustainable and scalable exploration program.

Exploration Research and Development (ERD)

- The overarching goal of ERD is to infuse technologies and research into the development of human exploration capabilities using a combination of unique in-house activities, competed research, and public-private partnerships. ERD is developing and testing prototype systems, as well as planning and developing flight missions to lunar orbit and the Moon; and conducting and

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enabling human research that will form the basis for future human spaceflight missions. ERD is comprised of five programs: Human Landing System (HLS), Advanced Cislunar Surface Capabilities (ACSC), Gateway, Advanced Exploration Systems (AES), and Human Research Program (HRP).

- The major initiative in the FY 2022 Budget is the HLS program, which utilizes essential commercial partnerships to develop and jointly deploy the integrated landing system that will transport crew to and from the lunar surface and establish a series of lunar missions that build on that capability. The Budget provides sufficient funding for the HLS program to maintain competition both leading up to and subsequent to the Artemis program's first crewed Moon landing mission.
- ACSC leads architecture and mission planning while providing technical direction for Human Exploration and Operations (HEO) missions through the HEO System Engineering and Integration office. The program is also conducting risk reduction studies to develop strategies and identify technologies to feed into lunar sustainability and future Mars efforts.
- Gateway is a platform that will orbit the Moon and support lunar landers and surface activities. Gateway will eventually consist of a Power and Propulsion Element (PPE), the Habitation and Logistics Outpost (HALO), at least one module contributed by NASA's international partners, and be supported by logistics services.
- AES will continue work to identify and address knowledge gaps and deliver fundamental capabilities to provide astronauts a place to live and work with integrated life support systems, radiation protection, food, fire safety, avionics and software, logistics management, and waste management systems.
- HRP is responsible for understanding and mitigating the highest risks to astronaut health and performance to ensure crews remain healthy and productive during long-duration missions beyond low-Earth orbit (LEO).

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FY 2022 Budget Request
Space Technology
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Space Technology	**1,100.0**	**1,100.0**	**1,425.0**	**1,454.5**	**1,486.4**	**1,519.2**	**1,552.9**
Space Technology			**1,425.0**				
Early Stage Innovation and Partnerships			145.0				
SBIR and STTR			287.0				
Technology Demonstration			501.8				
Technology Maturation			491.2				
Grand Total			**1,425.0**				

The Space Technology Mission Directorate (STMD) develops transformative, cross-cutting technologies that lead to research and technology breakthroughs to enable NASA's missions and is broadening its focus on cross-cutting space technologies that will support creating good jobs in a growing space industry.

The Space Technology investment portfolio covers the entire technology readiness spectrum, which includes:

- **Technology Demonstration** conducts system-level ground-based testing to determine feasibility, as well as space flight demonstrations of technologies and systems to effectively transition technologies and new capabilities for NASA missions and for use by other Government agencies and the commercial space industry. Some major highlights for FY 2022 include the following:
  - Complete Small Spacecraft Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment to support a Fall 2021 Launch Readiness Date (LRD);
  - Complete and deliver Deep Space Optical Communication and Low-Earth Orbit Flight Test of an Inflatable Decelerator to support Psyche's LRD in August 2022 and JPSS' LRD in September 2022;
  - Qualify Solar Electric Propulsion thrusters to support the Lunar Gateway Power and Propulsion Element;
  - Complete OSAM-1 spacecraft bus and SPIDER pallet deliveries leading to Systems Integration Review and space vehicle Integration and Testing;
  - Continue development of Cryogenic Fluid Management technologies leading to flight demonstrations in 2024 / 2025;
  - Initiate preliminary design of a 10-kilowatt electric-class fission surface power system leading to Mission Concept Design/System Requirements Review; and
  - Continue development of small spacecraft technologies with a renewed focus on enabling new mission architectures for scientific discovery, including climate research, and further emphasize industry partnerships.
- **Technology Maturation** advances disruptive space technologies from proof of concept to demonstration – maturing transformational and foundational technologies that primarily reside between early stage research and flight demonstration. Some highlights for FY 2022 include the following:
  - Initiate Industry and Commerce Innovation Opportunities to pursue technologies needed by the commercial space sector while enabling future NASA missions;

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- Deliver several Lunar Surface Innovative Initiative lunar surface technologies (e.g., PRIME1, Deployable Hopper, Nokia 4G/Wireless) to the surface the Moon in partnership with Commercial Lunar Payload Services (CLPS) of NASA's Science Mission Directorate; and
- Deliver qualified thrusters from Frontier Aerospace for flight qualification on Astrobotic's Peregrine Lander CLPS mission to Lacus Mortis, a large crater on the near side of the Moon.

- **Early Stage Innovation and Partnerships** spur collaboration with innovators across the Nation to capitalize on the ideas, talent, and experience of a diverse set of contributors to achieve Agency objectives. Efforts include targeting clean energy and climate-related technology challenges, expanding the number of NASA Innovative Advance Concept awards and exploring innovation pilots to enable breakthrough technology research and development in support of U.S. competitiveness. Expand engagement with the Nation's innovators through the Phase II continuations of Deep Space Food, Break the Ice and Watts on the Moon challenges, as well as additional prize funding to develop new prizes, potentially in partnership with SMD, ARMD, and/or other Government agencies.
- **Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)** programs leverage the Nation's innovative small business community to support early-stage research and development in support of NASA's mission in human exploration, science, and aeronautics. Efforts include additional emphasis on (1) engaging a broad, diverse base of innovators through the program, especially in engagements with Minority Serving Institutions and Historically Black Colleges and Universities; and (2) entrepreneurial engagement to encourage commercialization and economic impact.

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FY 2022 Budget Request
Space Operations
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Space Operations	**4,134.7**	**3,988.2**	**4,017.4**	**4,109.3**	**4,103.3**	**4,103.3**	**4,103.3**
International Space Station			**1,327.6**				
Space Transportation			**1,771.7**				
Commercial Crew Program			154.5				
Crew and Cargo Program			1,617.2				
Space and Flight Support (SFS)			**817.0**				
Human Space Flight Operations			101.8				
Launch Services			102.7				
Rocket Propulsion Test			47.8				
Communications Services Program			42.0				
Space Communications and Navigation			522.6				
Commercial LEO Development			**101.1**				
Grand Total			**4,017.4**				

The FY 2022 Budget for the Space Operations account consists of four areas: International Space Station (ISS), Space Transportation, Space and Flight Support (SFS), and Commercial LEO Development.

International Space Station (ISS)

- NASA is working to foster a robust commercial ecosystem in low-Earth orbit (LEO) in which NASA will be one of many customers. Through the ISS, NASA currently meets its own requirements for research and technology development, while also supporting a burgeoning community of non-NASA users. Over time, NASA has been and will be transitioning various aspects of human spaceflight operations in LEO to the private sector. This includes a transition over time from the ISS to the use of commercial space stations, when they become available.
- As the world's only crewed space-based multinational research laboratory and technology test bed, ISS supports the emerging commercial ecosystem in LEO, as well as the future of deep space human exploration. The ISS:
  - Promotes commerce in space through public-private partnerships as new commercialization concepts are explored and stimulates non-NASA demand to support commercial destinations being developed under the Commercial LEO Development program;
  - Advances exploration of the solar system and enables scientists to identify and quantify risks to human health and performance, develop countermeasures, and develop and test technologies that protect astronauts during extended human space exploration;
  - Supports unique research and development opportunities in the areas of biological and physical science;
  - Maintains the ISS international partnership that has brought together astronauts and scientists from dozens of spacefaring nations in peaceful cooperative activity; and
  - Supports current and planned Earth and Space Science observation missions.

Space Transportation

- Continues NASA's partnership with U.S. commercial space industry to develop and operate safe, reliable, and affordable systems to transport crew to and from ISS and LEO. This strategy will lay the foundation for more affordable and sustainable future human space transportation capabilities, bolster

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American leadership, reduce our current reliance on foreign providers for this service, and help stimulate the American aerospace industry.

- Sustains NASA's ISS cargo supply function in partnership with American private industry.
- Continues to advance commercial spaceflight and generate American jobs.

Space and Flight Support (SFS)

- Provides mission-critical space communications and navigation services to customer missions, including human spaceflight, science, and commercial crew and cargo missions.
- Advances next-generation space communication technologies, including optical communications, Delay/Disruption Tolerant Networking, and autonomous navigation, to reduce costs and improve performance.
- Begins projects demonstrating the use of commercially provided communication services to support NASA missions.
- Supports the readiness and health of the crew for all NASA human spaceflight endeavors.
- Provides safe, reliable, and cost-effective launch services for civil sector missions, as well as launch-related support to NASA missions in development.
- Continues to strategically manage NASA's rocket testing core capability to meet U.S. rocket testing requirements.

Commercial LEO Development

- Stimulates a commercial LEO space economy by partnering with U.S. private industry to enable development of LEO capabilities.
- Focuses on expanding access to space platforms to support the utilization of space by U.S. citizens, companies, academia, and international partners.
- Supports enabling, developing, and deploying commercial orbital destinations that NASA can use for research and technology demonstration purposes.
- Develops policies and practices that define commercial ISS usage and pricing.

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FY 2022 Budget Request
Science
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Science	**7,143.1**	**7,300.8**	**7,931.4**	**8,095.6**	**8,272.9**	**8,455.7**	**8,643.4**
Planetary Science			**3,200.0**				
Astrophysics			**1,400.2**				
James Webb Space Telescope			**175.4**				
Heliophysics			**796.7**				
Earth Science			**2,250.0**				
Biological and Physical Sciences			**109.1**				
Grand Total			**7,931.4**				

NASA's Science budget, managed by the Science Mission Directorate, includes five major science areas as well as the James Webb Space Telescope which is funded separately from Astrophysics. These areas include:

- **Earth Science** to enhance understanding of Earth systems and to observe the effects of climate change. The Budget invests heavily in climate and applications research, begins formulation of the first four Designated Observable missions, and initiates the Earth System Explorers program (consistent with Decadal Survey recommendations). The Budget also supports the ongoing development of the Earth System Observatory including PACE, CLARREO Pathfinder, NISAR, SWOT, and Landsat 9.

- **Planetary Science** to explore the planetary bodies of our solar system. The Budget funds the Lunar Discovery and Exploration program that supports public-private partnerships and innovative approaches to achieving human and science exploration goals. The Budget maintains support for the Planetary Defense program for near-Earth object detection and mitigation, including the Near-Earth Objects Surveyor mission. It also contains funding to explore new destinations in the solar system, such as the Europa Clipper and Dragonfly missions, and a robust competitive Discovery program, including Psyche and Lucy. The Budget supports a Mars Sample Return mission with key international partnerships, which will launch as early as FY 2026 and return samples to Earth. The Budget also supports the VIPER mission, which will explore the south pole of the Moon after its commercial lunar delivery in 2023.

- **Astrophysics** to study the universe and search for Earth-like planets. The Budget supports development of the Nancy Grace Roman Space Telescope planned for launch in 2026 and continues operations of the Hubble Space Telescope. The Budget includes funding for a competitive Explorers program, including recent selections, such as IXPE and SPHEREx, as well as new selections every two to three years. The Budget also supports initiation of a probe-class mission in FY 2022 pending Decadal Survey recommendations. The Budget supports ending the SOFIA mission. SOFIA's annual operations budget is the second-most expensive operating mission in the Astrophysics Division, yet the science productivity of the mission is not on par with other large science missions.

- **The James Webb Space Telescope** will explore all phases of our cosmic history – from within our solar system to the most distant observable galaxies in the early universe, and everything in between. Webb will seek the first stars that formed in the early universe, observe the formation of galaxies and protoplanetary systems, and explore potentially habitable exoplanets. The Budget supports a launch in October 2021.

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- **Heliophysics** to study the Sun and its influence throughout the solar system. The Budget supports the Interstellar Mapping and Acceleration Probe, new missions of opportunity within the Solar Terrestrial Probes program, and new Explorer mission selections (e.g., PUNCH, AWE, and TRACERS). The Budget includes funding for the Geospace Dynamics Constellation mission, the DRIVE initiative, and interagency efforts to improve space weather predictive capabilities (all priorities in the Decadal Survey).
- **Biological and Physical Sciences** to better understand how biological and physical systems work by observing them in ways not possible on Earth. The Budget supports space biology investigations, which seek to understand how living organisms respond to and evolve in the spaceflight environment, and physical science investigations to examine the fundamental laws of the universe from the unique vantage point of space.

In effectively managing this portfolio, the Science Mission Directorate:

- Focuses on three interdisciplinary objectives:
  - Discovering the secrets of the universe;
  - Searching for life in the Solar System and beyond; and
  - Protecting and improving life on Earth.
- Supports approximately 100 space missions:
  - Approximately 45 missions preparing for launch and approximately 55 operating missions
  - In addition, ongoing flights of sounding rockets, aircraft, and high-altitude balloons and associated science payloads
- Invests in world-class scientific research conducted by more than 10,000 U.S. scientists:
  - More than 3,000 openly competed research awards with universities, industry, and Government labs
  - World-leading research, frequently highlighted on the covers of *Science, Nature*, and major newspapers
- Executes innovative partnerships to enhance science and innovation, for example by:
  - Purchasing Earth Science observation data from commercial SmallSat constellations to augment or complement observations acquired by NASA;
  - Leveraging commercial partnerships to deliver science and technology payloads to the Moon;
  - Leveraging data and expertise through collaborations with other Federal agencies, such as USGS and NOAA;
  - Collaborating with nations across the globe on NASA missions and science; and
  - Enabling science learners across the U.S. through partnerships with community-based organizations.
- Enables the use of NASA science data to inform decision-makers in support of vital national needs, including disaster response, space weather prediction, and planetary defense
- Develops innovative technologies to enable advances in future missions and observational capabilities, for example:
  - Optics and detectors to characterize habitable planets around other stars;
  - Sensors to look for signs of past or present life on Mars and other planetary bodies; and
  - Instruments to advance our understanding of Earth's natural systems.

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FY 2022 Budget Request
Aeronautics
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Aeronautics	**783.9**	**828.7**	**914.8**	**933.7**	**954.1**	**975.2**	**996.8**
Aeronautics			**914.8**				
Airspace Operations and Safety Program			104.5				
Advanced Air Vehicles Program			243.7				
Integrated Aviation Systems Program			301.5				
Transformative Aero Concepts Program			148.0				
Aerosciences Eval. & Test Capab. Program			117.0				
Grand Total			**914.8**				

NASA Aeronautics conducts research to advance the safety, capacity, and efficiency of the air transportation system, reduce emissions, and sustain U.S. technological leadership in the aviation industry.

NASA is starting a new initiative in Aeronautics, the Sustainable Flight National Partnership (SFNP). This partnership aims to accomplish the aviation community's aggressive climate change agenda and enhance America's global leadership in aviation. NASA Aeronautics' cost-sharing partnerships with U.S. industry will enable the next generation single-aisle transport, expected by the early 2030s, to be a game-changing, ultra-efficient and low-carbon emitting design at least 25 percent more fuel-efficient than today.

The budget request supports five programs within the Agency's aeronautics portfolio:

- **Airspace Operations and Safety Program** (AOSP) works in close partnership with the Federal Aviation Administration and the aviation community to modernize and transform the national air traffic management system. The program is on the leading edge of research on increasingly autonomous aviation systems, including innovation in the management of Unmanned Aircraft Systems traffic and other novel aviation vehicles. The program is also pioneering the integration and analysis of data to support in-time system-wide safety assurance. In FY 2022, AOSP will:
  - Conduct a simulation of initial trajectory management services to enable efficient, environmentally sustainable operations;
  - Complete simulations and flight tests of automated in-flight safety/risk assessment tools with alternate proactive and fail-safe mitigation methods; and
  - Provide data from a collaborative simulation that addresses a key barrier to assessing the need for increasingly autonomous technologies to support remotely operated vehicles.
- **Advanced Air Vehicles Program** (AAVP) conducts research to meet the nation's growing long-term civil aviation needs. The program works in close partnership with academia, industry, and other government agencies to pioneer fundamental research and to mature the most promising technologies and concepts for transition to the user community, including demonstration of technologies critical for the SFNP. In FY 2022, AAVP will:
  - Validate prediction tools in order to use them for the X-59 validation process. These tools will predict noise values measured during flight;
  - Complete a Critical Design Review of a turbofan engine to determine the impact of large-scale power extraction from both high- and low-pressure engine spools;

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- Conduct buffet testing of a Transonic Truss-Braced Wing design to help understand the aerodynamics of the concept; and
- Complete validation testing of hover performance for Urban Air Mobility vehicle noise and prediction and assessment tools.

- **Integrated Aviation Systems Program** (IASP) funds the Sustainable Flight Demonstrator Project, which will build a full-scale, ultra-efficient X-plane to pave the way to a significant reduction in the aviation industry's carbon footprint. It also includes the Low-Boom Flight Demonstrator Project that will help enable eventual over-land commercial supersonic flight. The program explores, assesses, and demonstrates the benefits of the most promising technologies at an integrated system level in relevant environments, including in flight. In FY 2022, IASP will:
  - Release a request for proposals to U.S. industry to design and build a Sustainable Flight Demonstrator;
  - Conduct design and readiness reviews for each Electric Powertrain Flight Demonstration;
  - Conduct the first flight of the X-59 Low Boom Flight Demonstrator in the summer of 2022;
  - Conduct the first flight of the X-57 all-electric aircraft to better inform standards development for small aircraft that will be common in an Advanced Air Mobility (AAM) environment; and
  - Conduct National Campaign simulations and operations demonstrations to support the emerging AAM industry.
- **Transformative Aeronautics Concepts Program** (TACP) demonstrates initial feasibility of concepts supporting the discovery and development of new transformative solutions supporting the NASA Aeronautics strategy, including exploring opportunities to create a net zero-emissions aviation future. In FY 2022, TACP will:
  - Complete a Multi-disciplinary Design, Analyses, and Optimization activity, which will improve design and optimization tools; and
  - Complete three Convergence Aeronautics Solutions project activities: Solid-state Additively-manufactured Batteries for enhanced Energy, Recharging, and Safety; Sensor-based Prognostics to Avoid Runaway Reactions and Catastrophic Ignition; and Scalable Traffic Management for Emergency Response Operations.
- **Aerosciences Evaluation and Test Capabilities Portfolio** (AETC) manages NASA's versatile and comprehensive portfolio of aerosciences ground test capabilities and assets essential for validating new technologies and concepts. Among these assets are subsonic, transonic, supersonic, and hypersonic wind tunnels; propulsion test facilities; and specialty tunnels at Ames Research Center (ARC), Glenn Research Center (GRC), and Langley Research Center (LaRC). In FY 2022, AETC will:
  - Assess the condition and health of testing capabilities at ARC, GRC, and LaRC. The review will identify equipment with a high-risk of failure due to age or maintenance; and
  - Improve integration of computational fluid dynamics and experimental testing, which will enhance testing efficacy.

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FY 2022 Budget Request
Office of STEM Engagement
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Office of STEM Engagement	**120.0**	**127.0**	**147.0**	**150.0**	**153.3**	**156.7**	**160.2**
Office of STEM Engagement			**147.0**				
Grand Total			**147.0**				

NASA makes investments in engaging students, educators, and educational institutions to: attract diverse groups of students to STEM through learning opportunities that spark interest and provide connections to NASA's mission and work; create unique opportunities for a diverse set of students to contribute to NASA's work; and build a diverse future STEM workforce. The Office of STEM Engagement (OSTEM) leads NASA's STEM engagement function, providing strategic guidance and direction in partnership with the mission directorates. In FY 2022, NASA will focus on increasing diversity, equity, and inclusion in STEM by bolstering internships and other direct student opportunities, enhancing Next Gen STEM's K-12 portfolio of student learning opportunities, and expanding partnerships and networks to magnify their reach and impact. The STEM Engagement Program is comprised of four projects:

National Space Grant College Fellowship Project (Space Grant)

- The Budget provides a $6 million increase to Space Grant, a national network of colleges and universities with 52 consortia in all 50 states, the District of Columbia and Puerto Rico, and over 1,000 affiliates. In FY 2022, Space Grant will issue awards for year three of a four-year competitive awards cycle, which will increase base awards to $820,000 for each consortium. Space Grant will also execute a competitive solicitation for multiple consortia to jointly propose learning opportunities for the 2023 and 2024 eclipses, with focus on serving underrepresented and underserved students.

Minority University Research and Education Project (MUREP)

- The Budget provides a $10 million increase to MUREP to enable a greater reach to Minority Serving Institutions (MSIs) and underrepresented minorities in geographical areas of the country will MUREP does not have investments, and to build MSI capacity and competitiveness with a focus on student success. In FY 2022, efforts will include leading the formation of a Historically Black College and Universities (HBCU) focused element designed to address deficits in STEM research, faculty development, and student success. MUREP will also create competitive awards for Alaska Native and Native-Hawaiian, Tribal Colleges and Universities, and other Native Serving institutions to bolster STEM pathways.

Established Program to Stimulate Competitive Research (EPSCoR)

- NASA EPSCoR will execute its multiple competitive awards portfolio for eligible jurisdictions, with the aim of developing a broader academic research enterprise directed toward long-term, self-sustainable, nationally competitive capabilities in aerospace. In FY 2022, EPSCoR will conduct the Research, Rapid Response Research, Research Infrastructure Development, and ISS and Suborbital Flight Research Opportunities. EPSCoR, in partnership with the National Science Foundation, will support Fellows Advancing Science and Technology to enable Minority Serving Institutions (MSIs) within EPSCoR states to collaborate with NASA researchers and open new paths for them to compete for future research projects.

Next Generation STEM Project (Next Gen STEM)

- NASA will allocate an additional $4 million towards strategic investments in informal education and K-12 through Next Gen STEM, which supports informal education and K-12 student engagement. In FY 2022, NASA will forge a competitive two-tiered awards program for museums and other informal

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education institutions: (1) traditional large awards for exhibits and programs (approximately $750,000 to $1 million) and (2) small "Community Anchor" awards to help build capacity with newer-to-NASA institutions (approximately $25,000). Next Gen STEM will also focus on engaging underserved and underrepresented student groups through NASA mission learning opportunities and content, including Artemis and the James Webb Space Telescope.

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FY 2022 Budget Request
Safety, Security, and Mission Services
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Safety, Security, and Mission Services	**2,913.3**	**2,936.5**	**3,049.2**	**3,112.3**	**3,180.5**	**3,250.8**	**3,323.0**
Mission Services & Capabilities			**2,028.8**				
Information Technology (IT)			612.2				
Mission Enabling Services			731.5				
Infrastructure & Technical Capabilities			685.1				
Engineering, Safety, & Operations			**1,020.4**				
Agency Technical Authority			186.8				
Center Engineering, Safety, & Operations			833.7				
Grand Total			**3,049.2**				

Safety, Security, and Mission Services (SSMS) enable NASA's missions by providing foundational support capabilities. SSMS provides strategic direction and integration of essential business and technical functions across NASA's nine centers and Headquarters. SSMS funds independent oversight of NASA's mission programs to ensure the health and safety of NASA employees and the public. SSMS provides services and capabilities that ensure NASA has the technical skills, physical assets, financial resources, and top talent to be successful, safe, and reliable.

Goal 4 of the NASA Strategic Plan directs mission support to optimize its capabilities and operations to enable the Agency's missions in six key areas: (1) partnership strategies, (2) space access and services, (3) safety and mission assurance, (4) human capital management, (5) protection and cybersecurity, and (6) infrastructure and asset management. In response, NASA transitioned critical business services (e.g., human resource management, asset management, finance, and IT) to an enterprise management and service delivery model. An enterprise model will ensure NASA has the flexible, affordable, and adaptive services needed in the future. To achieve this level of service, SSMS will prioritize critical support, optimize operations, and mature enterprise capabilities.

In FY 2022, in addition to ensuring the foundational support services and safety oversight for NASA's missions, SSMS is focused on key initiatives based on critical needs:

- **Diversity, Equity, and Inclusion**: NASA is committed to implementing data analytics, workforce training, and leadership development and other services that will increase the inclusivity of the NASA workforce, science community, and space partners.
- **Business Innovation**: NASA will invest in Agency-wide business innovations that create strategic cohesion, service resilience, new efficiencies, and cutting-edge capabilities for mission success.
- **Cybersecurity**: NASA will target vital cybersecurity needs to protect against increasing cyberattacks and the threat of losing data, technology, and communications. This includes cloud security, Security Operations Center enhancements, encryption, Multi-Factor Authentication, increased logging functions, and enhanced monitoring tools.
- **Electric Vehicles**: NASA will implement the Federal government objectives of building out electric vehicle infrastructure to enable a fleet of vehicles with fewer carbon emissions and lower costs.
- **Orbital Debris**: With increased commercial and international activity in space, NASA will increase its work to understand the debris environment and mitigation options for orbital debris hazards that may threaten safe and secure space transit.

Mission Services and Capabilities (MSaC) provides enterprise solutions under three programs to meet workforce, infrastructure, information technology, and business operations requirements necessary to enable NASA's mission. MSaC ensures that critical Agency operations are effective, efficient, safe, and

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meet statutory, regulatory, and fiduciary responsibilities. These mission enabling services, capabilities and related processes provide efficient and effective administration across all NASA centers.

- **Information Technology** (IT) provides secure connectivity and data access for the NASA workforce and its partners – deploying over 100,000 continuous diagnostics and mitigation (CDM) tools across the corporate and mission networks and achieving Personal Identity Verification (PIV) access for 90 percent of unprivileged and 100 percent of privileged users. The program provides NASA end-users with cloud-based email and collaboration capabilities. The IT program supports over 250 applications that empower scientific research and mission support and the processing of approximately 4.3 million inquiries per year about NASA's Scientific and Technical Information, which provide the scientific community the information needed to achieve new discoveries.
- **Mission-Enabling Services** provides an enterprise approach to managing NASA's business operations and mission support activities. Missions rely on these institutional services to provide the business services and skilled staff required to accomplish their objectives. Business services include financial management, human capital management, procurement, small business, legislative affairs, equal opportunity and diversity management, legal, communications, international and interagency relations, and protective services.
- **Infrastructure and Technical Capabilities** (I&TC) enables NASA missions. The I&TC program provides sustainment, operations and maintenance for facilities and technical capabilities. The program also provides effective oversight and management of real property, environmental program activities, aircraft operations, and logistics functions. These capabilities enable NASA to meet its statutory and regulatory responsibilities and ensure that the necessary infrastructure is available to meet mission requirements. This mission is accomplished through effective management of assets and capabilities; proactive coordination with NASA mission directorates; enhanced institutional planning; proactive deployment of sustainable practices; ongoing regulatory compliance; and reducing infrastructure-related risks.

Engineering, Safety, and Operations provides for the ongoing management and operations of NASA Headquarters, nine field centers, and component facilities under two programs that support scientific and engineering activities. They contribute to the reduction of program risks by ensuring that technical skills and assets are ready and available to meet program and project milestones; mission and research endeavors are technically and scientifically sound; and center practices are safe and reliable.

- **Agency Technical Authority** (ATA) programs protect the health and safety of the NASA workforce by evaluating programs, projects, and operations to ensure safety and success. ATA trains and maintains a technical workforce for system engineering, system safety, reliability, quality, and space medicine. Through independent analysis and subject matter expertise, ATA develops policy, designs procedural requirements, and provides recommendations to NASA's Administrator, mission directorates, center directors, and program managers, who are ultimately responsible for the safety and success of all NASA activities. ATA is the foundation of NASA’s system of checks and balances, defined in NASA’s Strategic Management and Governance Handbook.
- **Center Engineering, Safety, and Operations** (CESO) is a key component of NASA’s overall approach to risk management. CESO provides center-level independent technical authority, strategic direction, and flexibility. Center-level oversight and reporting activities uphold the strategy and guidance from Agency Technical Authorities (ATAs), putting checks on safety, engineering, and mission assurance that are separate from mission directorates. CESO funds corporate leadership, NASA Headquarters operations and center management. Institutional and safety support for center operations and infrastructure are vital to allow centers the flexibility to address and manage conditions unique to their center. CESO ensures that Agency policies and guidance are operationalized across centers with consistency and efficiency.

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FY 2022 Budget Request
Construction & Environmental Compliance Restoration
($ Millions)

	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Construction & Envrmtl Compl Restoration	**432.5**	**428.5**	**390.3**	**398.4**	**407.1**	**416.1**	**425.3**
Construction of Facilities			**315.6**				
Institutional CoF			205.8				
Exploration CoF			89.3				
Space Operations CoF			20.5				
Environmental Compliance and Restoration			**74.7**				
Grand Total			**390.3**				

Construction & Environmental Compliance Restoration (CECR) provides for capital repairs and improvements to NASA's infrastructure and environmental compliance and restoration activities. With installations in 14 states, NASA collectively manages an inventory of more than 5,000 buildings and structures, of which 83 percent are beyond designed life. To ensure American preeminence in space, science, technology, and avionics, the Budget funds repair, replacement, and modernization of NASA's infrastructure. The FY 2022 budget provides for vital repair and construction work to ensure NASA's physical assets are safe, reliable, and mission-ready.

- **Institutional Construction of Facilities** (CoF) ensures that NASA's physical infrastructure is in sufficient condition to enable execution of Agency's missions, including utility systems, roads, facilities, and associated equipment. The Budget responds to NASA's maintenance backlog of ~$2.6 billion results by prioritizing, repairing, and replacing physical assets based on mission requirements. In addition to the new construction projects below, the FY 2022 budget of $205.8 million will provide for: the repair, replacement, or restoration of vital HVAC, water, sewer, electrical, and other systems ($106.5 million); investment in energy saving projects to avoid costs and increase sustainability ($8 million); demolition of unnecessary facilities that reduce the Agency's footprint and avoid costs ($15 million); and the required planning and design of all construction ($33.1 million).
  - $25 million for the construction of the Operations and Maintenance Facility at Johnson Space Center (JSP). The ~63,000 square foot, state-of-the-art facility will replace 28 existing and degraded buildings and allow demolition of ~100,000 square feet of unneeded space. The new facility will also significantly improve services for all mission activity at JSC, including the International Space Station, Orion, Commercial Crew, and numerous scientific and engineering research programs, while reducing the Agency footprint, saving energy, and avoiding costs.
  - $18.2 million for upgrades to the core and cross-center electrical infrastructure at Langley Research Center (LaRC). Upgrades include the completion of the underground, 22kV electrical distribution infrastructure of cables, feeders, and surge controls. The new electrical system will avoid risks to human life and mission performance by replacing obsolete equipment and enable vital mission activities and research conducted in LaRC's wind tunnels, research labs, flight system integration and testing facilities, and other offices and buildings.
- **Programmatic Construction of Facilities** funds projects to carry out specific Science, Exploration, and Space Operations programmatic requirements. Funding in this category is realigned from the mission directorates to the CECR budget, in accordance with statutory direction that all NASA construction projects be funded in the CECR account. In addition to the new construction below, the FY 2022 budget of $89.3 million for Exploration and $20.5 million for Space Operations will provide for repairs and modernization of vital infrastructure, including roads, critical systems (e.g., water, fire, electrical, mechanical), and facilities for both Exploration ($35 million) and Space Operations ($8 million).

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- $3.5 million to continue the modification of launch infrastructure at Kennedy Space Center (KSC) to support Space Launch System (SLS) activities. This project is jointly funded with Institutional CoF to upgrade systems for nitrogen, temperature and humidity control, air supply, fabrication, and emergency evacuation. The new launch infrastructure will enable Artemis and long-distance exploration programs.
- $15.8 million to continue the rehabilitation of KSC's Launch Control Center (LCC) HVAC system, including Air Handle Units (AHU), computer room air conditioning units, fan coils, chilled water pumps, and valves. Improvements to the LCC will ensure the ongoing operations of critical launch equipment, like monitoring systems, firing and computer rooms, and other controls. The new system will enhance sustainability and reduce operating costs through efficiency, while ensuring mission-critical operations (e.g., launch countdowns, controls, and communication) are not impacted by system failures.
- $35 million to continue the replacement of the Michoud Assembly Facility (MAF) ~1.7 million square foot roof, which houses NASA's primary, large-scale, environmentally controlled assembly environment. MAF's roof is severely degraded and threatens to cause physical harm, mission delays, and potentially devastating impacts to vital space systems if it were to collapse. The replacement will ensure NASA's mission success while utilizing modern materials that will enhance sustainability, reduce energy usage, and avoid associated costs.
- $12.5 million to complete the Deep Space Network Aperture Enhance Project (DAEP) beam waveguide (BWG) antennas at the Goldstone Deep Space Communication Complex in California and the counterpart Canberra site at the Madrid Deep Space Communication Complex. The DSS-53 antenna in Madrid will enable the array of four antennas for enhanced aperture. Enhancements to the DSS-23 antenna pedestal at Goldstone (including mechanical systems, HVAC, electrical, surveillance, fire detection, and flood controls) will ensure full operational ability. The completion of both antennae will enable radio frequency and optical communications for NASA's deep space exploration missions.

- **Environmental Compliance and Restoration** (ECR) supports cleanup of hazardous materials and waste products released to the surface or groundwater at current and former NASA installations or associated facilities. Over the years, NASA activities have contributed to environmental problems. It is the Agency's ethical and legal responsibility to address hazardous pollutants and environmental impacts. ECR activities include projects, studies, assessments, investigations, sampling, plans, designs, construction, engineering, program support, monitoring, and regulatory oversight. Funding also covers land acquisitions required to ensure operation of remedial treatment processes and facilities as part of remediation and cleanup measures.
  - The FY 2022 budget of $74.7 million will provide for remedial investigations and soil and groundwater cleanups at the Santa Susana Field Laboratory (SSFL), White Sands Test Facility, KSC, and Marshall Space Flight Center and continued operations of treatment systems and monitoring at other NASA centers and component facilities. SSFL activities in FY 2022 are of critical importance to the Agency and include the demolition of the Bravo and Coca Test Stands, continued groundwater treatment and monitoring, on-site storm and surface water management, and the management of cultural resources per the agreement with the State Historic Preservation Office and local Native American tribes.

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