ENABLING MISSION SUCCESS FROM THE GROUND UP: ADDRESSING NASA'S URGENT INFRASTRUCTURE NEEDS

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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C O N T E N T S

July 29, 2021

ENABLING MISSION SUCCESS FROM THE GROUND UP: ADDRESSING NASA'S URGENT INFRASTRUCTURE NEEDS

THURSDAY, JULY 29, 2021

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to notice, at 10:04 a.m., via Zoom, Hon. Don Beyer [Chairman of the Subcommittee] presiding.

SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

Enabling Mission Success from the Ground Up: Addressing NASA's Urgent Infrastructure Needs

Thursday, July 29, 2021
10:00 am
2318 Rayburn House Office Building and Online via Zoom

PURPOSE

The purpose of the hearing is to review the National Aeronautics and Space Administration's (NASA's) infrastructure and maintenance status, plans, and needs, including those related to physical infrastructure, mission support systems, research laboratories and test facilities, and to examine the enabling role of infrastructure in achieving NASA's current and future mission goals in science, aeronautics, human spaceflight, and space technology while ensuring the safety of agency personnel and operations.

WITNESS

- **Mr. Robert Gibbs,** Associate Administrator for the Mission Support Directorate, National Aeronautics and Space Administration

OVERARCHING QUESTIONS

- *How important are NASA's infrastructure and facilities to enabling mission success and achieving the agency's ambitious and inspirational goals?*
- *What are NASA's primary challenges in managing its infrastructure, property, and facilities?*
- *What is the impact of NASA's growing deferred maintenance portfolio on the agency's ability to conduct its missions?*
- *To what extent are NASA's existing facilities and infrastructure sufficient to meet the ambitious goals of its Moon to Mars, scientific, aeronautics, and space technology programs and advance NASA's world-class cutting-edge research?*
- *How vulnerable are the agency's facilities and infrastructure to the impacts of climate change—including rising sea levels and increased frequency and severity of extreme weather—and how is the agency preparing for or developing resiliency to these impacts?*
- *What are NASA's plans to improve the overall environmental sustainability and efficiency of its infrastructure and facilities?*

BACKGROUND

Across locations in 14 states, the National Aeronautics and Space Administration (NASA) manages $43 billion in assets and an inventory of over 5,000 buildings and structures.[1] NASA and its partners rely on the agency's infrastructure to conduct research, develop and operate missions, and otherwise conduct ambitious programs across aeronautics; Earth and space sciences; human exploration; space technology; and Science, Technology, Engineering, and Math (STEM) engagement. The NASA Inspector General (IG) has consistently named "addressing outdated infrastructure and facilities" as a top performance and management challenge for the agency; in 2020, the IG reiterated that, "to achieve its current exploration and research goals, the Agency needs to maintain [its] facilities in a safe and sustainable condition."[2] In May 2021, NASA Administrator Bill Nelson testified to Congress that the agency has identified $5.4 billion in infrastructure needs, above and beyond the annual budget request, in large part to address aging and damaged infrastructure across the agency.[3]

NASA's Current Management of Infrastructure and Facilities

NASA's physical infrastructure consists of Centers and facilities across the country. In addition to the Mary W. Jackson NASA Headquarters building in Washington, D.C., NASA's nine field Centers are:

- Ames Research Center (ARC, Moffett Field, California)
- Armstrong Flight Research Center (AFRC, Edwards, California)
- Glenn Research Center (Cleveland, Ohio)
- Goddard Space Flight Center (GSFC, Greenbelt, Maryland)
- Johnson Space Center (JSC, Houston, Texas)
- Kennedy Space Center (KSC, Cape Canaveral, Florida)
- Langley Research Center (LaRC, Hampton, Virginia)
- Marshall Space Flight Center (MSFC, Huntsville, Alabama)
- Stennis Space Center (SSC, Hancock County, Mississippi)

The Jet Propulsion Laboratory (JPL), located in Pasadena, CA, is a Federally Funded Research and Development Center within NASA's infrastructure. In addition to the field centers, NASA's critical physical infrastructure also includes research and test facilities that provide capabilities to specific field Centers and agency-wide:

- White Sands Test Facility (Las Cruces, New Mexico)
- Michoud Assembly Facility (MAF, New Orleans, Louisiana)
- Wallops Flight Facility (Wallops Island, Virginia)
- Independent Verification & Validation Facility (Fairmont, West Virginia)

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[1] NASA, FY2022 Congressional Justification NASA Budget Request. Available at: https://www.nasa.gov/sites/default/files/atoms/files/fy2022_congressional_justification_nasa_budget_request.pdf

[2] NASA Office of the Inspector General, "2020 Report on NASA's Top Management and Performance Challenges," November 12, 2020. Available at: https://oig.nasa.gov/docs/MC-2020.pdf

[3] Smith, Marcia, "Nelson Sees Jobs Bill as Solution to HLS and Other Funding Needs," *SpacePolicyOnline.com,* May 19, 2021. Available at: https://spacepolicyonline.com/news/nelson-sees-jobs-bill-as-solution-to-hls-and-other-funding-needs/

- Neil A. Armstrong Test Facility[4] (Sandusky, Ohio)

NASA owns and/or directly manages almost all its property, which comprises a total of 513 square miles (328,320 acres) of land with a current replacement value (CRV) of $35.8 billion. According to NASA's Facilities and Infrastructure Plan, written pursuant to the NASA Transition Authorization Act of 2017,[5] of these assets, 80 percent consist of constructed buildings and structures (including launch infrastructure, antennae, and test stands) while 20 percent consist of horizontal infrastructure (roadways, water distribution, sewar collection, storm drain collection, etc.).

In addition to supporting mission objectives, NASA facilities also support fundamental research and development. Major experimental, scientific, and test facilities include the Aerosciences Evaluation and Test Capabilities portfolio, which includes state-of-the-art subsonic, supersonic, and hypersonic wind tunnels;[6] high-performance computing facilities, such as the Pleiades supercomputer, one of the world's fastest and most powerful;[7] planetary sample analysis and curation facilities, such as the Lunar Sample Laboratory Facility at JSC;[8] and the B-2 test stand at Stennis Space Center, which tested Apollo-era rockets and most recently held the SLS core stage engines in place while they fired at full thrust for more than eight minutes.[9]

Upkeep of such fundamental research facilities has been a long-standing challenge. In 2010, the National Research Council (NRC)[10] released a report, *Capabilities for the Future: An Assessment of NASA Laboratories for Basic Research*, that stated that the "fundamental research community at NASA is not provided with healthy or stable funding for laboratory capabilities, and therefore NASA's vision and missions for the future are in jeopardy." The NRC found that research equipment were inadequate, basic research facilities were inferior to those found at the Department of Energy, top-tier universities, and corporate laboratories, and that the lack of timely maintenance could lead to safety issues, with potentially major adverse impact on missions and fundamental research operations.[11]

NASA has developed a Mission Dependency Index (MDI) as an indication of the relative importance of a facility to mission success and to help establish priorities and manage risk in its infrastructure portfolio.[5] According to the Government Accountability Office (GAO), NASA authorizes its individual centers to independently prioritize and approve projects below $1 million in total cost, and larger projects are prioritized by NASA headquarters, using the MDI, facility conditions, and other factors, including flood risk and budget considerations.[12]

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[4] Plum Brook Station was renamed the Neil A. Armstrong Test Facility on December 30, 2020.
[5] Section 837 of the NASA Transition Authorization Act of 2017 (Pub. L. 115-10)
[6] https://www.nasa.gov/aetc/description/
[7] https://www.nas.nasa.gov/hecc/resources/pleiades.html
[8] https://curator.jsc.nasa.gov/lunar/lun-fac.cfm
[9] NASA, "NASA Mega Moon Rocket Passes Key Test, Readies for Launch," March 18, 2021. Available at: https://www.nasa.gov/press-release/nasa-mega-moon-rocket-passes-key-test-readies-for-launch
[10] The operating arm of the National Academies of Sciences, Engineering, and Medicine was formerly referred to as the National Research Council.
[11] National Research Council. 2010. *Capabilities for the Future: An Assessment of NASA Laboratories for Basic Research*. Washington, DC: The National Academies Press. Available at: https://doi.org/10.17226/12903
[12] Government Accountability Office, "Federal Real Property Asset Management," GAO 19-57, November 2018. Available at: https://www.gao.gov/assets/gao-19-57.pdf

More than 83 percent of NASA's infrastructure is beyond its design life, and, as of 2017, more than 70 percent of facilities were at least 50 years old. According to the Facilities and Infrastructure Plan, approximately one-half of NASA's facilities were originally built during the 1960s for the Mercury, Gemini, and Apollo programs. Older facilities present many costly challenges to maintain as parts become obsolete and personnel with the technical expertise to manage these facilities become scarce.[11] In 2017, the NASA Office of Inspector General found that a "large portion of the infrastructure supporting NASA's technical capabilities is aging, which presents considerable risk to the Agency's overall mission as facilities degrade and become obsolete or considerably more expensive to maintain."[13] NASA's FY2022 budget request Congressional Justification document notes that failures requiring immediate repair are accounting for an increasing share of the maintenance budget—because unscheduled maintenance costs up to three times more than scheduled maintenance—even as the deferred maintenance backlog has grown to over $2.6 billion.[14]

As part of an effort to shift towards Agency-level master planning for facilities and infrastructure management, among other Agency functions, NASA has been implementing the Mission Support Future Architecture Program (MAP), a phased plan to evaluate and realign each mission support organization to an enterprise-level operating model and meet evolving mission needs. The MAP initiative is aimed towards enabling the sharing of capabilities across Centers, realigning budget structures, and improving collaboration across the agency.

NASA Facilities and Infrastructure in FY2022 budget request

NASA's infrastructure is primarily managed within the Mission Support Directorate (MSD). Within MSD, the Safety, Security, and Mission Services (SSMS) account maintains NASA's facilities, utility systems, and information technology, and the Construction and Environmental Compliance and Restoration (CECR) account manages capital repairs and improvements to NASA's infrastructure as well as the agencies' environmental compliance and restoration responsibilities. According to the FY2022 budget request Congressional Justification document, NASA's MSD uses both accounts to maintain NASA's critical infrastructure and must balance spending on maintenance, repairs and renewal, and replacement and demolition of that infrastructure.[15]

The FY2022 budget request for SSMS is $3.05 billion, an increase of $112.7 million (3.8%) over the FY2021 enacted level. As part of the FY2022 proposal for SSMS, NASA's Congressional Justification document states that the agency would increase services and content in cybersecurity—including $53.1 million to address the impacts of the SolarWinds incident at NASA—and electric vehicles—including $5 million to support transition of the NASA vehicle

[13] NASA Office of Inspector General, "NASA's Efforts to "Rightsize" its Workforce, Facilities, and Other Supporting Assets," March 21, 2018. Available at: https://oig.nasa.gov/audits/reports/FY17/IG-17-015.pdf
[14] NASA, "FY2022: Budget Estimates," May 2021. Available at: https://www.nasa.gov/sites/default/files/atoms/files/fy2022_congressional_justification_nasa_budget_request.pdf
[15] NASA, FY2022 Congressional Justification NASA Budget Request. Available at: https://www.nasa.gov/sites/default/files/atoms/files/fy2022_congressional_justification_nasa_budget_request.pdf

fleet to zero emission vehicles—in addition to maintenance of the agency's critical infrastructure.

The FY2022 budget request for CECR is $390.3 million, a decrease of $38.2 million (8.9%) below the FY2021 enacted level and would fund a number of capital repairs in the Construction of Facilities (CoF) account, including constructing the JSC Operation and Maintenance Facility, building seismic bracing at JPL, modifying the launch infrastructure at KSC for missions with the Space Launch System, and completing new antennae at the Goldstone and Canberra Deep Space Communication Complexes. However, the majority of ongoing CoF projects were halted upon closure of NASA's centers due to COVID-19 in FY2020, and NASA does not yet know the total cost associated with the halted projects; the Congressional Justification document states that, "in the absence of supplemental/recovery funds, planned FY2021 and/or FY2022 CoF projects may be deferred to ensure availability of funds for the ongoing COVID-19 recovery."

Statutory Authorities for Infrastructure Management and Partnerships at NASA

Congress has granted authorities to NASA to help the agency manage underused, or excess real property. NASA has general authority, under section 20113(c) of title 51, U.S. Code, to acquire, lease, and sell property and contract for facilities-related support services. In addition, beginning in 2003, Congress granted NASA Enhanced Use Leasing (EUL) Authority at two centers (ARC and KSC), under which NASA may retain lease revenues from lease agreements with private sector entities, state and local governments, academic institutions, as well as other Federal agencies, in areas of programmatic interest, for lease of non-excess but underutilized Agency properties. Congress expanded the NASA EUL authority to include all NASA centers in 2007, which is now codified in section 20145 of title 51, U.S. Code. With the EUL lease revenues, the agency can reduce or offset infrastructure maintenance costs, incrementally improve facility conditions, and improve mission effectiveness. According to the Report on NASA's Enhanced Use Leasing for Fiscal Year 2019, written pursuant to the NASA Authorization Act of 2008,[16] EUL agreements resulted in approximately $10.8 million in net proceeds revenue. During FY 2019 EUL agreements were active at five NASA Centers and facilities and include activities such as use of NASA Research Park at Ames Research Center, leasing of unutilized and undeveloped land in the Kennedy Space Center buffer zone to SpaceX and Blue Origin for eventual development of facilities to support their launch vehicle activities, and solar farm development at Michoud Assembly Facility.

Sustainability and Climate Change Considerations for NASA Infrastructure

According to NASA's 2020 Sustainability Report and Implementation Plan, the agency's sustainability policy is "to execute the mission without compromising the planet's resources so that future generations can meet their needs."[17] NASA's FY 2019 Energy Intensity—defined as energy consumption in British thermal units (BTU) per gross square footage (GSF)—was reduced by 41.3% from FY 2003, and by 3.2% from FY 2018.[18] NASA states that its core

[16] Section 1117 of the NASA Authorization Act of 2008 (P.L. 110-422)
[17] NASA, "Sustainability Report and Implementation Plan: 2020," June 2020. Available at: https://www.sustainability.gov/pdfs/nasa-2020-sustainability-plan.pdf
[18] *Ibid.*

strategies for making these reductions include "energy efficiency and renewable energy project implementation; operations and maintenance best practices; sustainable building design, construction, and renovation; and employee training, outreach, and awareness." For example, in FY 2018 and FY 2019, NASA completed light-emitting diode (LED) lighting upgrades at GSFC, LaRC, MAF, and SSC; AFRC and JFC upgraded heating, ventilation, and air conditioning (HVAC) equipment; and GSFC completed control upgrades to its central utility plant. NASA also requires that new facilities meet the Guiding Principles for Sustainable Federal Buildings and earn at least an LEED Silver certification. As of FY2019, NASA had 43 LEED-Silver-certified sustainable Federal buildings, representing 19.6% of the agency's total number of buildings and 23.8% of its GSF.

NASA identified, in the 2020 Sustainability Report and Implementation Plan, goals to continue reducing energy intensity in FY2020 by 1% and in FY2021 by 0.5% from FY2019 and FY2020, respectively.[19] Planned activities to increase energy efficiency and sustainability in FY 2021 and FY 2022 include: continuing to implement NASA's "Strategic Energy Investment Plan" which prioritizes projects that decrease facility costs and improve reliability; piloting the U.S. Department of Energy's (DOE) 50001 Ready Program[20] across the Agency to improve energy and water management and reduce consumption; and developing an agency-wide outreach campaign to support implementation of sustainability initiatives.[21] NASA is also aiming to reduce the overall agency facility footprint by 25-30% and, as discussed in the budget proposal, fully transition its ground fleet to zero-emission vehicles.

While NASA's sustainability efforts improve the agency's resilience to energy-related risk and reduce its energy consumption and greenhouse gas emissions, the agency's infrastructure is still vulnerable to the impacts of a changing climate. [22] As sea levels rise, along with the frequency and severity of extreme weather, including hurricanes, NASA's critical infrastructure will be at higher risk of flooding and storm-related damage.[23] This is in part because much of NASA's facilities are located on or near coastal regions, and up to two-thirds of NASA's infrastructure and assets lie within 16 feet (5 meters) of sea level.[24]

The nonprofit science research organization Climate Central assessed future flood risk at the Kennedy Space Center and found that the launch complexes—some of which date to the Apollo era, all of which are currently in use for NASA and commercial space launches—are already, today, likely to experience more flooding than in the past, and that the risk will only increase. In particular, the 2019 report concluded that "Complex 39A is estimated to face a 14% annual risk of flooding in 2020 and experience at least one flood event per year on average by 2060" and

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[19] *Ibid.*
[20] https://www.energy.gov/eere/amo/50001-ready-program
[21] NASA, "Sustainability Report and Implementation Plan: 2020," June 2020. Available at: https://www.sustainability.gov/pdfs/nasa-2020-sustainability-plan.pdf
[22] NASA, "NASA Watches Seas Levels Rise from Space, and Its Centers' Windows," November 5, 2020. Available at: https://www.nasa.gov/feature/esnt/2020/nasa-centers-on-the-coast-grapple-with-sea-level-rise
[23] Carlowicz, Michael, "Sea Level Rise Hits Home at NASA," NASA Earth Observatory Blog, August 26, 2015. Available at: https://earthobservatory.nasa.gov/features/NASASeaLevel/page1.php
[24] Rosenzweig, Cynthia, et al., "Enhancing Climate Resilience at NASA Centers: A Collaboration Between Science and Stewardship," September 1, 2014, *Bulletin of the American Meteorological Society,* Vol. 95, Issue 9. Available at: https://journals.ametsoc.org/view/journals/bams/95/9/bams-d-12-00169.1.xml

that "Complex 39B is expected to experience a 6% annual chance of flooding in 2020 and experience annual flooding by 2070."[25]

Impacts of coastal erosion, severe storms, and sea level rise are already being realized at NASA facilities. For example, NASA's Wallops Flight Facility, on Wallops Island, Virginia, has replenished eroding beaches around its launch complex five times; the cost has averaged $14 million for each restoration.[26] The Michoud Assembly Facility (MAF) in New Orleans, Louisiana, sits below sea level and was forced to shut down under the threat of six different storms in 2020 alone. Hurricane Zeta directly hit the MAF, where Space Launch System core stages manufacturing for future Artemis missions are underway, as a Category 2 storm in October. According to media reports based on statements from the MAF director, the damage to the MAF from Hurricane Zeta has only been temporarily repaired, and more resources would be needed for permanent fixes.[27]

[25] Climate Central, "Future Flood Risk: John F. Kennedy Space Center and Cape Canaveral Air Force Base," October 2019. Available at: https://www.climatecentral.org/pdfs/2019-10-21-SpaceCoastReport_Final.pdf
[26] NASA, "NASA Watches Seas Levels Rise from Space, and Its Centers' Windows," November 5, 2020. Available at: https://www.nasa.gov/feature/esnt/2020/nasa-centers-on-the-coast-grapple-with-sea-level-rise
[27] Sloss, Philip, "MAF Continues Tornado/Hurricane Recovery While Building SLS Stages Under Pandemic," *NASA Spaceflight,* March 31, 2021. Available at: https://www.nasaspaceflight.com/2021/03/maf-recovery-sls-stages-build/

Chairman BEYER. This hearing will come to order, and, without objection, the Chair is authorized to declare a recess at any time. Before I deliver my opening remarks, I wanted to note that today the Committee is meeting virtually, and I want to announce a couple of reminders to the Members about the conduct of this hearing. First, please keep their video on as—video feed on as long as you are present in the hearing. You are responsible for your own microphones. Please keep your microphones muted, unless you are speaking. And, finally, if Members have documents they wish to submit for the record, please e-mail them to the Committee Clerk, whose e-mail address was circulated prior to the hearing. So good morning, and welcome to today's hearing, "Enabling Mission Success from the Ground Up: Addressing NASA's Infrastructure Needs". I want to thank our NASA (National Aeronautics and Space Administration) witness for being with us today.

This last March many of us watched in awe as fire and smoke poured from the B–2 Test Stand at NASA's Stennis Space Center in Mississippi. The fire and smoke was expected, and part of NASA's hot-fire test of the engines and core stage of the world's most powerful rocket, the Space Launch System, SLS. It was a long-awaited milestone that was many years in the making, and the test was essential to retiring risk and ensuring the performance of the core stage in preparation for upcoming SLS flights. But getting to that critical test meant that NASA not only had to develop the SLS core stage, a challenging effort in its own right, it had to restore the B–2 Test Stand to its design condition, buildout the stand for the larger SLS stage, and complete the special test equipment interfaces, and that reconstruction effort took six years.

The B–2 story is a stark reminder of what it takes for NASA to achieve its ambitious goals of discovery, exploration, and innovation in space and aeronautics. Whether it's landing Perseverance on Mars, launching rockets, or testing experimental aircraft systems, or archiving massive amounts of Earth science data, achieving NASA's ambitious and inspiring missions require highly specialized facilities and dedicated physical infrastructure. For NASA, amazingly, that infrastructure comprises over 5,000 buildings and facilities, including those at its nine field centers, the Jet Propulsion Laboratory, and five major facilities, all located across 14 States.

However, like the B–2 Test Stand that was first used to test the Saturn 5 rocket of the Apollo era, more than 70 percent of NASA's facilities are 50 years old. Maintaining an increasingly aging infrastructure across such a vast physical footprint has been an ongoing challenge, and NASA's $2.6 billion deferred maintenance backlog is the case and point. Roads and bridges, like the Wallops Causeway Bridge that's reaching the end of its anticipated service life—someone taught me about this a long time ago, actually—the aging roof at Michoud Assembly Facility in Louisiana, HVAC (heating, ventilation, and air conditioning) and water systems, and so much more, need attention. And on top of these and other urgent infrastructure needs, NASA must also manage the impacts of climate change. The buildings battered by hurricanes, flooding, tornadoes, and the low-lying coastal facilities vulnerable to sea level rise.

In short, NASA's foundational infrastructure is cracking, and I fear we're reaching a tipping point. That's why it's essential that we prioritize investments in NASA infrastructure, especially at a time when Democrats and Republicans across the country are coming together on a commitment to new infrastructure—in NASA, we have repair, recapitalization, modernization, sustainability, and as I'm reading also even demolition, and that we do it now. Not doing so risks our future for NASA, a future that creates jobs, generated a 2019 economic impact of $64 billion, and that enables some of our most precious assets, people, innovation, and inspiration.

A 2010 National Academies report on NASA's research facilities stated "The institutional capabilities of the NASA centers, including their laboratories, have always been critical to the successful execution of NASA's flight projects. These capabilities have taken years to develop, depend very strongly on highly competent and experienced personnel, and the infrastructure that supports their research." The report underscored that NASA's research labs need to be on par with top-tier universities, corporate laboratories, and other government labs in order to sustain NASA's leadership in science and aeronautics and attract the best talent. It's clear that solving the mysteries of dark energy, finding evidence of microbial life beyond Earth, and advancing core competencies in hypersonics research will take the not only the best minds, but world-class facilities.

So in closing, when we talk about NASA's infrastructure needs of today, what we're really talking about is NASA's innovation potential of tomorrow. That innovation has profound implications for our economic growth, our workforce, and our international standing. And, as we know from examples like the cell phone cameras we use constantly, NASA's innovation holds the potential promise of breakthroughs that can literally change our lives for the better, every day. I look forward to working with my colleagues on the Committee and in Congress to address NASA's urgent infrastructure needs, and doing so now.

[The prepared statement of Chairman Beyer follows:]

Good morning, and welcome to today's hearing, "Enabling Mission Success from the Ground Up: Addressing NASA's Infrastructure Needs".

I want to thank our NASA witness for being with us today.

This last March, many of us watched in awe as fire and smoke poured out from the B–2 Test Stand at NASA's Stennis Space Center in Mississippi. The fire and smoke was expected and part of NASA's hot-fire test of the engines and core stage of the world's most powerful rocket, the Space Launch System.

It was a long-awaited milestone that was many years in the making, and the test was essential to retiring risk and ensuring the performance of the core stage in preparation for upcoming SLS flight tests.

Getting to that critical test meant that NASA not only had to develop the SLS core stage, a challenging effort in its own right, it had to restore the B–2 Test Stand to its design condition, buildout the stand for the larger SLS stage, and complete special test equipment interfaces. That reconstruction effort took six years.

The B–2 story is a stark reminder of what it takes for NASA to achieve its ambitious goals of discovery, exploration, and innovation in space and aeronautics.

Whether it's landing Perseverance on Mars, launching rockets, testing experimental aircraft systems, or archiving massive amounts of Earth science data, achieving NASA's ambitious and inspiring missions require highly specialized facilities and dedicated physical infrastructure.

For NASA, that infrastructure comprises over 5000 buildings and facilities, including those at its nine field centers, the Jet Propulsion Laboratory, and five major facilities, all located across 14 states.

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Roads and bridges, like the Wallops Causeway Bridge that is reaching the end of its anticipated service life, the aging roof at Michoud Assembly Facility in Louisiana, HVAC and water systems, and so much more, need attention.

And on top of these and other urgent infrastructure needs, NASA must also manage the impacts of climate change-the buildings battered by hurricanes, flooding, and tornadoes, and the low lying coastal facilities vulnerable to sea level rise.

In short, NASA's foundational infrastructure is cracking, and I fear we're reaching a tipping point.

That's why it is essential that we prioritize investments in NASA infrastructure-for repair, recapitalization, and modernization, and also sustainability-and that we do it now.

Not doing so risks our future for NASA, a future that creates jobs, generated a 2019 economic impact of $64 billion, and that enables some of our most precious assets-people, innovation, and inspiration.

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The report underscored that NASA's research labs need to be on par with top-tier universities, corporate laboratories, and other government labs, in order to sustain NASA's leadership in science and aeronautics and attract the best talent.

It's clear that solving the mysteries of dark energy, finding evidence of microbial life beyond Earth, and advancing core competencies in hypersonics research will take the not only the best minds, but world-class facilities.

In closing, when we talk about NASA's infrastructure needs of today, what we're really talking about is NASA's innovation potential of tomorrow. That innovation has profound implications for our economic growth, our workforce, and our international standing. And, as we know from examples like the cell phone cameras we use constantly, NASA's innovation holds the potential promise of breakthroughs that can literally change our lives for the better, every day.

I look forward to working with my colleagues on the Committee and in Congress on addressing NASA's urgent infrastructure needs, and doing so now.

Chairman BEYER. So now let me recognize my friend Dr. Babin, from Houston, Texas, for an opening statement. Brian?

Mr. BABIN. Yes, sir. Thank you very much, Mr. Chairman. The purpose of today's hearing is to address NASA's complex infrastructure issues. NASA is one of the largest property holders in the Federal Government. They manage nine field centers and six other facilities in 14 different States. This includes $40 billion in assets, with an inventory of more than 5,000 buildings and structures. As our NASA witness will testify, many of NASA's buildings and labs are relics of the Apollo, Gemini, and Mercury era, and some even pre-date NASA to the National Advisory Committee for Aeronautics era. Indeed, 83 percent of NASA's facilities are beyond their designed life. It costs up to three times more to repair or to replace equipment after it has failed, rather than if the maintenance had occurred as scheduled. In 2013, the last time this Committee examined NASA's infrastructure, the deferred maintenance backlog was estimated to cost $2.1 billion. Well, now it is going to cost us $2.66 billion.

I proudly represent the Johnson Space Center (JSC), home to NASA's historic Mission Control Center in Houston, and many other unique national capabilities, like the Sonny Carter Neutral Buoyancy Laboratory that trains astronauts for space walks, the Experimental Impact Laboratory that studies the effects of high ve-

locity impacts into geologic materials, Ellington Field, that houses many of NASA's critical aircraft, and the Astral Materials Acquisition and Curation Office that studies materials returned from space, and the White Sands test facility that tests materials and propulsion systems. Because I represent one of the largest NASA centers, I am certainly aware of the challenges that NASA faces when it comes to infrastructure. There is no greater advocate for NASA facilities which are critical national assets.

Unfortunately, long term infrastructure and maintenance investments take a back seat to near term program and mission requirements. But failure to adequately maintain and manage infrastructure could actually compromise NASA's ability to carry out its vast array of missions, and that's why NASA Office of the Inspector General (IG) highlighted infrastructure in its 2020 report on top management and performance challenges. And rather than being an afterthought, NASA must proactively assist, and manage its infrastructure and budgets to reflect its missions and its responsibility.

To its credit, NASA has attempted to do this through various initiatives over the years. NASA developed an agency facility strategy, an agency master plan, center master plans, elevated mission support to the Directorate level, developed a mission dependency index, and a facilities condition index, conducted a technical capabilities assessment, as well as a business services assessment, and is moving toward a new NASA operating model and Mission Support Architecture Program. That's a lot of management jargon, but hopefully it will lead to efficient decisionmaking and research allocation.

Put simply, NASA should do what every family in this country does, that is to manage its budget. When a family considers new spending, they factor in the rent, the mortgage, and upkeep. NASA's fiscal year 2022 budget request calls for an overall increase of 6.3 percent. NASA's fiscal year 2022 budget request for safety, security, and mission services, which funds center maintenance and operations, is roughly three billion, a 3.8 percent increase over fiscal year 2021 enacted levels. The fiscal year 2022 request for construction, environmental compliance, and remediation is actually a 9 percent reduction from fiscal year 2021 enacted levels. If NASA's facilities and infrastructure are in need, they should be appropriately prioritized in the agency's budget request. Administration—Administrator Nelson indicated earlier this year that NASA has a list of infrastructure requirements totaling over $5 billion. But the administration has not formally requested additional funding, to my knowledge, and that means additional infrastructure funding hasn't been cleared by the Office of Management and Budget, nor has it been considered in the larger context of the Federal budget, including offsets, deficits, or additional revenue requirements.

I think that we can all agree that NASA's infrastructure is critical to its overall mission success, but it needs to be incorporated and prioritized in the formal budget process, not as an off budget wish list. Creating a budget is what every family in this country does, and I'm confident that NASA, the administration, and Con-

gress can, and must, do the same. And so with that, Mr. Chairman, thank you so very much, and I will yield back.

[The prepared statement of Mr. Babin follows:]

The purpose of today's hearing is to address NASA's complex infrastructure issues. NASA is one of the largest property holders in the federal government. They manage nine field centers and six other facilities in 14 different states. This includes $40 billion in assets with an inventory of more than 5,000 buildings and structures. As our NASA witness will testify, many of NASA's buildings and labs are relics of the Apollo, Gemini, and Mercury era, and some even predate NASA to the National Advisory Committee for Aeronautics era. Indeed, 83 percent of NASA's facilities are beyond their design life. It costs up to three times more to repair or replace equipment after it has failed rather than if the maintenance had occurred as scheduled. In 2013, the last time this Committee examined NASA's infrastructure, the deferred maintenance backlog was estimated to cost $2.1 billion. It is now $2.66 billion.

I proudly represent the Johnson Space Center—home to NASA's historic Mission Control Center, and many other unique national capabilities like the Sonny Carter Neutral Buoyancy Laboratory that trains astronauts for spacewalks; the Experimental Impact Laboratory that studies the effects of high-velocity impacts into geologic materials; Ellington Field that houses many of NASA's critical aircraft; the Astromaterials Acquisition and Curation Office that studies materials returned from space; and the White Sands Test Facility that tests materials and propulsion systems. Because I represent one of the largest NASA centers, I am certainly aware of the challenges NASA faces when it comes to infrastructure. There is no greater advocate for NASA facilities, which are critical national assets.

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Rather than being an afterthought, NASA must proactively assess and manage its infrastructure and budgets to reflect its missions and responsibilities. To its credit, NASA has attempted to do this through various initiatives over the years. NASA developed an Agency Facilities Strategy, an Agency Master Plan, Center Master Plans, elevated mission support to the directorate level, developed a Mission Dependency Index and a Facilities Condition Index, conducted a Technical Capabilities Assessment as well as a Business Services Assessment, and is moving towards a new NASA Operating Model and Mission Support Architecture Program. That's a lot of management jargon, but hopefully it will lead to efficient decision-making and resource allocation.

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Chairman BEYER. Ranking Member Babin, thank you very much for your comments. I greatly appreciate them. And now let me rank—let me recognize the Chairwoman of the Full Committee, Chairwoman Johnson from Texas.

Chairwoman JOHNSON. Well thank you very much, and I want to thank you, Chairman Beyer, for holding this hearing today on a very timely topic of NASA's urgent infrastructure needs. The Subcommittee held a hearing back in 2013 on NASA's aging infrastructure. We heard then about the risks to NASA's ability to successfully and safely achieve its ambitious missions with infrastructure that was largely dated back to the Apollo era, and was more than 40 years old. On this date in 1958, NASA was established. We knew then, as we know now, that infrastructure has to be kept to—up to date. More than 50 years old, many of the concerns from 2013 still ring true today. For example, what was $2.2 billion deferred maintenance back in 2013 has grown to be more than $2.6 billion, so NASA is falling behind, not catching up.

NASA's infrastructure needs span the spectrum. They include the mundane, but the critical, and often forgotten, utility and access systems across nine centers, and other research and test facilities. They also include the specialized and unique R&D facilities that no other entity has, including wind tunnels for subsonic and hypersonic aircraft, gigantic clean rooms, and vacuum chambers for highly sensitive interplanetary spacecraft, one of the most powerful supercomputers on the planet, neutral buoyancy tools, and countless others. Managing this vast infrastructure is made more challenging by climate change, with some of NASA's critical facilities located in coastal, low-lying regions vulnerable to sea level rise and the increasing frequency and severity of extreme weather. In my home State of Texas, Houston's Johnson Space Center saw significant flooding in 2017 from Hurricane Harvey. It's clear that NASA's infrastructure challenges need attention now if NASA is to continue to lead and succeed in achieving its inspiring and ambitious missions. That's why I'm working hard to have Congress address NASA infrastructure as part of a larger investment in the Federal R&D infrastructure.

While the path forward in Congress may not yet be totally clear, my commitment to addressing our R&D infrastructure needs is steadfast. Science, research, and innovation are our future. Without necessary core capabilities, such as facilities and infrastructure, we run the risk of constraining that future. That's not the vision I want for NASA. As I close, I want to thank our witness, Mr. Robert Gibbs, for appearing before us today, and I look forward to his testimony. Thank you, and I yield back.

[The prepared statement of Chairwoman Johnson follows:]

Good morning.

I want to thank Chairman Beyer for holding this hearing today on the very timely topic of NASA's urgent infrastructure needs.

This Subcommittee held a hearing back in 2013 on NASA's aging infrastructure. We heard then about the risks to NASA's ability to successfully and safely achieve its ambitious missions with infrastructure that largely dated back to the Apollo era and was more than 40 years old. Now, that infrastructure is more than 50 years old and many of the concerns from 2013 still ring true today. For example, what was $2.2 billion deferred maintenance backlog in 2013 has grown to more than $2.6 billion, so NASA is falling behind, not catching up.

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spacecraft, one of the most powerful supercomputers on the planet, neutral buoyancy pools, and countless others.

Managing this vast infrastructure is made more challenging by climate change, with some of NASA's critical facilities located in coastal, low-lying regions vulnerable to sea level rise and the increasing frequency and severity of extreme weather. In my home state of Texas, Houston's Johnson Space Center saw significant flooding in 2017 from Hurricane Harvey.

It's clear that NASA's infrastructure challenges need attention now if NASA is to continue to lead and succeed in achieving its inspiring and ambitious missions. That's why I am working hard to have Congress address NASA infrastructure as part of a larger investment in Federal R&D infrastructure. While the path forward in Congress may not yet be totally clear, my commitment to addressing our R&D infrastructure needs is steadfast. Science, research, and innovation are our future. Without the necessary core capabilities, such as facilities and infrastructure, we run the risk of constraining that future. That's not the vision I want for NASA.

As I close, I want to thank our witness, Mr. Robert Gibbs, for appearing before us today, and I look forward to his testimony.

Thank you, and I yield back.

Chairman BEYER. Madam Chair, thank you very much for your opening statement. At this time I'd like to introduce our witness. Mr. Robert Gibbs is the Associate Administrator for the Mission Support Directorate at NASA Headquarters in Washington, which provides institutional support to enable successful accounts of NASA mission objectives. Mr. Gibbs first joined NASA as the Assistant Administrator for the Office of Human Capital Management, and NASA's Chief Human Capital Officer in May 2017. From 2013 to 2017 he served as the Chief Human Capital Officer at the Department of Energy (DOE). And prior to becoming a member of the Senior Executive Service, Mr. Gibbs completed the nuclear training pipeline and served at sea with the U.S. Navy, completing numerous strategic deterrent patrols; and ashore at nuclear repair facilities. He's a retired Naval officer. He holds a Bachelor of Arts in Business Management from the University of Washington, and he's a Doctor of Jurisprudence from Northern Virginia's George Mason University.

So welcome, Mr. Gibbs. As you know, you have five minutes for your spoken testimony, and your written testimony, however long it is, will be included the record for the hearing. And when you've completed your spoken testimony, we'll begin with the questions. Each Member will have five minutes to question our one-person panel. So, Mr. Gibbs, you're center stage, and you are now recognized.

TESTIMONY OF MR. ROBERT GIBBS, ASSOCIATE ADMINISTRATOR FOR THE MISSION SUPPORT DIRECTORATE, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. GIBBS. Thank you, Chairman Beyer, Ranking Member Babin, and Members of the Subcommittee. Thank you for the opportunity to appear today to discuss NASA's infrastructure. We look forward to working with you to change the trajectory of NASA's infrastructure health and ensure the agency's continued prominence as a national illustration of leadership in space, exploration, technical, and aeronautic innovation. I'd like to begin by offering a backdrop for this conversation to contextualize the challenges NASA faces. When NASA was founded in 1958, public investment enabled a national vision to lead the world in space ex-

ploration and scientific discovery. Apollo era infrastructure provided a modern foundation from which we launched into space and the first humans, Americans, stepped onto the surface of the moon. Over the last 60 years NASA has continued to inspire the world, explore the universe, to learn to live and work in space, advance science, and develop technologies that improve life for everyone.

Today America has a rapidly expanding space industry, including increased commercial and international participation. NASA's role remains crucial in enabling commercial growth investing in science and engineering for responsible space activity for the global community of space faring nations. Our current missions are no less inspirational, to return humans to the Moon, establish a permanent lunar presence, and extend humanity to Mars, expand our understanding of climate science, and the human impacts on—to make engineering breakthroughs, and drive economic expansion. However, a majority of our facilities and assets are relics of the Apollo era. We are now in a state of marked obsolescence and degradation.

Chairman BEYER. Mr. Gibbs your sound keeps coming in and out. It's almost cycling. If some of the NASA technical folks could help us?

Mr. GIBBS. I mean, is this any better? Maybe I just need to lean forward a bit.

Mr. PERLMUTTER. Let's see. Just keep talking for a second.

Mr. GIBBS. How about this? I'll try two mikes. Is two mikes better?

STAFF. Sir, it's——

Chairman BEYER. Yes——

STAFF [continuing]. As if——

Chairman BEYER [continuing]. Please.

STAFF [continuing]. There's an automatic—it's as if there's an automatic gain control, and it's taking the volume up and down, so they may want to check that.

Mr. GIBBS. I'm looking at our tech guys, and we'll hopefully get this straightened out. If you can hear me, I'll continue.

Chairman BEYER. Yes, please. Continue.

Mr. GIBBS. As I was saying, this leads us to one inescapable point. NASA's infrastructure represents the single greatest threat to mission success. Approximately 82 percent of our facilities are beyond their designed life. Our annual maintenance requirements are increasing every year, and exceeding our resources. Maintenance of 5,000 plus buildings and structures has been consistently underfunded due to competing priorities resulting in the deferred maintenance of 2.6 billion referenced earlier. Historically, recent NASA budget requests constitute the absolutely essential requirements that ensure mission success, but NASA continues to carry a significant threat of infrastructure failure.

NASA has had a substantial number of critical infrastructure requirements for repair, modernization, recapitalization, new capability across the centers. These requirements represent executable infrastructure actions that NASA has assessed would go far to off-

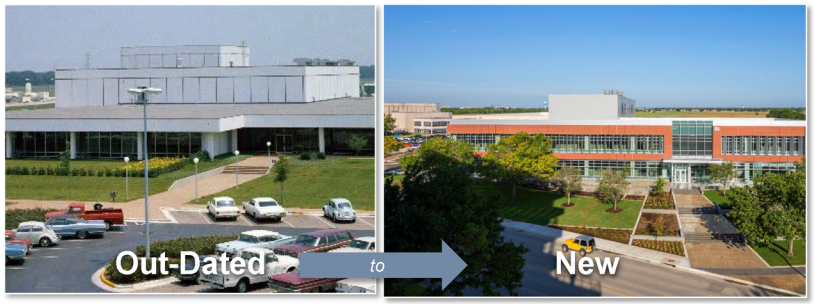
set these mounting risks and possible delays to schedule, hardware, continuing operations, and personal safety. If you could please display slide one?

[Slide one follows:]

Aging to Modern Infrastructure

Goddard Flight Projects Building

JSC Human Health & Performance Lab



Langley Measurement Systems Lab

Ames Bioscience Collaborative Facility

I want to provide some examples of the Artemis era investments we need to maintain our technical capabilities that enable these groundbreaking achievements. A hypersonic wind tunnel at Langley Research Center would enable future investments in high-speed travel and more efficient air travel. A new robotics lab at the Jet Propulsion Laboratory in California would propel NASA forward in the uncrewed exploration of Mars and other planets. We recently opened a Health and Human Performance Lab at Johnson Space Center in Texas, which provides NASA the collaborative research environment to understand impacts, and the potential of space travel. Could you please show slide two?

[Slide two follows:]

Failing Infrastructure

With Costly Repercussions

JSC
Potable Water Pipe

Rupture of a main water piper caused flooding damage and shut down facilities that support the International Space Station and Orion programs.

GRC
Transformer Fire

Electrical fire caused costly damage, threatened employee wellbeing, and closed four aeronautics test facilities critical for mission work.

AFRC
Water Main Break

Ruptured water main costs $2M in damage to the apron and shut down mission activities in the hanger, delay mission milestones.

GSFC
Wallops Causeway Bridge

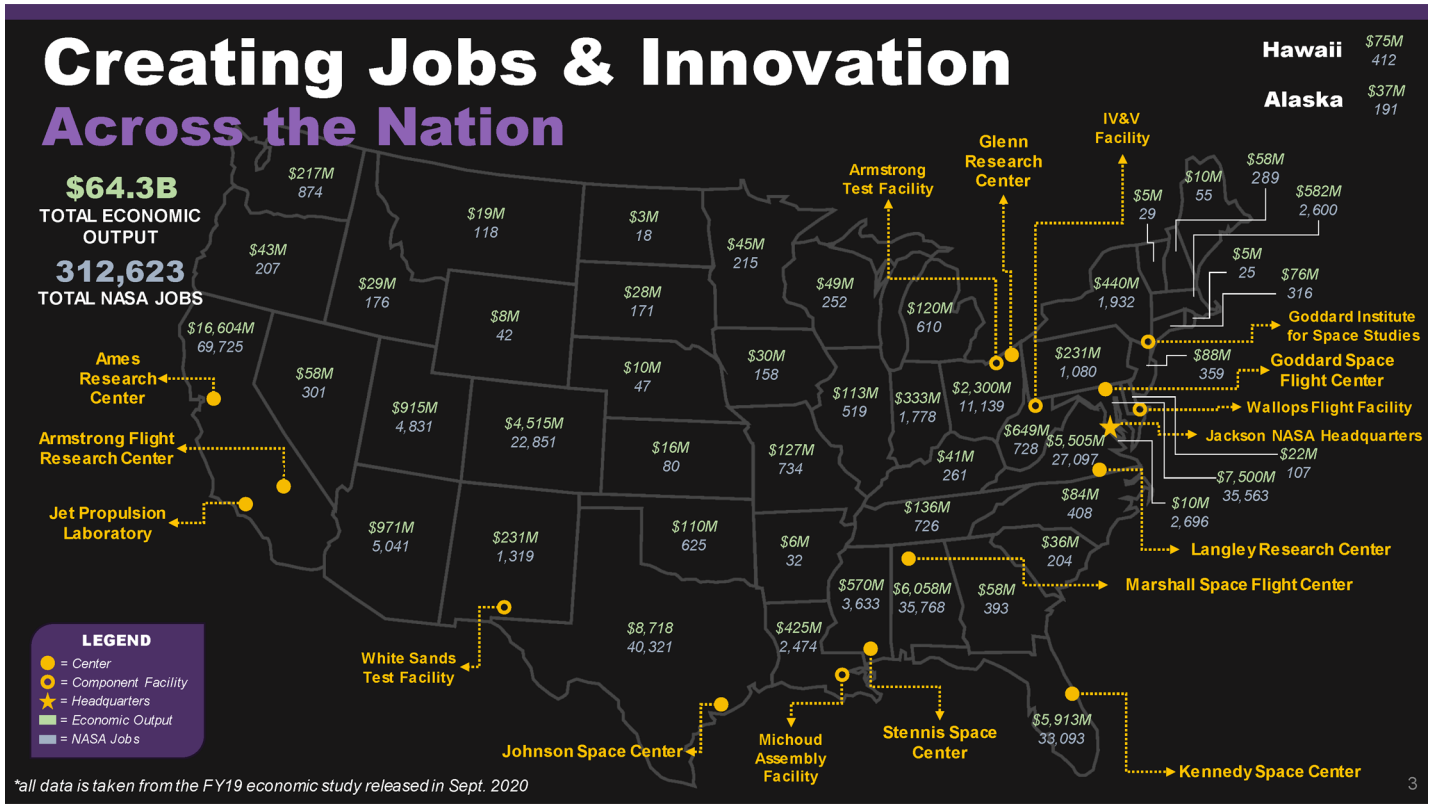
Significant degradation of the bridge, which is the only access to the launch site for ISS resupply activities, is at serious risk. Scaffolding has been erected to catch debris that falls from the structure.

Horizontal infrastructure is just as vital to NASA's operation as the specialized crane at Kennedy that assembles the space launch system. When a water main ruptures, like the one did at Johnson Space Center in 2020, mission activity halts. Timelines are delayed, and repairs are costly. Other examples include the degradation of the Wallops Flight Facility Causeway bridge in Virginia, which is the only access to the launch complex that supplies the International Space Station, and necessary site-wide infrastructure improvements to enable increased launch tempo required by NASA, DOD (Department of Defense), and commercial partners at the spaceport at Kennedy Space Center (KSC)—you'd show slide three?

[Slide three follows:]

Creating Jobs & Innovation

Across the Nation



*all data is taken from the FY19 economic study released in Sept. 2020

In closing, a greater investment is needed to modernize and build the capabilities of the future, something our commercial and international partners, our employees, and our stakeholders demand. Investing in NASA capability leads directly to scientific innovation, more efficient, more effective space travel, and development of the next generation of scientists, engineers, and astronauts. Funding NASA's infrastructure will accelerate 21st century advancements in climate science, avionics, propulsion, green technologies, miniaturization, and so much more. Given NASA's role as an—proven role as an economic driver, innovation catalyst, and jobs creator, an investment in NASA's infrastructure and next generation capabilities is an investment in American jobs and expanding the commercial markets. Thank you, Chairman Beyer, Ranking Member Babin, and the Members of the Committee and the Subcommittee, for giving me this time. I'm happy to answer any questions.

[The prepared statement of Mr. Gibbs follows:]

National Aeronautics and
Space Administration

Hold for Release Until
Presented by Witness

July 29, 2021

Committee on Science, Space, and Technology
Subcommittee on Space and Aeronautics

U.S. House of Representatives

Statement of:
Mr. Robert Gibbs
Associate Administrator
Mission Support Directorate

117th Congress

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National Aeronautics and Space Administration

before the

Subcommittee on Space and Aeronautics
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Chairman Beyer, Ranking Member Babin, and Members of the Subcommittee, thank you for the opportunity to appear today to discuss NASA's infrastructure management challenges as the Agency prepares to support the requirements of dynamic and increasing mission goals in Fiscal Year (FY) 2022 and beyond.

NASA has made bold commitments to achieve new discoveries and knowledge in diverse areas of space exploration, science, technology, and aeronautics: the continued and growing presence of humans in space aboard the International Space Station (ISS); a return to the Moon under the Artemis program that will allow humans to explore the Moon and eventually Mars; the development of cutting-edge space technologies and robotic exploration of the universe; advancements in knowledge about Earth systems and our changing climate; and continuing achievements in technology that will meet global needs for safe, efficient, flexible, and environmentally sustainable air transportation. As the Agency moves forward to meet all these inspiring and ambitious goals, NASA must have the physical infrastructure that provide the reliable and durable foundation for these efforts.

NASA must steward reliable, cost-effective infrastructure capabilities that fully support the requirements of its missions and programs. The Agency administers an inventory of over 5,000 buildings and structures, with an asset value over $39 billion. The majority of NASA's physical assets date back to the Apollo era, with approximately 83 percent of facilities beyond their design life. Over time, this has led to a total of over $2.6 billion in NASA deferred maintenance. Additionally, unplanned maintenance can consume up to 30 percent of the maintenance budget in a fiscal year, due to unanticipated disruptions, failures, and natural disasters, creating more unaddressed maintenance issues and failures. Laboratory, engineering, and testing capabilities are the bedrock of mission activities, which depend on reliable assets, including facilities, equipment, and horizontal infrastructure (water; electric; heating, ventilation, and air conditioning [HVAC]; etc.). NASA has a substantial number of critical infrastructure requirements – for repair, modernization, recapitalization, and new capability – across the NASA Centers. These requirements represent executable infrastructure actions that NASA has assessed would go far to effectively offset mounting risks to NASA mission schedules and hardware, continuing operations, and personnel safety. To ensure America's preeminence in aerospace, science, technology, and exploration, addressing and sustaining NASA's infrastructure is paramount.

Infrastructure Funding

NASA's infrastructure funding is divided between two accounts: Safety, Security, and Mission Services (SSMS); and Construction and Environmental Compliance and Restoration (CECR). SSMS provides for the maintenance and management of assets and infrastructure, including some repairs and responses to disruptive events, such as pandemics and natural disasters. CECR provides for the repair of failed or failing assets to restore functionality, modernization to upgrade outdated facilities, recapitalization to replace and consolidate degraded facilities, and the construction of new capabilities. All projects drive down NASA's environmental burden and operational costs through the reduction of NASA's substantial footprint (by consolidation and demolition) and the building of sustainable, Leadership in Energy and Environmental Design (LEED)-certified structures.

Balancing maintenance, management, and construction activities between these budgets is necessary to support Agency health and the long-term sustainability of NASA assets. In a constrained appropriations environment, SSMS and CECR have a symbiotic relationship that must stay in balance for NASA to sustain its critical infrastructure. As the balance shifts, SSMS projects are deferred or simple maintenance projects may become complex construction and repair projects. As one or both budgets decrease, the risk to NASA's mission increases, with unplanned infrastructure failures becoming inevitable.

With consideration for affordability, NASA uses risk assessments and life-cycle cost analysis to prioritize critical repairs, and balance these against strategic investments that will modernize facilities and reduce operating costs. Using established tools and indices, NASA assesses the age and condition of individual facilities; the cost to sustain them; and their potential for associated risks to missions, safety, and the environment.

Agency Master Planning

NASA is enhancing its infrastructure planning with the establishment of the Agency Master Plan (AMP), which integrates the Center master plans into a single, cohesive strategy for infrastructure investment, divestment, and sustainment. In addition to utilization metrics and facility conditions, the new planning process uses a Mission Relevance Index to better understand the true mission connection of each asset, including facilities and horizontal infrastructure. The AMP will establish a 20-year vision for physical infrastructure and real property assets that aligns to evolving and future mission requirements. NASA will use this process to identify critical capabilities and areas for asset sustainment, investment, or divestment throughout the Agency, as well as to evaluate and leverage other Federal agency and private sector assets when available.

The master planning process is driven from mission needs but is supported by Center conditions and requirements. By integrating its infrastructure portfolio in this way, NASA is able to better prioritize, sustain, and divest assets, leading to a more affordable, efficient, and overall reduced footprint. Given that Center master plans must respond to changing circumstances, the process is an essential, continuing strategic tool for aligning real property assets with evolving mission requirements and technical capabilities needs. Evolving strategic circumstances, such as resource levels and a growing understanding of the nature and severity of potential climate and extreme weather risks, are critical factors in assessing the suitability of Center master plans over time. The Agency periodically reassesses master plans to ensure that they address NASA's most critical needs within its budget authority. The AMP, expected to be published in 2022, will include specific goals and objectives focused on climate risks and adaptation, and will clearly demonstrate NASA's commitment to integrate climate risk management into Agency management processes and tools.

NASA Maintenance

NASA utilizes funding provided in SSMS to sustain and maintain existing facilities. Maintenance projects include ongoing care, evaluation, and routine upgrades that can help to mitigate expensive repairs and failures and prolong the design life of facilities and systems. Ongoing maintenance is important to protect critical capabilities, mitigate safety and health risks, and sustain assets over the long term, particularly for institutional infrastructure such as electrical, mechanical, life safety, and utility systems. Deferrals of regular maintenance increase the risk of more costly and unplanned repairs in the longer term.

In FY 2022, NASA will invest in improvements to mitigate systemic arc-flash issues in electrical systems across the Agency, as well as invest in Condition-Based Maintenance (CBM). CBM utilizes sensors to detect anomalies before they become failures. CBM's Online Condition Monitoring, coupled with Predictive Testing and Inspection, enables our workforce to provide the right maintenance at the right time. This approach, paired with immediate investments in the replacement of obsolete items for the Agency's higher-criticality assets, can provide corrective mitigation for known risks and avoid mission/schedule impacts. These strategies will focus on increasing asset availability while creating repair cost avoidance that can be reinvested back into the maintenance program, driving NASA toward greater affordability in the long term.

NASA Construction

NASA's CECR budget provides for the construction and repair of infrastructure, including energy-saving projects that reduce the Agency's operating costs and environmental burden. CECR also provides for demolition of unneeded facilities, including those that have fallen into severe disrepair. Demolition is directly linked to construction activities and is critical to reducing the Agency's infrastructure footprint and reaching NASA's environmental goals. The majority of NASA's construction budget, however, is spent stemming the tide of age and degrading support infrastructure.

NASA construction projects, including horizontal infrastructure such as roads and utilities, span mission areas and enable the work of the Agency's Centers. CECR is comprised of both institutional funding for Center-wide or foundational infrastructure, as well as program-specific infrastructure, like the unique testing or assembly facilities associated with individual missions. These facilities support specialized capabilities, some being one-of-a-kind, and are vital for the manufacturing, testing, processing, or operation of hardware. To meet mission requirements, construction projects may involve modification of existing technical capabilities essential to the success of NASA programs. These project lists are dynamic, as they evolve with emerging needs and shifting mission priorities.

NASA's construction budget focuses on the following distinct categories:

***Repairs*:** Repair projects are those undertaken to address immediate needs to fix problems, damage, or failures that inhibit operational capability and impact mission success. Generally completed within one to two years, these projects predominantly include necessary upgrades to aging horizontal infrastructure, building systems and projects that address safety risks, such as arc-flash mitigation projects or earthquake hardening. Repair projects are identified by observation of recurring system failures, breakages, and increasing maintenance costs. Over the past 10 years, NASA has seen a significant increase in the number of repair projects – including electrical, water, stormwater, mechanical, and fire safety – that address degraded horizontal infrastructure and building systems needed to support critical mission capabilities.

In FY 2022, a key NASA repair project includes the 22-kilovolt (kV) upgrades to the electrical distribution system at the Langley Research Center (LaRC) in Virginia. This project completes the

underground infrastructure for the final two 22kV loops in the Center's site-wide electrical distribution system, and corrects the persistent failures that are caused by obsolete design and equipment. Other repair examples include the Utility Control System Risk Reduction project at the Marshall Space Flight Center (MSFC) in Alabama, and the Repair Center-Wide Fire Systems project at the Armstrong Flight Research Center in California. NASA will also undertake the final phase of work to upgrade the safety and reliability of institutional power systems at Kennedy Space Center (KSC), and will replace potable water storage and tanks to ensure reliable potable water supply for Center-wide operations at the Johnson Space Center (JSC) in Texas. At the Jet Propulsion Laboratory in California, NASA will replace the electrical substation to address vital electrical needs and improve reliability, and undertake seismic bracing to protect equipment, assets, and research against earthquakes.

Renewal: NASA facilities renewal projects address the strategic sustainability of NASA infrastructure for the longer term through modernization, recapitalization, the construction of new capability and/or consolidation tasks. These include major repair-by-replacement or refurbishment efforts that result in a full retirement of risk associated with obsolete structures and systems, and effectively align with NASA's facilities master planning goals. Renewal projects often engage demolition and construction efforts for removal and replacement of structures, and generally take longer to complete (more than three years).

Renewal projects replace old, obsolete, failing facilities with sustainable, flexible, energy-efficient facilities that often consolidate functional use and improve work efficiency and collaboration. In FY 2022, a key NASA renewal project is the Operations and Maintenance Facility at JSC. This new construction project consolidates the functions of 28 1960s-era outlying metal buildings into a single operations and maintenance facility. With the construction of this 63,000-square-foot facility, approximately 100,000 square feet of existing building will be demolished, resulting in a reduction in deferred maintenance, a significant footprint reduction, energy savings, and cost avoidance due to reductions in operations and maintenance.

NASA will also continue upgrades and modifications to various facilities at KSC, including the Launch Control Center, Booster Fabrication Facility, and Vehicle Assembly Building, in support of the Artemis Program, specifically the Space Launch System (SLS) activities. NASA will continue the phased replacement of the Building 103 roof at the MSFC Michoud Assembly Facility in Louisiana. The Building 103 facility is home for the production and assembly of the SLS core stage. This work will advance hardening of the roof of this almost-80-year-old deteriorating building, which has been subject to hurricanes and a tornado, against further extreme weather.

Energy Savings Projects: NASA invests in projects that reduce energy consumption, improve energy efficiency, reduce utility bills, and, where possible, increase renewable energy production. Energy savings projects help mitigate the risk to NASA missions and operations from rising energy costs and improve the ability to monitor and control consumption. At NASA Centers, these projects often include installation upgrades or efficiency improvement measures to existing operational systems, such as HVAC and energy monitoring and control.

In FY 2022, NASA will invest approximately $8 million on energy-savings projects that will avoid an estimated $1.2 million in utility costs. These projects support NASA's dedication to environmental stewardship and efficiency. Specific projects include the construction of a second thermal energy storage tank at MSFC, and an upgrade of the energy monitoring and control system at the Glenn Research Center in Ohio.

Demolition and Disposal: Demolition is an integral element of the Agency's facilities management strategy. Demolition and disposal of obsolete, unneeded infrastructure is one of the most direct and effective ways to reduce facilities burden, deferred maintenance, and operations and maintenance costs. Demolition is critical to reducing risk to NASA's missions posed by safety or environmental liabilities.

NASA has achieved a five-percent reduction in footprint since 2015, and is projecting another ten-percent reduction by 2024 with sustained CECR budgets. In 2021, NASA demolished or disposed of 29 facilities, resulting in a reduction of 845,000 square feet, eliminating approximately $138 million in current replacement value and approximately $12 million in deferred maintenance. Under current budget authority, NASA maintains a five-year backlog of demolition projects and re-assesses its demolition requirements annually, adjusting priorities to ensure mission success. In FY 2022, NASA plans to spend an estimated $15 million to demolish approximately 11 facilities totaling more than 253,000 square feet, including the Research Laboratory and the Pearl Young Conference Center at LaRC.

NASA also reduces its operational and environmental burden by transferring assets to other agencies or disposing of them through the Federal Facilities Disposition process administered by the General Services Administration, when the circumstances meet the applicable regulatory and strategic thresholds. NASA will continue to explore the disposition of land and structures through sale, when it is economically feasible, to reduce leased space from its inventory.

Facilities Disposition: Depending upon the utilization profile, physical circumstances, and the outlook for future mission needs, NASA pursues available options for leasing facilities that are underutilized. NASA's complement of Federal out-grant authorities, such as the National Aeronautics and Space Act ("Space Act") and the National Historic Preservation Act, offer flexibility to the Agency in finding paths for the reutilization of facilities that would otherwise be subject to disuse, decay, and rising maintenance costs.

NASA has found particular utility in its Enhanced Use Leasing (EUL) authority provided by amendments to the Space Act. NASA's EUL authority enables the Agency to enter into out-lease agreements with commercial, academic, or other nongovernmental entities for use of NASA underutilized facilities. NASA may collect and retain fair-market-value proceeds from these leases, which may be used for maintenance, capital revitalization, and/or improvements to real property assets. By entering into EUL agreements with public and private sector entities, currently underutilized NASA facilities may be leveraged into more productive properties, maximizing asset utilization and mitigating NASA property maintenance and repair costs. NASA is presently engaged in 70 EULs at six NASA Centers. NASA's current EUL authority expires on December 31, 2021.

Environmental Compliance and Restoration

NASA's budget supports the Environmental Compliance and Restoration (ECR) program, which cleans up hazardous materials and waste products that have been released to the surface or groundwater at NASA installations or associated facilities. These include current or former sites where NASA operations have contributed to environmental problems, and other sites where the Agency is legally obligated to address hazardous pollutants.

All NASA Centers and supporting facilities have some level of clean-up activity. NASA prioritizes these cleanups to protect human health and the environment, and preserve natural resources for the future, with the greatest priority on sites impacting neighboring communities. NASA's FY 2022 budget request for ECR is $74.7 million to continue support for a portfolio that includes 134 cleanup projects at NASA Centers. NASA continually strives to minimize impacts on its surrounding communities, and in accordance with applicable regulations and the Administration's Environmental Justice priorities, communicates with and provides opportunities for community feedback during the cleanup processes.

The ECR program addresses a variety of chemical pollutants that have been associated with NASA's long history of space and aeronautics hardware development and flight operations. Further, the ECR program encompasses proactive efforts in the area of emerging chemicals of concern, such as per- and

polyfluoroalkyl substances (PFAS). The Agency has undertaken work to begin a Preliminary Assessment effort, under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines, to identify areas of potential concern for the presence of PFAS at all NASA Centers. The first phase of this assessment process, which is based on historical and administrative records reviews, will conclude toward the end of Summer 2021, and transition to a second phase of Center site investigations and sampling. NASA looks forward to communicating with the Subcommittee about the early results of its PFAS efforts when information is finalized.

In FY 2022, NASA will continue cleanup activities at all of its Centers, with priority given to protecting public health and the environment and conforming to environmental regulations and statutory requirements. In particular, NASA will continue to conduct essential cleanup work at the Santa Susana Field Laboratory (SSFL) in California, including planned demolition of test stands, ongoing groundwater cleanup and treatment, and long-term air and groundwater monitoring. This effort continues as NASA awaits the Department of Toxic Substances Control's (the State of California's regulator) finalization of their Program Environmental Impact Report and publication of their Notice of Determination. NASA's unwavering commitment at SSFL is to undertake and complete a cleanup that is based in science and protective of public health and the environment.

Conclusion

To maintain its benefit and capability as a national symbol for progress, discovery, and science, NASA must have the enabling technical infrastructure capabilities and facilities necessary to efficiently and effectively support its programs. The decline of NASA's infrastructure and reliance on degraded, Apollo-era facilities is the single greatest threat to mission success.

NASA's FY 2022 budget request reflects encouraging support for NASA's mission goals by the Administration. NASA infrastructure funding is an essential part of the equation to provide safe and efficient, healthy facilities to support the continued success of those missions in the future. Investment in NASA's infrastructure ensures America's leadership in human exploration, scientific research and discovery, and technology advancement. At a moment of increased international competition, industry participation, and global interest in space, full support for NASA's FY 2022 SSMS and CECR budgets provides vital investments in the foundation of the Nation's preeminent space program that will advance national interests, scientific benefit, and technological innovation.

We look forward to working with Congress to address these important requirements for continued mission success. In conclusion, I thank the Subcommittee for the opportunity to testify before you today. I would be happy to answer any questions that you may have.

Robert Gibbs, Associate Administrator for the Mission Support Directorate

Robert Gibbs, Associate Administrator for the Mission Support Directorate
Credits: NASA/Joel Kowsky

Mr. Robert (Bob) Gibbs is the Associate Administrator for the Mission Support Directorate (MSD) at NASA Headquarters in Washington. Gibbs joined NASA as the assistant administrator for the Office of Human Capital Management and NASA's chief human capital officer in May 2017. In this role, Gibbs had stewardship responsibility for NASA's workforce and for carrying out responsibilities in accordance with the Chief Human Capital Officers Act of 2002. His responsibilities included: setting the agency's workforce development strategy; assessing workforce characteristics and future needs based on the agency's mission and strategic plan; aligning the agency's human resources policies and programs with organizational mission, strategic goals, and performance outcomes; and, serving as a member of the Office of Personnel Management-led Chief Human Capital Officers Council.

From 2013 to 2017, Gibbs served as the chief human capital officer at the Department of Energy, where he was responsible for implementing agency-wide efforts on shared services, accountability, engagement and human capital transformation.

Prior to becoming a member of the Senior Executive Service, Gibbs completed the nuclear training pipeline and served at sea onboard the USS. Daniel Webster, the USS Henry L. Stimson and USS Simon Bolivar, completing numerous strategic deterrent patrols; and ashore at nuclear repair facilities including the Trident Refit Facility, Bangor, Maine, and the Washington and Naval Reactors Headquarters.

His assignments at Naval Reactors, a joint Department of Energy and Department of Navy program, included positions in the Office of Resource Management, ultimately serving as director of navy budgets and selection by Adm. F. L. Bowman to serve as director of civilian programs. While still on active duty, he was selected by Adm. K. H. Donald to serve as director of management and administration. In that capacity, he was responsible for management, personnel, and support programs and policies. He has led several enterprise-wide initiatives (total force management, succession planning, pay for performance, industrial relations, outreach and enterprise consolidation) to structure the workforce to meet current and future requirements in a challenging and diverse environment across two federal agencies and multiple field offices.

Gibbs was born and raised in Boston. A retired naval officer, he holds a Bachelor of Arts in business management from the University of Washington and a Doctor of Jurisprudence from George Mason University. He is a member of the Maryland and American bar associations. Gibbs is the recipient of numerous military awards and citations. He resides in Southern Maryland with his wife and four children.

Chairman BEYER. Mr. Gibbs, thank you very much. It's fascinating to look at your map, and realize that—more than 5 billion in NASA investments in Virginia, which I represent, and Alabama, with Mr. Brooks, Florida, with Mr. Posey, over 4 billion in Colorado, with Mr. Perlmutter, and over 16 billion in California. Poor New Jersey is left out. Let me begin.

Mr. Gibbs, Mr. Babin talked about, you know, how families plan their budget, and how we shouldn't be, you know, doing emergency off the books funding for something like this. I notice that your 2.6 billion number, that's roughly 7 percent of the 39 billion in asset value of NASA. Are we in a different period now? Why is there a crisis at this time, looking back at budgets over the last five, 10, 15, 20 years? Have—has NASA structurally failed to ask for the right amount of money to keep up this infrastructure on an ongoing basis?

Mr. GIBBS. So I think I——

Chairman BEYER. You see where I'm going with this? OK.

Mr. GIBBS. Yeah. Yes, sir, I do. I do see where you're going with this, and I think it's a very fair question. You know, for 10 of the last 12 years we—our budget that we have received has been less than what we have asked for. You know, with an aging infrastructure, as we have at NASA, this becomes a—sort of a circular problem, right? You can't invest to maintain your aging infrastructure, it gets older, you need more money to invest, you have less dollars, and it goes around like that. I do think that we are at a critical point right now with infrastructure. I'm concerned. It's what keeps me up at night. My portfolio has a lot more than infrastructure in it, and I will tell you, I am concerned.

Chairman BEYER. Great. Thank you. When we had Senator Administrator Nelson here in May, he suggested a number like 5.4 billion in infrastructure needs. What's the gap—the doubling between the 2.6 that we typically use for NASA and Senator Nelson's 5.4?

Mr. GIBBS. So deferred maintenance and the $5.4 billion investment portfolio are slightly different things. If we were to receive those additional funds, it would retire a majority, or a substantial majority, of the deferred maintenance. But the 5.4 is looking at—across the entire complex of NASA, driven by the mission. You know, what are the things that we need to invest in to make our mission successful not only today, but going forward? What is the facility, the infrastructure, all the investments we need to make?

It falls into categories like modernization. Where do we need to build new capability? We talked a little bit about the hypersonics tunnel. I think that is a new capability that should be a national capability, and work for the Department of Defense. We talked about recapitalization, modernization, and repair, so it's bringing all of these facilities back up to acceptable standards. I think that's the way I would address that, Mr. Chairman.

Chairman BEYER. Thank you. Yeah, Mr. Gibbs, the 2010 National Research Council report I had mentioned raised significant concerns about the research laboratories. Are we yet at the point where the infrastructure is an impediment to scientific progress and discovery?

Mr. GIBBS. I think we're able to continue with scientific discovery, but that point where infrastructure is going to start limiting mission is around the corner. I think it's in the very near future for us, is how I'd answer that, sir.

Chairman BEYER. OK. One small point. You—in your written testimony you talked about mitigating systemic arc flash issues in electrical systems. Are these—is this a new problem, or is this—are the arc flashes something we've been dealing with for a long time?

Mr. GIBBS. It's a problem that has existed for a period of time. I mean, when you're talking about arc flash, you're talking about electrical explosions, when you have a low impedance to ground on energized equipment. It has gotten worse as our electrical infrastructure has aged. You know, now it requires—you can't work on energized gear. You have to de-energize systems, sometimes laboratories, or structures, or parts of our centers, in order to work on this gear. So it is a personnel safety issue. It has an unpredictable failure rate, or failure mode, so we have to be, you know, putting personnel safety first. It requires us to take additional steps, and those steps are required more often right now.

Chairman BEYER. I seem to recall six and a half years ago we had an arc flash in the Metro tunnel here in Washington, DC. that killed someone. One last question. I was fascinated that there were 134 cleanup projects— service or groundwater installations, hazardous wastes. How are we doing in our responsibility to those 134 communities?

Mr. GIBBS. You know, we put public safety and protecting the environment as one of our greatest priorities. The budget that we have in '23—'22 is enough to maintain our fiscal responsibilities, our statutory responsibilities, in these facilities. You know, we talked a little bit about the Wallops bridge. There has been an issue—Wallops and Chincoteague—in the water supply, and I think we've done a very good job of installing water filtration equipment, providing the town with clean drinking water, monthly sampling, which is showing no results of any contaminant, and doing all of these things, and digging new wells, as a way to sort of ensure that we hold up our end of the environmental questions that face the agency.

Chairman BEYER. Mr. Gibbs, thank you very much. Let me now recognize the Ranking Member, Mr. Babin, for his questions.

Mr. BABIN. There it is. OK. Thank you very much, Mr. Chairman and Mr. Gibbs. Thank you for being here. We appreciate you. And my question, as I mentioned in my opening statement, there at JSC in Houston is home to the Astral Materials Acquisition and Curation Office. As NASA plans to develop the Mars Sample Return Mission, there's an ongoing debate over where the returned samples will be processed and housed. At a hearing earlier this year, NASA scientists indicated that they had not decided as of yet on that location. From an infrastructure perspective, does it make sense to build a new capability somewhere else, rather than utilizing existing facilities, particularly when NASA already has an infrastructure backlog?

Mr. GIBBS. So, to answer your question directly, JSC, Johnson Space Center, is the center that owns the Mars sample curation,

right? The sample return program. I don't think we have come through where that facility is going to be located yet.

Mr. BABIN. OK. Well, is NASA planning to use the existing infrastructure at JSC to support this mission? Or where—what are some of the thoughts there among those who are making this decision?

Mr. GIBBS. Sir, I'd have to take that for the record and talk with my science colleagues. I do know at this point we haven't made a decision as an agency.

Mr. BABIN. OK. Well, NASA released a request for proposals for space suits this week. The Johnson Space Center maintains the Nation's space suit and the extra-vehicular activity (EVA) expertise. How much funding does JSC receive for infrastructure from the Human Exploration Mission Directorate to fund space suit and EVA facilities?

Mr. GIBBS. I apologize that I'll have to take that for the record. I do not control the HEO (Human Exploration and Operations) Program budget for space suits that is—that—developed and maintained at Johnson.

Mr. BABIN. OK. Well, I want to hear your opinion, then. If NASA outsources space suits and EVA capabilities, will JSC's budget to maintain the facilities be covered through the Safety Security Admission Service Account to offset any funding shortfalls caused by the acquisition strategy?

Mr. GIBBS. So at this point I have no intention of lowering the budget of Johnson, if that answers your question.

Mr. BABIN. OK. Were additional costs to maintain the critical infrastructure necessary to enable EVAs, and space suit development and training, considered in any cost-benefit analysis of acquisition or purchase to determine the best value for the taxpayer?

Mr. GIBBS. Again, I apologize, but I'd have to take that for the record and talk with our procurement folks. My gut tells me yes. We go through a very in-depth analysis as we work through all procurement opportunities. But I don't——

Mr. BABIN. OK.

Mr. GIBBS [continuing]. Know that for a fact.

Mr. BABIN. OK. How does NASA ensure that such a cost-benefit analysis is an apples-to-apples comparison? I can envision a scenario where a service contract would be cheaper at face value, but when—when the necessary NASA facility and infrastructure costs are accounted for, though—the overall taxpayer cost is larger if facilities are not decommissioned.

Mr. GIBBS. Yeah. I will tell you—I'll answer that very generically, that—I will tell you, as we go through these propositions, we spend a lot of time to ensure that we have accuracy in our data. When we're looking at procurement opportunities, we look at total life cycle costs. All in, what do they cost us to procure this activity or this service? Additionally, what we have are folks from across the agency with multiple stakeholders sitting in with us as we go through these procurement and other decisions to ensure that all the folks that are impacted by these decisions get that voice heard. And we have a pretty strong group, honestly, that do this—that does this work at the agency.

Mr. BABIN. OK. The NASA IG semi-annual report to Congress recently highlighted the fact that a recommendation from 2013 has still not been implemented by NASA. The recommendation states, "Ensure life cycle and milestone reviews, incorporate programmatic and technical risks, and are conducted with the Associate Administrator for Human Exploration and Operations Mission Directorate, and other senior agency officials." Why hasn't NASA implemented this recommendation?

Mr. GIBBS. I'd have to take that for the record, sir.

Mr. BABIN. OK. Well, can you ensure that NASA provides a response to these questions for the record, if you don't mind? We would greatly appreciate that, seeing the answers to these.

Mr. GIBBS. Yes, sir. Happy to do so. Thank you for your questions.

Mr. BABIN. OK. Thank you. Mr. Chairman, I yield back.

Chairman BEYER. Thank you, Mr. Babin, very much. And I recognize the Chair of the Full Committee, if our Chairwoman is still here. If she was here, but if she is not, then let me recognize Chairwoman Zoe Lofgren. Not Chair of this Committee, but Chair of lots of other things. So, Ms. Lofgren, the floor is yours.

Ms. LOFGREN. Thank you very much, Mr. Chairman, and thanks for holding this hearing. Obviously we have infrastructure needs throughout this agency, and no matter where those infrastructure needs, it matters to all of us because it's the science mission that drives our decisionmaking. But I do want to mention the Ames Research Center. It's not in my district, but it is in the county I represent, and it is the second oldest NASA center. It's my perception that the infrastructure needs has sometimes fallen off the priorities, and a sense that one of the biggest barriers to funding is the lack of strong advocates at the top of the agency.

Now, that could be that, you know, other centers are dominated by specific programs, for example Earth science or aeronautics. Ames is a blend of smaller programs across all the divisions, and so that kind of advocacy is diffused. I'm wondering what kind of evaluation we are going to use so that a program like Ames doesn't get lost in the dust, if you will, what kind of objective evaluation is going to be used. And, Mr. Gibbs, I thank you so much for your advocacy. You know, it's possible, we hope not, that not every priority will be funded. If there's not 100 percent funding, how are you going to prioritize what gets funded?

Mr. GIBBS. Thank you, ma'am. I appreciate your question. First, on the concept of—I—how do we make all these things work, right, across the agency? We have a lot of competing priorities, a lot of competing needs, and in a limited resource environment, it's tough. I'll just tell you, frankly, this is a tough problem to solve. We have an agency master planning process which we have stood up in the last year which involves representatives from all of the mission directorates that come in and say, here are our requirements. It involves all of the centers saying, here are our capabilities. And then we take a look at those things and say, OK, across our infrastructure portfolio, how do we put these things in buckets? Fundamentally, what are the things we absolutely know we need today and tomorrow to complete our mission? So those—that's one bucket we can set aside. What are the things that we know we don't need,

that should be on our demo list? Let's put that aside. Now let's really focus on those things in the middle that could possibly be out grants, using enhanced use lease (EUL) authority, where, you know, it's things we could just maintain at a very minimal funding level, so that way we can continue to stretch our dollars to the greatest extent possible.

I will tell you that I think Ames has pretty good representation within the agency, and its importance to the overall agency mission, I think, goes without question, if that——

Ms. LOFGREN. Well, I appreciate that. And so many of the scientists there, you know, some live in my district, and I'll tell you, it's tough, because, you know, Ames is located in the middle of Silicon Valley. You've got kids walking out of college that are earning two or three times what those scientists are earning, and they stay there because of their commitment to the mission, and I really respect that, and I appreciate what they are doing, and we need to make sure that their service and sacrifice is honored in every way possible.

I'm wondering, Mr. Gibbs, would it be possible to share that document that you've just described so the Committee can understand the thinking of the agency as you sort through the very challenging decisions you need to make?

Mr. GIBBS. Yeah. We're very happy to work with the Committee and get you the information you need.

Ms. LOFGREN. I would love to see that. Mr. Chairman, thank you so much for holding this hearing. I think it's essential, and, you know, as we know, it's already—the national—pardon me. The National Research Council has already deemed NASA's infrastructure needs to be, you know, trailing NSF (National Science Foundation) and other facilities, DOE, university facilities. We really can't permit that to continue, and I appreciate your leadership, and that of the Chair and the Ranking Member, to make sure that that changes. And, with that, Mr. Chairman, I yield back.

Chairman BEYER. Thank you very much, Ms. Lofgren. I now recognize the Chairman from Cape Canaveral—or the Member from Cape Canaveral, Mr. Posey.

Mr. POSEY. Thank you very much, Chairman Beyer, for holding this hearing addressing NASA's urgent infrastructure needs. Great to have you here, Mr. Gibbs, and great to see NASA making great strides that it has made in regards to its operation. I remember when the legislature appropriated a few million dollars for a life sciences lab, it took I think something like 3 years for NASA to get it together and come up with a lease to offer them. Wow, what a paradigm swing we've seen since those days, which I most notably observed through the leadership of Bob Cabana at KSC, and I'm sure Janet Pepco will do just as great a job.

Between the civil and commercial space launches at Kennedy Space Center, it puts a tremendous strain on its existing infrastructure, as you mentioned. This is sometimes maybe a good thing that we're doing so well, but we should work to address the needs that would meet a higher launch cadence at Kennedy Space Center. This means increasing high-flying capacity, and adding wider roads to accommodate the transportation of the next generation vehicles, as you well know.

The State of Florida has been forward leaning on addressing the infrastructure challenges with some funding, and after the cancellation of the Shuttle Program the Kennedy Space Center pivoted to supporting not only space flights, but also the commercial sector array. KSC repurposed critical national capabilities like the vehicle assembly building, and the crawler transporter, and made other underutilized facilities, like the orbiter processing facilities and launch pads, available for commercial users. My question is, as the commercial space sector grows, how can NASA best leverage the unique partnership it has with Space Florida to maintain its infrastructure that is key not only to NASA, but to the State of Florida?

Mr. GIBBS. Yeah, I—thank you, sir, for your question. I think that's a great partnership. You know, the Indian River Bridge, we worked with the State of Florida, Space Florida, the Florida Department of Transportation, and the U.S. Department of Transportation and their INFRA (Infrastructure For Rebuilding America) grant Program to be able to recapitalize the bridge. Right now NASA is paying to relocate all of the utilities at the Indian River Bridge. Construction will begin later this fall, with completion by 2025. So that's a great example of Florida working with NASA to achieve that joint sort of program of expanding the space industry.

I will also tell you that we are going to have to make additional infrastructure investments at KSC to support this increased launch tempo. 2021 is going to see the most launches NASA has ever done, and that pace is expected to continue through '24 or '25. We have to make commensurate investments in infrastructure to be able to support commercial, DOD, and NASA's launches in the future.

Mr. POSEY. You know, I understand that KSC submitted a construction of facility request for Fiscal Year 2022 of 63.8 million, but only 33.3 million was approved for inclusion in the President's budget request, a request to build a new Hybrid platform of 22–1/2 million, and the RL–10 engine shell down at eight million to support the SLS. Block 1–B were both rejected, unfortunately. Do you know why the infrastructure projects associated with SLS Block 1–B were not supported?

Mr. GIBBS. Yes, sir. I—so that is a Human Exploration Operations Program funded line item. That's what they're funding. But I will tell you, again, it's the same symptom of limited resources. You have to measure those resources across the agency in order to meet requirements. Now, I think those were not necessarily declined. I think they were deferred to later progress, but I'd have to check with our HEO Program folks to make sure I'm giving you the accurate information.

Mr. POSEY. OK. Do you know if there's other plans to address the shortfall?

Mr. GIBBS. I do not. I do not.

Mr. POSEY. Thank you, Mr. Chairman. I see my time is about to expire. I yield back. Thank you for—again for this hearing.

Chairman BEYER. Thank you, Mr. Posey, very much. I now recognize the past and future Governor of Florida, Member Charlie Crist.

Mr. CRIST. Thank you very much, Mr. Chairman, and Mr. Gibbs, thank you for being with us this morning. As you know, NASA's enhanced use lease authority allows the agency to lease underuti-

lized property to private entities, academic institutions, and State and local governments, while also allowing NASA to keep the proceeds to cover maintenance costs and other activities. It's my understanding that NASA has used this authority with great success at Kennedy Space Center to help transform the facility into a robust, multi-user spaceport to include SpaceX, Blue Origin, and others. It's this type of innovation that gave the Space Coast its new nickname of the Comeback Coast, following the shuttle's retirement and resulting layoffs in 2011. However, you note in your testimony that NASA's enhanced use lease authority expires at the end of the calendar year. What is the impact to NASA if this authorization is allowed to lapse, and what would happen to those leases?

Mr. GIBBS. So the impact would be significant. Enhanced use lease authority allows us to charge a fair market value for facilities and infrastructure that we—is underutilized in the NASA portfolio. Being able to take these proceeds in and apply it to infrastructure, apply it to needs, apply it to other areas of critical sort of needing some dollars, an infusion of dollars, to maintain or get it back to adequate levels is incredibly important. Additionally, those partnerships, those relationships that the EULs, enhanced use lease authorities, actually form are just as important, you know, as we go forward.

Now, the impact to the folks that currently have EULs, it's probably fairly minimal, as I would assume that they would be allowed to continue through the period of the agreement. The issue becomes that we have 15 new EULs we're looking to enact in fiscal year 2022, and I couldn't do any of those, and a lot of those relate to Space Coast activity not only here, but in the State of Virginia as well. So I think, you know, EULs are going to be critical for our success kind of going forward.

Mr. CRIST. Thank you. Administrator Nelson previously has testified that NASA has identified a set of infrastructure needs totaling about $5.4 billion. It's no secret that Kennedy Space Senator's—Center is located right on the Atlantic Coast of Florida, which makes it vulnerable to climate change. Do any of the infrastructure needs the administrator referenced address the need for climate adaptations at Kennedy?

Mr. GIBBS. They do. I will tell you that, you know, working with the impacts of climate and climate change are incredibly important. Kennedy is a great example of something that we're working on to solve. We've built a 17-foot dune, barrier dune, between the waterways and the launch pads that we used recycled soil from the Air Force, when they were doing dredging operations. The dune is 17 feet tall, it's 200 foot at the base, 100 foot at the height, and then it's, you know, planted with native grass and plants. You know, those sorts of efforts to ensure that we can continue to conduct our mission are incredibly important.

So yes, you know, we do look at, you know, the coastline restoration efforts not only there, but at Wallops. You know, we look at earthquake hardening at the Jet Propulsion Laboratories in California as part of this program as well. So there is quite a bit.

Mr. CRIST. OK. Thank you, sir. Beyond the 5.4 billion Administrator Nelson referenced, does NASA have a plan of action to protect Kennedy's assets from the impacts of climate change? And if

so, what's included in that plan, and what does NASA need from Congress to carry it out?

Mr. GIBBS. Well, I appreciate the question. You know, so—at this point in time, we plan these things into our infrastructure budgets. It's about an every 3 year cycle for shoreline replenishment, and other things that go on to support Kennedy, but that's about as much of an answer as I can give you.

Mr. CRIST. Fine. Well, NASA's Fiscal Year 2022 budget request notes that, due to COVID–19 closures at NASA centers, most ongoing facility construction projects were halted, and that "in the absence of supplementary funds, planned construction projects may be deferred." Can you discuss which construction projects at Kennedy were significantly impacted by COVID closures, and what impacts will that have on NASA missions carried out at Kennedy, including the launching of the Artemis missions?

Mr. GIBBS. So I'll take the complete answer for the record, but I'll give you sort of—the overall picture is there are a lot of requests for equitable adjustments that went on because of COVID, but that isn't telling you the entire story. The whole story really is that we have to delay, defer, and descope projects on a regular basis because our construction funds are lower than requested. The reality is I've had to delay, defer, descope 47 projects over the last two budget cycles because I just didn't have the resources.

Mr. CRIST. Thank you very much——

Mr. GIBBS. Hopefully that answers your question.

Mr. CRIST. Appreciate that. Thank you, Mr. Chairman.

Chairman BEYER. Thank you very much. I believe we'll now move to Mr.—no—get this right. No, Ms.—Member Kim from California. You are now recognized. Madam—Young Kim? It is your turn to proceed.

Mr. PERLMUTTER. I don't think she heard you. There you go.

Chairman BEYER. OK. Congresswoman Kim? If you can hear us, it is now your turn to ask questions of Mr. Gibbs. And if you're having a—technical problems, we can move on to Mr. Gonzalez, and come back to you, if that would be OK.

STAFF. Just sent a signal——

Chairman BEYER. There we go.

STAFF. —Mrs. Kim to unmute.

Chairman BEYER. Mrs. Kim, I think that—think we had you there for a minute. You seem unmuted at the moment. Please proceed.

Mrs. KIM. Am I up? OK. Sorry about that. All right. Well, I want to thank you, Chairman Meyer, for yielding, and I want to thank you, Mr. Gibbs, for testifying before the Subcommittee today. NASA currently has a maintenance backlog of over $2.66 billion, so how is it that funding broken down by NASA's condition-based maintenance approach and its prioritized risk assessment process? And do all these projects fall under the same priority, or are some more necessary than others? Can you provide the Committee with a prioritized list of the $2.66 billion maintenance backlog?

Mr. GIBBS. Yes, we can provide you with that list. Understand it's not a static sort of thing. If there's additional resources that we're applying, needs change, and the rest of it, but we'd be happy

to provide information to show you how we establish our priorities, and what those priorities are, if that helps.

Mrs. KIM. Sure. You know, understanding that maintenance is a priority, why was——

Mr. GIBBS. Yeah.

Mrs. KIM [continuing]. This not included in the President's fiscal year 2022 budget request?

Mr. GIBBS. Again, you know, it's one of those things where if you have limited resources, you have to apply those resources to first support the mission, ensure safety, ensure health, and all of those things, and then you have to do the best you can with the resources you have. Unfortunately, maintenance generally is one of the things that gets deferred on a regular basis, if you're funded less than, you know, what you would've requested. And this isn't something that happened overnight, right? I think we talked in 2013 of a $2.2 billion deferred backlog, and it occurred—and it happened long before that.

You know, part of this—and this may not be the best answer, but I think it's really part of our reality, is that maintenance, and construction, and these things, it's not, you know, the glamorous stuff that you see. It's not rocket launches, and launch pads, and landing on Mars, and doing all of the really cool, really important science that we do, and aeronautics, and all the rest of it. Some of this is, you know, you're—you can't see it. It's the infrastructure behind the scenes that, you know, you don't invest in if you have a new lab, but, you know, you have to remember that these labs and launch pads are so—are supported by this horizontal infrastructure, most of which is pre-World War II, or in that era. So it becomes a very difficult problem. I hope I——

Mrs. KIM. Well, how is——

Mr. GIBBS [continuing]. Answered your question.

Mrs. KIM. Mr. Gibbs—so how is the deferred maintenance backlog affecting our ability to meet timeline goals for the Space Launch System and Orion Programs?

Mr. GIBBS. Well, right now it's not. It's not impacting our ability to achieve those goals. But I will tell you, as you don't do maintenance, infrastructure systems equipment decays. It—you have an issue with it becoming obsolete, so you have to do certain maintenance. And if you don't do that maintenance, the bill you pay at the other end—I think you heard earlier someone was saying three times. That is a good, strong industry number. It's about three times if it fails on—with an unplanned issue, as opposed to doing that deferred maintenance. But, again, it's environment that we have to operate in, and have been operating in for a long period of time.

Mrs. KIM. Sure. You know, let me ask one last question. How can NASA better engage with the private sector and other agencies to better utilize, on a reimbursable basis, NASA test stands, and wind tunnels, and other unique facilities?

Mr. GIBBS. You know, I think using the Space Act Agreements and the enhanced use lease authority, which we discussed earlier, are two great vehicles. But I will tell you, working with others, industry, academia, other Federal agencies, which we do on a regular

basis today, is absolutely crucial to our success going forward. It has to be part of our program.

Mrs. KIM. Well, with that, thank you so much. I will yield back my time.

Mr. GIBBS. Thank you, ma'am.

Chairman BEYER. Thank you, Ms. Kim, very much. Let me now introduce the Congressman from the great State of Colorado, Mr. Perlmutter.

Mr. PERLMUTTER. Thanks, Mr. Chair, and you can see my bumper sticker in the background there, Mr. Gibbs. You know where I'm coming from. I want to get us to Mars by 2033. And so I guess I hear you, and I apologize, as a Member of Congress, that, you know, to do the plumbing, and to do the road work, and do the basic things for any, you know, facility, you guys are kind of put to the back of the bus. And, personally, I want to be an advocate for you as we go through this infrastructure package, and the reconciliation. And so I would like that list of deferred maintenance projects that you have.

I know Ambassador Beyer, with Charlie Crist, and I think Brian Babin still on here, and Don Norcross, all of us to be advocates for you as we go through this infrastructure moment, because you're definitely infrastructure, in my opinion. And I don't want to be a Pollyanna about it, you know, because you've had to deal with these shortfalls, you know, year in, year out, but I'd like to, at this moment, given what we're trying to do, to plus you up a lot.

So give me an idea—one, I—Ms. Kim asked for that list. I'd like that list of needs. Second, my question would be sort of—the Artemis Program, the Moon, Mars, what are your top two or three infrastructure needs for you to be able to support the Artemis Program?

Mr. GIBBS. That's a great question. Let's talk a little bit about that $5.4 billion infrastructure list we keep talking about or around. What I will tell you is it'll put jobs in almost every State, and I will execute that 5.5—$5.4 billion investment in 5 years. We have a lot of stuff already in the box, ready to go, to start investing in this infrastructure. We've spent a lot of time on this. We started with a much larger list, and then cut it down, and said, OK, what are our real needs to support those things? What are the opportunities that we can exploit going forward? What are the things that we can do so our house is in order so, we ever get this opportunity, you know, we would be ready for it? So I think that's one incredibly important thing.

I will tell you, and I'll be happy to provide the list, the Artemis related is about $608 million in that bucket, ready to go to support Artemis going forward. I don't have the—all of the projects and programs specifically laid out of all 5.4 billion, but I'll be happy to take that for the record and provide you that information.

Mr. PERLMUTTER. I'd like it. So I have—I represent the Federal Center in Colorado. I have the National Renewable Energy Lab (NREL), we have, you know, sort of the Lockheed Waterton plant south, so there's a big NASA presence, or a number of NASA projects. On the Federal Center I have a laboratory, it's a USGS (United States Geological Survey) laboratory, so not something you have to worry about, but of the same vintage of many of your facili-

ties, and literally the roof is ready to fall in. It was a World War II era laboratory, couple hundred scientists and engineers, and we've got to get a new facility for it, because over the years it just has, one, outgrown itself, it's aged, and when I'm looking at some of the statistics here, 83 percent of your infrastructure is beyond design life. More than 70 percent is at least 50 years old, and approximately half of your facilities were built at or before the Mercury, Gemini, and Apollo Programs. Is that true?

Mr. GIBBS. Yes. Yes, it is true, and, honestly, Congressman, I—having come from the Department of Energy I'm very familiar with NREL, I'm very familiar with WAPA (Western Area Power Administration), out—just outside of Denver as well, the Western Area Power Administration, for the investments. I will tell you, the infrastructure of NASA is significantly degraded when you compare it to that of the DOE. I can tell you that from having been in both agencies and seeing those things. So yes, that is true.

We have some unbelievably difficult challenges to face. We have facilities in California that don't have heat and air conditioning. Our Advanced Material Structure Lab at Langley went without air conditioning for a period this summer while they were doing critical work. You know, there—this just goes on and on across. Now, we do have an opportunity at this moment—if there is investment, we can work on the other side of it, and replace these facilities with state-of-the-art facilities that'll support not only NASA, but the Nation's interests going forward. So hopefully we're going to have an opportunity to do those things.

Mr. PERLMUTTER. Well, I—will be an advocate for you, and I think the other Members of our Committee, Democrats and Republicans, will advocate, and I'm saying to my colleagues this is the moment for us to advocate for something like this. It's squarely within the infrastructure package, in my opinion. Thank you, Mr. Gibbs, for your testimony.

Mr. GIBBS. Thank you, sir. I have been told by my folks that this—the $5.4 billion list has been provided to the Committee staff, so you do have it.

Mr. PERLMUTTER. Well, that's—but also make sure that we get it, and our——

Mr. GIBBS. Yes, sir.

Mr. PERLMUTTER [continuing]. Staff, and the Committee staff, is great. I would ask them to provide it to us so that we can start pounding away at some of our colleagues to make sure all of it, or at least a chunk of it, is in this package as it winds its way through the House and the Senate.

Mr. GIBBS. Will do, sir——

Mr. PERLMUTTER. Thank you.

Chairman BEYER. And thank you, Mr. Perlmutter. We'll make sure that we get it out to every Member of the Committee. And now let me recognize the gentleman from New Jersey, who is also an expert on space traffic and orbital debris, Mr. Norcross.

Mr. NORCROSS. Thank you very much, Chairman, appreciate it. Mr. Gibbs, great to have you here. When we read, and I've mentioned it quite often, NASA has been one of those organizations that we all look up to, that was always on the cutting edge, and, you know, it gave us real hope for the future, and you've done great

things. I look at the assets, 14 States, 43 billion in assets, 5,000 buildings, it's a massive infrastructure. But what I hear today is rather distressing, and—certainly focusing on the infrastructure needs. And you talk about limited resources. Have you ever had adequate resources to run the organization? Has there ever been a time in your career?

Mr. GIBBS. Not since I've been in the job, but I will tell you, in 2012, the Mission Support Directorate comprised about 17 percent of the overall agency budget. Here in 2021, 2022, I'm around 12 percent. And this is coming at a time when the agency's budget, if you use it as a proxy for requirements, is going up. So I have an increasing requirements portfolio, and a decreasing resources portfolio, in which to supply mission support, which mission success is built on. It's a challenging proposition.

Mr. NORCROSS. Now—exactly where I'm headed toward, that—you know, we hear about deferred maintenance, and you have a list, and there's certain degrees of lists that you have. You know, is it urgent, does it have to be done? And, when you think about the risk, is it a strategy when the likelihood of an assets failure may have severe consequences? This is a decision that is made—yearly basis when—where your resources go, the money goes.

Mr. GIBBS. Yeah.

Mr. NORCROSS. And that's what I want to talk about, is the culture of what is going on. One of the easiest things, and this is across business spectrums, whether you have a refinery or an office building, is deferred maintenance, not preventative maintenance. And that's where I want to really focus on, on how important that is, that each time you defer maintenance, you are making a choice to increase risk. We've seen example after example what has happened across this country when that risk is taken on. Sometimes you win, but sometimes you lose, and in your business, when you lose, people's lives are on the line.

So let's talk about that. When you put together a budget, when is it that you say, we have to fix things, or we can't do this? It seems that NASA's always, we'll get it done no matter what, and that's the risk I'm going to ask you about. How are you dealing with that, and at what point do you say no?

Mr. GIBBS. So I've got to tell you, that's a—that is a great point, and it's one of those subtle points of culture. It's the other side of the coin of engagement, right? We have the best workforce in the Federal Government, we're the best place to work in the Federal Government, all those things are true, because our folks are engaged and our leaders care about their people. The other side of that is we're going to get stuff done. We're going to work to nearly kill ourselves to get things done, and I think that sort of A student mentality sometimes can have unforeseen repercussions, and that is, well, they made it—they made due with X dollars, we can give them a little bit less, and they'll make due with that too. So I think that has sometimes come into the thinking of a lot of folks.

I will tell you, though, when it comes to safety, you know, that is a line I will not cross. I will shut down a facility, I will shut down a system, if I'm endangering personnel safety. If we get to that point, I won't hesitate, and then we'll figure out how to re-

cover the programs and projects, but personnel safety is paramount, and I won't put anyone at risk with the infrastructure——

Mr. NORCROSS. Now——

Mr. GIBBS [continuing]. Budget we have. Yes, sir.

Mr. NORCROSS [continuing]. If you know that risk, and that's——

Mr. GIBBS. Yeah.

Mr. NORCROSS [continuing]. The point we're making here——

Mr. GIBBS. Yeah.

Mr. NORCROSS [continuing]. Is, without preventative maintenance, and that—because the arc flash that our Chairman brought up——

Mr. GIBBS. Yeah.

Mr. NORCROSS [continuing]. You know, is stunning to me. There had been—the energized gear risk has been in place for over a decade. That—this is nothing new. I saw the transformer that was on fire. That's nothing new. These are things that maintenance, and preventative maintenance, can figure out before it happens.

Mr. GIBBS. Right.

Mr. NORCROSS. We have great advocates here, and I count myself as one of them. Even though you have nothing in New Jersey, we care a lot about you because of what you do for our country. But this culture——

Mr. PERLMUTTER. That was mean.

Mr. NORCROSS [continuing]. That culture has to change. You just have to put that maintenance up there in certain degrees as a risk to life and limb, and if you don't know the risks, you don't know when it's going on. So, Mr. Chairman, and certainly to my colleague Mr. Perlmutter, we are there to help you, but we can't always get it done, and then live with the consequences later on. With that, I yield back.

Mr. GIBBS. Thank you, sir.

Chairman BEYER. Mr. Norcross, thank you very much. And Mr. Gibbs, you may not realize this, but when Mr. Norcross, who is an accomplished electrician, talks to you about arc flashes, he knows what he's talking about.

Mr. GIBBS. Yes, sir.

Chairman BEYER. We're blessed to have people with a wide range of great skillsets. Representative Gonzalez has been with us for most of this hearing. Representative Gonzalez, if you're here, we'd love to recognize you for questioning.

Mr. PERLMUTTER. I think Representative Gonzalez is in the Financial Services hearing, because I can——

Chairman BEYER. OK.

Mr. PERLMUTTER [continuing]. See him on my TV.

Chairman BEYER. OK. In the meantime, our dear friend——

Mr. PERLMUTTER. I do see——

Chairman BEYER. —Mr. Weber——

Mr. PERLMUTTER. —Mr. Weber——

Chairman BEYER [continuing]. Of Texas has just arrived. Mr. Weber, if you're ready from your car to talk to Mr. Gibbs, we would like to recognize you.

Mr. WEBER. Well, yeah, thank you, I'm ready. And actually, it's not my car, it belongs to the bank and me. You know how that goes.

Chairman BEYER. Yeah.

Mr. WEBER. Beyer's laughing because he loves selling those cars. But anyway, thank you. Mr. Gibbs, I've read that over 83 percent of NASA's infrastructure is beyond its design life, with more than 70 percent of facilities, as of 2017, being 50 years old. Fiscal year 2022 congressional justification document explains that immediate repairs compile a growing share of the maintenance budgets, with unscheduled maintenance costs up to three times more than scheduled. So my question is how long has this problem been going—and it's continued to—how long has it been continuing, and how do we ensure we don't end up with a similar situation, or worse, in 10 years?

Mr. GIBBS. That's a great question. I would tell you that our opportunity—if the opportunity is presented for additional resources, where we can build new and retire the old, if we can put more dollars into our demolition account, if I can find ways to get rid of some of this deferred maintenance by demoing it and building new, that is one way for us to attack this problem. I think it's absolutely critical, as we go forward, that we continue to invest in those facilities and get—really to shrink our footprint so the portfolio is manageable in the future, getting to your future conversation.

You know, I don't think we're in a place where NASA has to own each—own of everything or 5,000 pieces of infrastructure. We need to work very closely with our mission directorates and develop a sustainable portfolio that supports our missions today, and going forward. So there's a lot there. Hopefully I answered your question.

Mr. WEBER. Well thank you, and I appreciate that. And you talked about, you know, a smaller footprint—and I'm not able to see the clock there, Mr. Chairman, so I'll—I've got another question. Mr. Gibbs—so, with that in mind, do you believe the existing established structure within NASA for prioritizing infrastructure repairs and upgrades, and the dispensing of funds, is the best, or are you able to extrapolate—if you're going to reduce your footprint, are you able to identify ways you can do that, and then kind of categorize that those will be, if you will, at the back of the—end of the line?

Mr. GIBBS. Yeah. The short answer there is yes. You know, when we built the agency master planning process, the one we're using now at the agency level, we worked with industry heavily to see how did you do it? We went out and saw people that owned scientific, and laboratory, and high science sort of portfolios, and inventory of infrastructure, and asked them the—for their advice, they—how would you manage this? We then took that and overlaid it into a NASA process which involved our mission directorates, who determined the future—the current and future missions of the agency, and our centers to really understand what's the condition of the things that we're dealing with today? I think that process is going to lead us to a pretty good place. And, like I said, we're well underway in that.

Mr. WEBER. Yeah. Well—how much—do I have any time left, Mr. Chairman?

Chairman BEYER. You—Mr. Weber, you still have 2 minutes left.

Mr. WEBER. Good, good, good. I should've started a timer. So, Mr. Gibbs, who lays out that plan? How do we coordinate that? And I

know this is a tricky question, political question in some regard, with the changing of the guard every so often, every, say 2 years in Congress, or 4 years in the White House, how do we maintain that continuity?

Mr. GIBBS. I think through the publication of the agency master plan, which will be published in fiscal year 2022. We work very hard on all of the things that we're working on. And one thing doesn't change—while the missions may change, and we have to be able to adapt to those missions changes as the administration's priorities change, the thing that doesn't change is a really in depth knowledge and understanding of our infrastructure as it exists today. That's the backbone. That really tells us what our capabilities are, and allows us to do measurement of what we need, and what we don't need, depending on the mission. So I think there's—I think we—we're in a pretty good place, sir.

Mr. WEBER. And as the commercialization of space continues, and NASA becomes a customer, if you will, are you able—is that going to necessitate, for lack of a better term, on an ongoing basis changing that plan as we see working with—I mean companies, and as we see this new commercialization process gaining foothold, or speed, or however you choose to look at it? Or gaining warp speed, maybe. So does that——

Mr. GIBBS. That—yeah, that's a great question. You know, I would say—you know, it's really interesting, when you talk about the commercialization of space, you know, even if we're buying services from private companies or from private industry, whether it be launch or anything else, they still generally end up relying on NASA backbone and infrastructure, like the spaceport at Kennedy. So while the service may be cheaper on the front end, I'm going to have those commercial companies come to me and say, hey, we need greater electricity. We'll need to dispose of waste. Launch services, greater pad availability, and all of these things. So from an infrastructure perspective, it all comes right back around, and we still have to continue to invest in our infrastructure to support commercial space.

Mr. WEBER. Well, that's good to hear, that there's a plan in place that'll ensure we can do that. Thank you, Mr. Chairman. I yield back.

Chairman BEYER. Thank you, Mr. Weber, very much. I believe, unless Mr. Gonzalez is abandoning his other Committee hearing, that we have heard from all of our Members to—with Mr. Gibbs today, so thank you, Mr. Gibbs, very much. Really appreciate your coming and testifying with a great knowledge of what NASA needs. And I can promise we will all, Democrat and Republican, do our best to make sure that NASA has the dollars in the years to come to close that infrastructure gap.

Mr. GIBBS. Thank you, Mr. Chairman, and thank you to the Committee. Thank you for your time.

Chairman BEYER. Yeah. Thank you. So, before we bring the hearing to a close, thank you. The record will remain open for two weeks for additional statements from Members, and for any additional questions the Committee may ask of the witness. I'll make sure that we get the—distribution to the Full Committee of the $5.4 billion, both urgent and looking forward, infrastructure needs.

And with that, Mr. Gibbs, you are excused to go back to your other job, and the hearing is now adjourned.

Mr. GIBBS. Thank you.

[Whereupon, at 11:20 a.m., the Subcommittee was adjourned.]

Appendix

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Robert Gibbs

Questions for the Record to:

Mr. Robert Gibbs

Submitted by Chairman Beyer

1. **How does the state and condition of NASA facilities and infrastructure, including laboratories, compare to other Federal R&D agencies, such as the Department of Energy? What explains any significant differences?**

A: NASA administers an inventory of over 5,000 buildings and structures, with an asset value over $39 billion. The majority of the Agency's physical assets date back to the Apollo era, with approximately 83 percent of facilities beyond their design life. NASA's deferred maintenance backlog is over $2.6 billion and growing, the effect of which is a further compounding of risk caused by unplanned maintenance costs and delays.

NASA Safety, Security, and Mission Support (SSMS), which provides for the maintenance of the Agency's physical assets, has been funded below the President's Budget Request level in 9 of the past 12 years. Construction, Environmental Compliance and Restoration (CECR) has been funded below request level in 11 of the past 12 years. NASA's ability to provide leading-edge facilities to support its missions is severely impacted by this sustained funding reduction over time. The impact of under-funding to SSMS requires reductions to planned facilities maintenance work at all NASA locations, including replacement of air conditioning and evaporative coolers, roofing repairs, electrical repairs, safety upgrades, and mechanical pumps. Institutional Construction of Facilities (CoF), an essential element of CECR, is required for the renewal of NASA Center facilities. Reductions in CECR have resulted in the deferral or cancellation of projects necessary to revitalize NASA's infrastructure.

NASA is not in a position to attest to the infrastructure maintenance status or policies for other Federal agencies.

2. **How often does NASA need to conduct unexpected repairs or maintenance in order to ensure the safety of agency personnel and/or NASA research and development projects and activities? How significant is the issue of any emergency or unanticipated repairs?**

A: NASA's current deferred maintenance backlog is valued at $2.6 billion and continues to grow. NASA's increasing backlog of deferred maintenance, resulting from and coupled with Apollo-era physical assets, 83 percent of which are beyond their design life, contributes to a greater number of unplanned maintenance actions across all Centers. Unplanned maintenance actions account for up to 30 percent of NASA's annual maintenance budget. Unplanned repair actions result in unanticipated disruptions and delays to planned work in support of NASA's missions. The age of NASA's facilities has a direct and substantial impact on the quality of the work environment for NASA employees. Deferred maintenance also increases the risk of damage to critical infrastructure from extreme weather or climate events. Given the increasing backlog of deferred maintenance actions and the constrained resource environment, NASA's declining infrastructure represents the single most significant threat to the Agency's mission success.

3. **During the question-and-answer portion of the hearing, in response to a question by Mr. Crist, you mentioned coastline restoration efforts at NASA's Wallops Flight Facility, on Wallops Island, Virginia. I understand that Wallops has had to replenish eroding beaches around its launch complex five times already, with an average cost of $14 million for each restoration. Could you please describe the nature of the challenges with beach erosion, its impacts, and what is being done to mitigate the erosion?**

A: With approximately $1.5 billion worth of constructed Federal and State assets at Wallops Flight Facility (WFF), beach erosion and rising water levels pose a significant future risk to WFF operational readiness and capability. WFF supports over $100 million annually in mission work (for NASA and the U.S. Navy) and approximately $1.9 billion of Commercial Resupply Services work for the International Space Station.

WFF has conducted three rounds of beach replenishment since 2012. The first project (2012) was conducted in two phases – phase 1 was a 1,700-foot extension of the existing seawall; phase 2 was a 3.2-million-cubic-yard sand replenishment project. The total cost of the project was $49 million. The second project (2014) included a 650-thousand-cubic-yard beach replenishment. The total cost of this project was $11 million. The third project (2020-2021) included moving 1.1 million cubic yards of sand from the northern section of Wallops Island and depositing that sand south along more vulnerable stretches of the island. The project also included the installation of five detached breakwaters which appear to be having a very positive effect on the shoreline directly behind these structures. The total cost for this project was $24 million.

4. **NASA's Michoud Assembly Facility in New Orleans and Stennis Space Center in Hancock County, Mississippi, which have been essential to the Space Launch System development and testing, are low-lying facilities—Michoud is actually below sea level— and closed for at least five major storm threats during the 2020 hurricane season.**

    a. **What damage, if any, was sustained to either facility in the 2020 hurricane season, and what is the state of any repairs?**

A: NASA received extensive damage from Hurricane Zeta to both Michoud Assembly Facility (MAF) and Stennis Space Center (SSC). The total combined damage to both facilities was nearly $174 million. The most severe damage was to the roof of Building 103, the main manufacturing building at MAF for the Space Launch System (SLS) core stage. Repairs to the Building 103 roof are currently allocated over five construction phases; the first phase of construction was underway prior to the arrival of Hurricane Zeta in 2020. NASA's estimate for damages at MAF, $151.7 million, reflects the fact that additional damage inflicted by Hurricane Zeta to the incremental construction work that was underway has accelerated the need to complete the full roof replacement. Other unplanned storm-related costs included site-wide clean up and temporary repairs at both MAF and SSC. NASA is currently assessing the damage to MAF and SSC due to Hurricane Ida in August 2021, which compounded the damage previously received by Zeta at both sites.

NASA's FY 2022 budget request includes $35 million for the next incremental phase of work to replace the 1.7-million-square-foot roof. NASA's priority is to avoid costly delays and potential harm caused by failures or collapses of the existing roof, which was beyond design life and has been further impacted by weather.

b. What can NASA do to improve resilience at these two facilities, particularly for the increasing frequency and severity of severe weather, such as hurricanes?

A: NASA is improving resiliency at both SSC and MAF as permanent repairs are made to facilities. The new roof system for Building 103 at MAF is designed to current code of Category IV, capable of withstanding sustained winds up to 135 mph with 30-40-pound-per-square-foot wind uplift. This is a significant improvement on the current Category I roof system that was designed to sustain winds to 75 mph and 12.5-pounds-per-square-foot wind uplift. Recently completed building repairs from a tornado that damaged MAF in early 2017 were also constructed to current wind codes. Those buildings did not sustain wind damage from the hurricane activity in 2020. Hardening the facilities at MAF and SSC as part of post-storm weather repairs is an extremely high priority for NASA.

c. How is NASA assessing its infrastructure and facilities, overall, for vulnerabilities to climate change?

A: NASA is developing an Agency Resilience Framework (ARF) that includes adaptation to climate change. This framework will be integrated into the Agency Master Plan and Center Master Plans. The ARF will provide guidance for development of Center Resilience Plans (CRPs) and will include a process for identifying threats, vulnerabilities, and risks; developing adaptation strategies; and prioritizing adaptation actions. Centers will use mission-essential functions, Continuity of Operation Plans (COOP), and key objectives as inputs in preparing baseline resilience assessments and strategies for real property, infrastructure, and public lands and waters.

5. In response to one of my questions during the hearing, you mentioned a hypersonics tunnel at NASA's Langley Research Center as an important new, national capability that could come from infrastructure investment at NASA.

a. How would a new hypersonics wind tunnel at Langley compare to NASA's existing wind tunnel and other aerosciences test facilities, in terms of capabilities and mission area applications?

A: Langley Research Center's (LaRC) master plan envisions a Hypersonic High-Reynolds Number Tunnel (HHRNT) that would provide an expanded test capability in support of NASA's role in applied research and development on hypersonic technologies to advance the Technology Readiness Levels (TRL) from fundamental concepts to flight readiness. The notional HHRNT would significantly enhance the testing ranges for Mach 6 and Mach 10 capabilities and would add new Mach 8 and Mach 12 capabilities. This capability could be a significant contributor to flight vehicle design, particularly where testing for fully turbulent conditions is required. NASA is also in close coordination with the Department of Defense (DoD) as DoD evaluates the test facilities required to meet its requirements. Any decisions about refurbishing or replacing NASA hypersonic facilities would need to be fully coordinated to ensure that future NASA facilities complement rather than duplicate those operated by other Federal agencies.

It is important to note that NASA Center master plans provide a 20-year forecast for each Center that serves as a roadmap to the development and sustainment of facilities, infrastructure, and land. The Center master plans provide a planning blueprint that helps to inform investment and divestment decisions at both the Center and Agency level that will support NASA's goals for revitalizing, modernizing, and equipping its infrastructure assets to meet future needs. While this is a valuable internal infrastructure planning outline, it is also important to note that individual facilities actions are subject to Agency approval and funding decisions aligned with the annual Agency budget formulation process,

Administration review, and Congressional provision of appropriated funds. Thus, individual master plan projects such as the HHRNT remain aspirational to Agency planning within the context of the outlook for NASA CoF budget requirements in the foreseeable future.

b. What is the current age and condition of Langley's most active aerosciences test facilities?

A: There are seven critical Aerosciences ground test facilities at LaRC that are part of NASA's AETC portfolio. Each are experiencing the effects of age and require constant maintenance. These seven facilities include:

- 20' Vertical Spin Tunnel (VST): 80 years old; currently operational. Scheduled for replacement by the new Flight Dynamics Research Facility, construction anticipated to begin in FY 2022.
- 4' Unitary Plan Wind Tunnel (4' UPWT): 66 years old; undergoing maintenance but currently operational.
- Langley Aerothermodynamics Laboratory (LAL): 64 years old; consists of three medium-sized hypersonics facilities. Two are currently operational and heavily utilized and one is in standby state.
- 16' Transonic Dynamics Tunnel (TDT): 61 years old; currently undergoing major maintenance for the last three years. Scheduled to return to full operations start of 2022.
- 8' High Temperature Tunnel (HTT): 56 years old; currently operational.
- 14'x22' Subsonic Tunnel (14x22): 51 years old; currently operational.
- National Transonic Facility (NTF): 39 years old; currently operational.

6. As the Mission Support Directorate Associate Administrator, you are also responsible for the agency's overall hiring and staff retention activities. To what extent do you see the current state of NASA's R&D infrastructure—such as its laboratories, computing facilities, or testing centers—as a factor in NASA's ability to attract a diverse workforce of the best talent?

A: To ensure that NASA has an appropriate workforce, both now and in the future, it is essential to have a clear understanding of the skills that are needed, and the physical infrastructure required to optimally utilize this talent. Over the years, NASA has easily attracted candidates eager to be a part of its workforce. However, recently the Agency has noted the declining infrastructure continually challenges its ability to appropriately utilize this workforce, which ultimately impacts the ability to attract and retain the best and brightest talent.

Some of these challenges, while important, may be alleviated as NASA continues to become more proficient in managing and excelling in a predominantly virtual environment. As the Agency progresses toward management of a workforce in the post-COVID world, we have learned that a work environment that is geographically flexible or agnostic may offer cost efficiencies and effective outcomes. NASA is preparing for a future of work that will be able to benefit from these new flexibilities to provide needed services in a more efficient manner.

7. NASA, through the Mission Support Directorate, has undertaken the Deep Space Network Aperture Enhancement Program—DAEP—to replace the larger antennae of the Deep Space Network with arrays of smaller antennae by 2025.

a. What is the current progress of the DAEP, and will it meet the goal of completion by 2025?

A: NASA has completed 50 percent of its objective and is on track to complete 70 percent by 2022, 85 percent by 2025, and 100 percent by 2027. The original plan was to retire the large, 70-meter antennas, but the plan was adjusted to accommodate evolving requirements and the fact that the 70-meter antennas remain in good shape to support many legacy extended missions.

b. With the completion of the DAEP, does NASA project that the Deep Space Network will be sufficient to meet the needs of the agency for communications beyond low Earth orbit, including for Artemis activities at and around the Moon and science missions elsewhere in the Solar System?

A: Since the 70-meter antennas are not being decommissioned, the Deep Space Network (DSN) is expected to meet all NASA's requirements. NASA is continuously updating DSN user projections and assessing the ability of the DSN to meet those needs. In addition, NASA is currently evaluating its communications requirements for future Artemis Missions.

8. NASA has been implementing its Mission Support Future Architecture Program (MAP) to evaluate and align each mission support organization into an enterprise model. What activities under MAP are relevant to infrastructure, facilities, and/or maintenance, and what progress has NASA made thus far on those MAP activities?

A: The Mission Support Future Architecture Program (MAP) transitioned NASA's foundational business operations to an enterprise model of management and service delivery. Similar to other mission support services, enterprise management of infrastructure finds agility to be a core tenet in order to respond exceptionally to emerging issues, adapt to evolving mission and environmental conditions, and make tradeoffs across the Agency to effectively allocate its resources. For NASA to be fully enabled to meet its current and future mission set, it is vital for leaders to make strategic decisions regarding the balance of Center facilities, laboratories, and equipment.

NASA's response to the COVID-19 pandemic demonstrates key benefits of enterprise management and the service delivery model. Within a week of the announcement to limit Federal facilities to mission-critical functions, NASA transitioned a vast majority of its workforce to offsite, telework conditions, with little to no disruption to work. Business functions like human capital, facility management, information technology, health services, finance, procurement, legal support, and communications supported the safety and welfare of the NASA workforce and continuing productivity. Facility cleaning and access standards, the legal and logistical considerations surrounding construction and repairs, and protective services that ensured the security of NASA assets, were all adapted to COVID conditions. This rapid and consistent response was enabled by the enterprise model that MAP established.

Additionally, the Agency Master Plan is a specific infrastructure product that is made possible through MAP. It will establish a 20-year vision for physical infrastructure and real property assets that aligns to evolving and future mission requirements. NASA will use this process to identify critical capabilities and areas for asset sustainment, investment, or divestment throughout the Agency, as well as to evaluate and leverage other Federal agency and private sector assets when available. Coupled with using the Agency Master Plan, NASA will look to implement enterprise solutions for maintenance, real estate agreements, and facility information technology (IT) in order to drive the Agency toward an affordable portfolio of services that are available for current and future mission needs.

9. What is the status of the agency-wide Preliminary Assessment of polyfluoroalkyl substance, or PFAS contamination, initiated in FY2020? When can we expect to see the results of that assessment?

A: NASA is in the process of finalizing the Center-specific Preliminary Assessments (PAs) of polyflouroalkyl substances (PFAS) for NASA facilities, with completion expected by January 2022. The PAs consist of employee interviews, records searches, and field reconnaissance to identify areas of potential concern. Based on the results of the PAs, NASA plans to implement Site Inspections (SIs), which involve sampling, at identified areas of potential concern, to verify the presence of any release of PFAS to the environment and whether further action is required. NASA expects to complete the SIs by the end of FY 2022.

10. The Government Accountability Office found in January 2021 that NASA's reported environmental liabilities have increased by over 45 percent between fiscal years 2014 and 2019.

a. What is the reason for this increase?

A: NASA's Unfunded Environmental Liability (UEL) is updated and audited on a yearly basis by an outside financial auditor hired by the Office of Inspector General (OIG), which has found for the past 10 years that the estimates are reasonable, accurate, and the process is in compliance with Generally Acceptable Accounting Principles (GAAP) with no findings or recommendations.

The scope of the soil cleanup at NASA's Santa Susana Field Laboratory (SSFL) in California expanded from approximately 500,000 cubic yards of soil removal to approximately 800,000 cubic yards. That increase and smaller restoration scope changes at other Centers resulted in the increase of the NASA UEL from 2014 to 2019.

In 2019, NASA completed a Supplemental Environmental Impact Statement (SEIS) which evaluated the environmental impact of its action to clean up soil contamination at SSFL. NASA initiated preparation of the SEIS when it determined that, pursuant to information found in the California Department of Toxic Substances Control (DTSC) Draft Programmatic Environmental Impact Review (PEIR) for the SSFL cleanup, the quantity of soil that may need to be removed from the SSFL site far exceeded the estimate NASA used in its 2014 Final Environmental Impact Statement. Depending on the cleanup that is implemented, Agency costs may be substantially higher than was reasonably anticipated at the time NASA entered into its 2010 Administrative Order on Consent with the DTSC. The SSFL cleanup is NASA's largest unfunded environmental liability.

b. GAO also found that NASA's reported liabilities estimate does not include some costs because of uncertain conditions or incomplete data. What is the risk to NASA by not knowing the full extent of its environmental liabilities?

A: Based on accounting standards, NASA is required to present the UEL on its financial statement and disclose actions that may occur but cannot be estimated. An example of such action is that NASA cannot estimate the full cleanup without completing an investigation to select a remedy and estimate its costs. The risk of not knowing the full extent of cleanup liability is that NASA will require additional funds in the future once cleanup methods are able to be estimated and implemented.

Actions for cleanup are prioritized such that actions required to prevent human health exposure are addressed first. Because NASA's remediation program is mature, NASA has identified most of the risks and has implemented cleanups and institutional controls to protect current and future exposures; however, it is possible that other sites requiring response and remediation will be identified. The risk associated with the incomplete data is that the scope of ongoing or to-be-identified cleanup actions may increase once additional information becomes available.

c. Do you expect NASA's environmental liabilities to continue to increase in the future?

A: Once characterization activities have been completed and cleanup strategies are identified and implemented, and sites are in a long-term operation and maintenance status, NASA expects that in later years the environmental liability may be limited to long-term operations of treatment systems and monitoring.

NASA expects unfunded environmental liabilities to potentially increase as toxicological and ecological data are generated for emerging chemicals, such as PFAS. As new information emerges on PFAS, NASA will monitor and be responsive to Environmental Protection Agency (EPA) guidelines and enforceable standards if promulgated.

d. **How is NASA addressing its growing environmental liabilities?**

A: NASA addresses its environmental liabilities through planning, budgeting, and execution of the Environmental Compliance and Restoration (ECR) Program. Depending on the legal authority upon which the cleanup is based (e.g., Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] or Resource Conservation and Recovery Act [RCRA]), NASA coordinates its cleanup actions with appropriate Federal and State regulators and other potentially responsible parties. Because the bulk of NASA's cleanup sites are from past actions, and not due to current hazardous waste/hazardous substance management activities, it is expected that, over time, NASA's environmental liabilities will decrease in cost and scope. However, NASA will be mindful of statutory and regulatory requirements applicable to emerging contaminants of concern (e.g., per- and polyflouroalkyl substances [PFAS]) and may account for these in future ECR-funded cleanup actions.

Questions for the Record to:

Mr. Robert Gibbs

Submitted by Mr. Gonzalez

1. **Mr. Gibbs, as you mentioned in your testimony, 83% of NASA's facilities are beyond their design life. At Glenn Research Center in-particular, there are 19 various projects that are important for Glenn's infrastructure requirements. Given the sheer number of NASA facilities across the nation that each need their own attention and the presumed backlogs for specific projects at each one, where are the needs of NASA Glenn prioritized in-comparison to other Centers?**

A: NASA balances its infrastructure needs against risk to mission, safety of people, and the ability to reduce maintenance burden while improving sustainability (energy efficiency, climate, etc.). Facility projects at all the NASA Centers, including the Glenn Research Center (GRC), are evaluated, prioritized, and funded as budgets permit. Historically, GRC has a comparable number of facility projects with respect to all other Centers. However, NASA has deferred 36 projects over the last two budget cycles, including some at GRC. In FY 2022, NASA plans to execute two site-wide electrical repair projects at GRC that continue the phased approach toward restoring the reliability of this critical Center infrastructure.

2. **Mr. Gibbs, on the subject of hypersonics, I understand that NASA and the Department of Defense have been working on ways to enhance America's ability to develop these systems especially given the nature of Russia and China's own programs. In-particular, there has been discussion of reutilizing the Hypersonic Tunnel Facility at the Neil Armstrong Test Facility in Sandusky, Ohio to assist, as currently it is not being used for hypersonics, but a separate NASA project. Do you have any insight into the renewal and construction efforts surrounding this?**

A: NASA's Aeronautics Research Mission Directorate (ARMD) invests in a broad range of technologies, including hypersonic testing and advancements, to the meet future needs of the aviation community and the Nation. This includes research and development in advanced high-temperature materials and computational tools to enable safe and affordable hypersonic flight for both military and civil applications. NASA enjoys a strong partnership with the Department of Defense (DoD) whereby we provide access to Agency facilities, tools, and experts, and in exchange receive access to data from DoD projects and tests which NASA uses to improve our tools and methods to advance hypersonic flight.

The Hypersonic Tunnel Facility (HTF) currently houses the NASA Electric Aircraft Testbed (NEAT), a unique test facility supporting critical NASA ARMD electrified propulsion research. It provides the ability, otherwise non-existent in the U.S., for testing high-power hybrid electric propulsion systems and components at the multi-megawatt (MW) level (up to 24MW), including cryogenic and altitude conditions. The NEAT is fully utilized in support of NASA's high-priority research for sustainable aviation, with a multi-year backlog of tests in partnership with industry and universities awaiting entry into the facility.

DoD has expressed a need to increase its capacity for testing associated with the development of hypersonic vehicles for a range of DoD missions and purposes. DoD approached NASA GRC in 2018 to begin discussions about potentially reactivating the HTF. NASA GRC has entered into a fully reimbursable agreement with the DoD to undertake a series of engineering tasks focused on assessing and documenting the current condition of the HTF's major systems and components. This signed agreement is the first of several steps to guide decisions associated with establishing the feasibility of reactivating the HTF. The tasks began in June 2021 and the anticipated completion date is May 2022. All activities associated with this agreement are coordinated by NASA GRC to avoid any disruptive impact on NEAT operations or other NASA programs at the Armstrong Test Facility.

Reactivation of the HTF would require relocation of NEAT to a different location since key HTF infrastructure components are currently used for or otherwise obstructed by NEAT operations. NASA would require any relocation of the existing NEAT capability to be done in a way that avoids or mitigates disruptions to high-priority NEAT testing and operations. NASA has no need to move this facility and has no funding or plans to do so. Because NASA has no need to use the HTF for hypersonics testing, costs for construction, reactivation, and operation of HTF are not covered by NASA's budget or included in future operational plans.

3. **Mr. Gibbs, given the urgency in preventing the U.S. from falling further behind in this sector, is there anything Congress can do to expedite the process for restarting and renewing this facility?**

A: NASA has no mission requirement to reactivate the HTF for NASA hypersonic testing purposes. At present, the HTF houses NEAT, a unique test facility supporting critical electrified propulsion research aligned with NASA's priorities for sustainable aviation. However, as noted above, at this time NASA has been working closely with DoD to the maximum extent practicable to facilitate their efforts to explore the potential and requirements for reactivation of the HTF, provided NASA's mission requirements are met and are not compromised by HTF relocation or operations.

4. **Mr. Gibbs, how much funding for horizontal infrastructure (roads, fences, and underground utilities, many of which are out of view) in FY21 was allocated to NASA Glenn? And compared to the request for FY22, will this year's request be enough to ensure Glenn's needs are fulfilled?**

A: In FY 2021, NASA funded $25.0 million (at GRC) for three Construction of Facilities (CoF) projects, including the "Repair Cooling Tower Nos. 3 & 6 Water Distribution System" project, the "Repair Steam Distribution System, Phase 4" project, and the "Repair Electrical Distribution Systems, Phase 3 of 5" project.

Within the FY 2022 Construction and Environmental Compliance and Restoration request, NASA plans to allocate $20.0 million for CoF projects at GRC. These include phased repairs to GRC's storm sewer system and to the electrical distribution system to increase safety and reliability. Additionally, NASA's CoF request includes funding to upgrade the energy monitoring and control system at GRC. These projects are consistent with the methodology described in the response to Question #1, above.

5. **Mr. Gibbs, you specifically mentioned in your testimony the upgrade of the energy monitoring and control system at Glenn. Can you speak more as to why this project in- particular was chosen for your testimony over others at Glenn?**

A: The upgrade of the energy monitoring and control system was submitted by GRC as part of a yearly internal call for energy efficiency projects. As part of the Agency's commitment to reduce its use of energy and drive toward a sustainable infrastructure, a portion of the construction budget is set aside each year to invest in projects that will significantly reduce energy consumption. In this case, GRC submitted a project that would allow for better Center control of energy usage at several high-energy-consuming facilities. The project has an excellent payback of 5.5 years and will help reduce the utility costs at the Center. This does not address GRC's horizontal infrastructure challenges, but it will allow avoided costs to be reinvested into GRC's maintenance program.

6. **Mr. Gibbs, given the limited funding for the various infrastructure needs across NASA, how will the utilization of all major wind tunnel facilities across the agency be affected? Additionally, how has the pandemic affected overall wind tunnel operations?**

A: NASA carefully manages its AETC testing requirements and resources are dedicated through ARMD to ensure that AETC test facilities are operationally funded and managed to a baseline of full occupancy for one daily shift. At the same time, NASA must focus on the most critical maintenance items across the portfolio to support this level of operation and must also deal with real-time failures, which are increasing as facilities age. There is an evolving challenge to manage and mitigate for down-time at NASA's facilities and the potential loss of test-time to support the research requirements of the Agency and its partner users (Federal, industry, academia).

With regard to the effects of COVID-19, after an initial cessation of ground test activities to ensure prudent safety measures could be employed, most major wind tunnels began to come back on line by late 2020, and ongoing maintenance projects have resumed in the rest. Safety remains a priority as test operations continue.

7. **Mr. Gibbs, how does NASA plan to bring these wind tunnels back into full operation?**

A: The AETC wind tunnels are currently operational or undergoing maintenance in order to return them to an operational state. NASA's plan is to continue to carefully assess, manage, and mitigate the most serious maintenance requirements based on actual demand for utilization of these facilities.