

# NASA

National Aeronautics and Space Administration

Office of Inspector General

Office of Audits

# AUDIT OF NASA'S REQUIREMENTS FOR PLUM BROOK STATION

April 23, 2015

Report No. IG-15-014





## **Office of Inspector General**

To report, fraud, waste, abuse, or mismanagement, contact the NASA OIG Hotline at 800-424-9183 or 800-535-8134 (TDD) or visit <http://oig.nasa.gov/hotline.html>. You can also write to NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, D.C. 20026. The identity of each writer and caller can be kept confidential, upon request, to the extent permitted by law.

To suggest ideas for or to request future audits contact the Assistant Inspector General for Audits at <http://oig.nasa.gov/audits/staff.html>.



# RESULTS IN BRIEF

## Audit of NASA's Requirements for Plum Brook Station

NASA Office of Inspector General  
Office of Audits

April 23, 2015

IG-15-014 (A-14-013-00)

### WHY WE PERFORMED THIS AUDIT

Plum Brook Station, located about 50 miles west of NASA's Glenn Research Center in Sandusky, Ohio, is home to several unique space-related test facilities, including the Space Power Facility (SPF), an environmental simulation chamber used to test hardware in a simulated space or planetary environment. However, a majority of Plum Brook's test facilities are underutilized and the level of use and funding they receive depends on whether individual NASA programs or external customers choose to perform testing there rather than at other NASA or private facilities. The NASA Authorization Act of 2010 directed the Agency to examine its real property assets and downsize to fit current and future missions and expected funding levels, paying particular attention to removing unneeded or duplicative infrastructure. In this audit, we assessed the cost of operating Plum Brook in light of its current and expected use.

### WHAT WE FOUND

Over the past 10 years, Plum Brook has eliminated approximately 1.3 million square feet of buildings and structures from its property. However, it continues to maintain several major testing facilities – most prominently the SPF and the Spacecraft Propulsion Research Facility (B-2), the world's largest thermal vacuum chamber that is also capable of testing rocket engines. Of these facilities, only the SPF has a full slate of testing planned over the next several years. In contrast, Plum Brook's Hypersonic Tunnel Facility and Cryogenic Components Laboratory have not been utilized for at least 4 years while a third facility – the Combined Effects Chamber designed for large-scale liquid hydrogen experiments – is unusable in its current condition. As of February 2015, NASA had not identified any customers for these three facilities. Moreover, although NASA's Solar Electric Propulsion Project plans to perform testing in the B-2 vacuum chamber in 2015, future utilization of the facility's rocket testing capabilities is uncertain. While NASA officials told us the B-2 could be used to test the Space Launch System's (SLS) upper stage rockets, such testing would require \$15 million in basic refurbishment to the facility – costs the SLS Program or any other potential customer would be expected to cover in addition to potentially significant program-specific test costs necessary to meet customer requirements.

Plum Brook maintains a large amount of property to act as a buffer zone of open space to accommodate rocket testing at the B-2. If it becomes clear that such testing is not likely to resume, Plum Brook may be able to achieve cost savings by reducing the size of the buffer or at a minimum reducing the level of landscaping and road maintenance it performs in the zone.

Finally, although Plum Brook and local officials have discussed several ideas to bring additional revenues to the site such as establishing a wind farm and leasing land for commercial research, funding for these efforts has not materialized and it appears unlikely these efforts will come to fruition.

## WHAT WE RECOMMENDED

---

In order to assist NASA in ensuring effective and appropriate utilization of Plum Brook test facilities, we recommended the Assistant Administrator for Strategic Infrastructure and the Director of Plum Brook determine a long-term strategy for Plum Brook and evaluate and pursue plans to excess or demolish any unneeded infrastructure.

In response to a draft of our report, management concurred with our recommendations and described corrective actions they plan to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

**For more information on the NASA Office of Inspector General and to view this and other reports visit <http://oig.nasa.gov/>.**

---

# TABLE OF CONTENTS

<b>Introduction</b> .....	1
Background .....	1
<b>With the Exception of the SPF, Plum Brook’s Testing Facilities Have Few or No Customers</b> .....	8
Utilization of Plum Brook’s Test Facilities .....	8
Proposed Projects to Offset the Costs of Operating Plum Brook are Unfunded and Unlikely to Come to Fruition.....	13
<b>Conclusion</b> .....	15
<b>Recommendations, Management’s Response, and Our Evaluation</b> .....	16
<b>Appendix A: Scope and Methodology</b> .....	17
<b>Appendix B: Management Comments</b> .....	20
<b>Appendix C: Report Distribution</b> .....	22

# Acronyms

---

B-2	Spacecraft Propulsion Research Facility
CCL	Cryogenic Components Laboratory
CEC	Combined Effects Chamber
GAO	Government Accountability Office
HTF	Hypersonic Tunnel Facility
OIG	Office of Inspector General
NPR	NASA Procedural Requirement
SLS	Space Launch System
SPF	Space Power Facility

# INTRODUCTION

Located about 50 miles west of Glenn Research Center (Glenn) in Sandusky, Ohio, NASA's Plum Brook Station is home to several unique test facilities, including an environmental simulation chamber used to test hardware in a simulated space or planetary environment. However, a majority of the test facilities are underutilized, with the level of use and funding for these facilities depending on NASA programs and external customers choosing to perform testing at Plum Brook rather than at other NASA or private facilities.

The NASA Authorization Act of 2010 directed the Agency to examine its real property assets and downsize to fit current and future missions and expected funding levels, paying particular attention to removing unneeded or duplicative infrastructure. In two prior audit reports, the NASA Office of Inspector General (OIG) identified underutilized testing facilities at Plum Brook and raised concern over the lack of a strong customer base to support the site.<sup>1</sup> In addition, a 2005 NASA internal study identified Plum Brook as one of four Agency sites with insufficient work at the time to justify continued operations.<sup>2</sup> In this audit, we assessed the cost of operating Plum Brook in light of its current and expected utilization. Details of the audit's scope and methodology are in Appendix A.

## Background

---

The Federal Government purchased the 6,400 acres that compose the Plum Brook site in 1941. Originally, the site was home to the Plum Brook Ordnance Works, one of the top three suppliers of *trinitrotoluene*, better known as the explosive TNT, in the United States. Although most of the original facilities were designed to be temporary, during this early period, the Government built 99 concrete and steel-reinforced igloo-shaped structures to house explosives, many of which still remain on site. Production of TNT at Plum Brook ended in 1945.

In 1951, NASA's predecessor agency, the National Advisory Committee for Aeronautics, directed Glenn to design and build a nuclear reactor as part of a program to develop a nuclear airplane.<sup>3</sup> Glenn eventually chose Plum Brook as the site for the reactor, which became operational in 1961. Although President Kennedy cancelled the nuclear airplane program that same year, Plum Brook scientists used the reactor to conduct other research until 1973 when it was shut down permanently.<sup>4</sup> In addition to the reactor, the Government built other testing facilities at Plum Brook during the 1960s that supported various NASA and commercial programs, including development of the Centaur, Delta, and Atlas rockets and components for the Mars Pathfinder and the International Space Station.

---

<sup>1</sup> NASA OIG, "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices" (IG-12-020, August 9, 2012) and "NASA's Efforts to Reduce Unneeded Infrastructure and Facilities" (IG-13-008, February 12, 2013).

<sup>2</sup> This study was never officially finalized, and NASA took no action to implement its recommendations.

<sup>3</sup> At the time, Glenn was known as Lewis Field.

<sup>4</sup> NASA completed dismantling of the reactor and associated environmental cleanup efforts in 2012.

According to Plum Brook’s Real Property Management System, as of August 2014, the site contained 196 buildings, structures, and other property with a total current replacement value of more than \$877.5 million.<sup>5</sup> In addition, approximately 124 civil servant and contractor personnel currently work at the site.

In July 2012, NASA instituted a Technical Capabilities Assessment Team charged with identifying the critical capabilities the Agency needs in order to meet current and future missions and making recommendations regarding investing in, consolidating, or eliminating unneeded facilities and capabilities. Plum Brook’s capabilities were to be included as a part of this initiative.

## Plum Brook Test Facilities

Plum Brook boasts five major test facilities: Space Power Facility (SPF), Spacecraft Propulsion Research Facility (B-2), Hypersonic Tunnel Facility (HTF), Cryogenic Components Laboratory (CCL), and Combined Effects Chamber (CEC). Non-testing facilities at Plum Brook include an engineering building that houses administrative offices, other support buildings, and 71 of the original 99 igloos. NASA and Agency tenants, including the U.S. Department of Agriculture and the Federal Bureau of Investigations, use some of the igloos for storage.<sup>6</sup>

### *Space Power Facility*

Originally constructed in 1968, the SPF is an environmental simulation chamber used to test hardware in a simulated space or planetary environment. At 100 feet in diameter and 122 feet high, NASA used the SPF thermal vacuum chamber to test airbag landing systems for the Mars Pathfinder and components for the Mars Rovers, Spirit, and Opportunity.

The SPF also houses two additional testing chambers: Reverberant Acoustic Test Facility and Mechanical Vibration Facility. According to Plum Brook officials, the Reverberant Acoustic Test Facility – completed in 2011 at a cost of approximately \$30 million – is the world’s most powerful chamber designed to simulate the extreme sound pressure associated with launch, emergency abort, and reentry of space vehicles.



<sup>5</sup> “Current replacement value” is the total escalated value of the original facility cost in present-day dollars. This value is not an estimated cost to rebuild or replace the facility, but is the book value of the asset escalated by the Building Cost Index found in *Engineering News-Record*, a McGraw Hill publication.

<sup>6</sup> The annual cost to maintain the remaining igloos has averaged approximately \$19,000 over the last 3 years. Plum Brook officials told us they plan to continue demolishing the igloos over the coming years until none remain.



Currently under construction, the Mechanical Vibration Facility is expected to be the world's highest capacity and most powerful facility designed to simulate the intense shaking associated with launch, emergency abort, and reentry of space vehicles. Once the Mechanical Vibration Facility's vibration table is complete, it will be used to test NASA's Orion Multi-Purpose Crew Vehicle. The facility is scheduled to complete final inspection in June 2015 at a cost of approximately \$25 million.

**SPF Mechanical Vibration Facility**



Source: NASA.

### ***Spacecraft Propulsion Research Facility***

Originally constructed in 1964, the B-2 has two primary capabilities: (1) the world's largest thermal vacuum chamber that is capable of accommodating liquid hydrogen, and (2) a rocket propulsion testing capability for conducting hot-fire upper-stage launch vehicle and rocket engine testing. The B-2 is the only facility in the world capable of verifying rocket engine and upper-stage starts and restarts after long-term exposure to the cold and vacuum of space. However, the B-2's rocket propulsion testing capability has not been utilized since 1998, and costly refurbishment would be required to restore the facility to its full capabilities.

**Delta III Rocket Components Being Lowered into the B-2 Thermal Vacuum Chamber**



Source: NASA.

### ***Hypersonic Tunnel Facility***

Originally constructed in 1967, the HTF was designed to conduct research, development, and acceptance testing of hypersonic air breathing propulsion systems in conditions typical of hypersonic flight. The HTF was last used in 2002 and currently receives only minimal levels of maintenance. Plum Brook personnel describe the facility as in generally good order and are actively seeking customers for the HTF; however, if users do not come forward, NASA plans to demolish the facility in 2018.



### ***Cryogenic Components Laboratory***

The CCL was designed for research, development, and qualification of cryogenic materials, components, and systems. In 2008, relocation of the CCL from Glenn to Plum Brook was completed in response to a request from the City of Cleveland to clear the area for an airport expansion project. The City of Cleveland covered the expense of the relocation in exchange for obtaining the land for the expansion effort. The OIG reported that NASA accepted the offer to move rather than demolish the CCL, which had not been used since 1994, without ensuring its continuing need.<sup>7</sup> In July 2007, Glenn indicated the CCL would be needed for a period of 6 months beginning in January 2008 to support test requirements related to NASA’s Constellation Program. According to Plum Brook officials, the CCL performed three test projects for the Constellation Program between 2008 and 2011. However, as of February 2015, no future testing was planned and NASA has placed the CCL in inactive status.<sup>8</sup> Plum Brook officials told us they plan to move the CCL’s pressure vessels to other Plum Brook facilities, such as the B-2, and demolish the remainder of the CCL at some point in the future.



<sup>7</sup> NASA OIG, “Observations on the Review and Approval of Glenn Research Center’s Relocation of the Cryogenic Components Laboratory Facility” (IG-07-027, September 28, 2007 and related addendum, November 30, 2007)

<sup>8</sup> According to NASA guidance, a facility is considered “inactive” when no personnel occupy the facility; utilities are curtailed other than required for fire prevention, security, and safety; the facility is secured to prevent unauthorized access and injury to personnel; and the facility does not receive funding for renewal or other significant improvement.

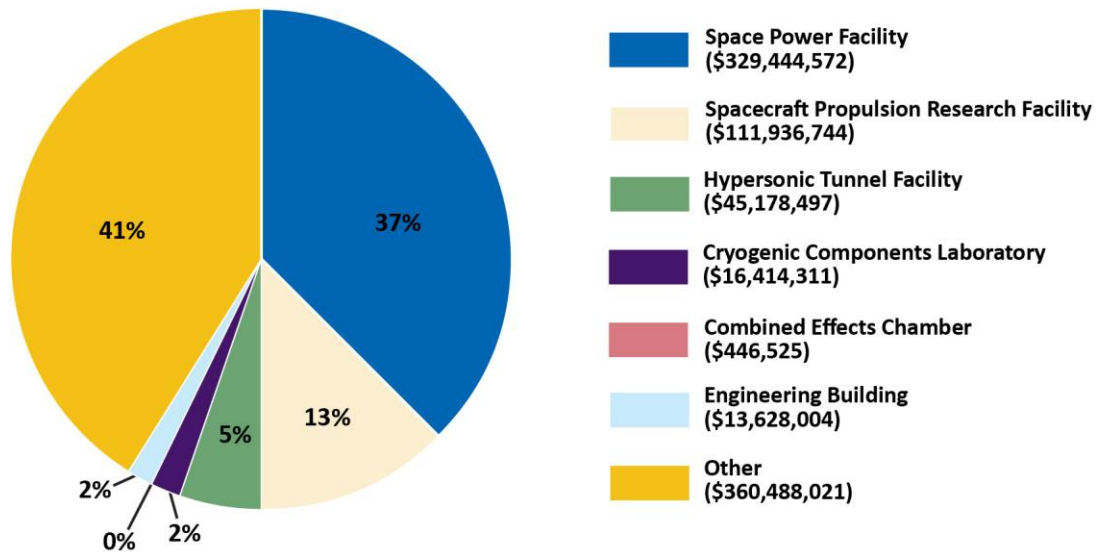
## Combined Effects Chamber

The CEC was salvaged from the former Cryogenic Propellant Tank Facility (which was demolished in 2012) and relocated in 2014 to an area near the B-2. The CEC is 25 feet in diameter with a 20-foot diameter door pressure vessel designed to allow large-scale liquid hydrogen experiments. The CEC is not usable in its current condition and NASA has not identified any future customers.

## Current Replacement Value of Plum Brook Facilities

The SPF and B-2 are the most expensive and utilized test facilities at Plum Brook. These two facilities, including their 14 supporting structures, account for approximately half of the total current replacement value for all of Plum Brook. An additional 180 structures – including the HTF, CCL, CEC, engineering building, and storage igloos – account for the remainder (see Figure 1).

**Figure 1: Comparison of Current Replacement Value of Plum Brook Facilities**



Source: OIG analysis of current replacement value data provided by NASA Headquarters. These amounts include the primary building and supporting buildings and structures for each test facility.

Since October 2011, Plum Brook has demolished or excessed 18 structures, thereby reducing its total current replacement value by approximately \$138.9 million and its total deferred maintenance by approximately \$12 million.<sup>9</sup> As shown in Table 1, the total deferred maintenance for Plum Brook as of October 2014 is approximately \$54.1 million. Of this amount, the SPF and B-2 account for \$18.6 million and \$1.8 million, respectively, of Plum Brook's deferred maintenance.

<sup>9</sup> NASA defines deferred maintenance as the essential but unfunded work necessary to bring Centers up to required facilities maintenance standards.

**Table 1: Reduction in Plum Brook Station Facilities**

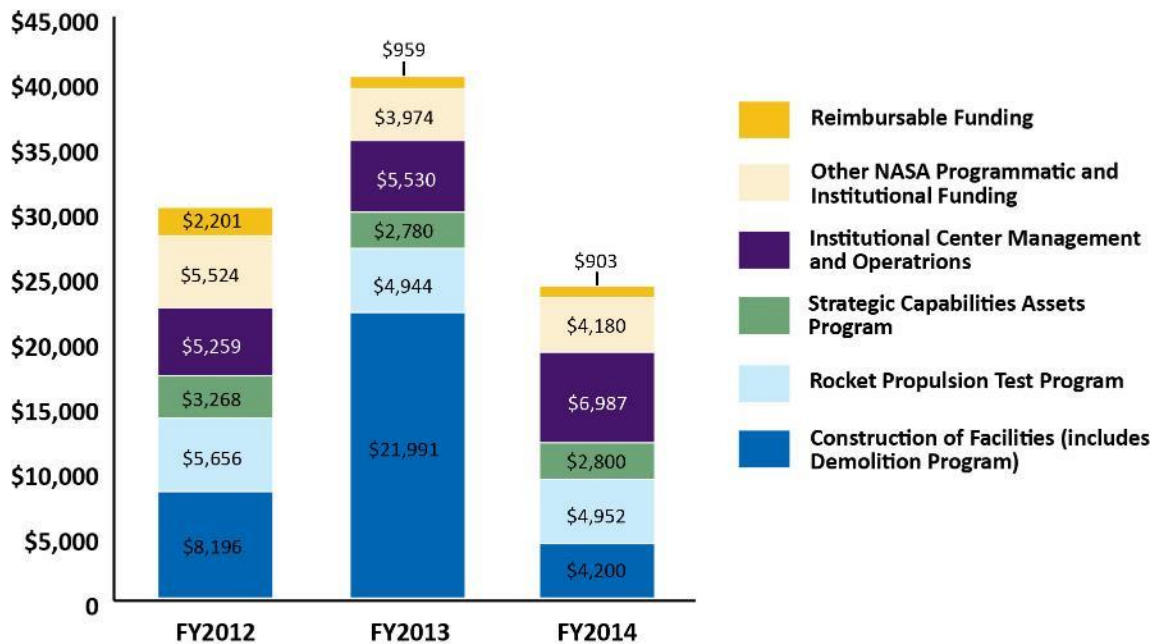
Fiscal Year	Number of Buildings or Structures	Total Current Replacement Value	Total Deferred Maintenance
2012	214	\$1,016,414,862	\$66,190,000
2013	204	882,335,266	54,510,000
2014	196	877,536,674	54,090,000
<b>Total Reduction</b>	<b>18</b>	<b>\$138,878,188</b>	<b>\$12,100,000</b>

Source: OIG analysis.

## Funding for Plum Brook Operations

As shown in Figure 2, for fiscal years 2012 through 2014 Plum Brook received an average of approximately \$31 million in annual funding from a variety of sources.

**Figure 2: Funding Provided to Plum Brook for Fiscal Years 2012 through 2014 (dollars in thousands)**



Source: OIG analysis.

For fiscal years 2012 and 2013, Plum Brook’s largest single source of funding – more than \$30 million – came from NASA’s Construction of Facilities budget, which NASA uses to construct new facilities, make major renovations and repairs to current facilities, and demolish unused facilities. During this period, Plum Brook spent more than \$22.5 million of that funding to complete repairs to the SPF and approximately \$5.8 million to relocate Plum Brook’s main gate to reroute traffic entering the site away from a residential area. Much of the remaining funds were used to demolish unneeded facilities at Plum Brook.

Plum Brook receives the majority of its institutional operations and maintenance funding from three sources: Strategic Capabilities Assets Program, Rocket Propulsion Test Program, and Glenn's Center Management and Operations fund. The Strategic Capabilities Assets Program is a NASA Headquarters program that manages key Agency capabilities and assets deemed essential to the future needs of NASA and the Nation – a designation that includes the SPF. Located at Stennis Space Center, the Rocket Propulsion Test Program manages NASA's major rocket propulsion testing facilities and provides significant funding for the B-2. Plum Brook funding from these three sources has averaged approximately \$14 million per year for the last 3 years.

Receipts from leased property and reimbursable testing account for the remainder of Plum Brook's funding. Plum Brook has tenants, including several that lease land for agricultural use.<sup>10</sup> Over the past 3 years, Plum Brook received approximately \$1.4 million from tenants and commercial leases and approximately \$2.6 million from reimbursable test operations.

In addition, NASA programs and others interested in using Plum Brook facilities must pay the costs needed to meet their specific requirements, including those associated with testing preparation and execution, such as labor, materials, and any special equipment needed. These programs are also expected to fund any needed upgrades or repairs not funded by institutional sources.

Finally, in October 2014 the Ohio Development Services Agency announced a \$2 million business assistance grant to the Ohio Company that holds the Test Facilities Operations Maintenance and Engineering contract for Plum Brook and Glenn. According to Plum Brook's Director, this grant should be sufficient to fund repairs to the three smaller of the seven total water pumps at the B-2.

---

<sup>10</sup> For additional information about Plum Brook's agricultural leases, see NASA OIG, "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices" (IG-12-020, August 9, 2012).

# WITH THE EXCEPTION OF THE SPF, PLUM BROOK'S TESTING FACILITIES HAVE FEW OR NO CUSTOMERS

Over the past 10 years, Plum Brook has eliminated approximately 1.3 million square feet of buildings and structures. Of its major test facilities, only the SPF has a full slate of testing planned for the next several years. Although NASA's Astrophysics Division and the U.S. Army plan to perform testing in the B-2's thermal vacuum chamber in 2015, future utilization of the B-2's companion rocket testing capabilities is uncertain. Moreover, no testing has taken place in the HTF and the CCL for more than 4 years, and the CEC has not yet been used. In addition, Plum Brook maintains a large amount of property to act as a buffer zone of open space to accommodate rocket testing at the B-2. If it becomes clear that such testing is not likely to resume, Plum Brook may be able to achieve additional cost savings by reducing the size of its buffer zone or, at a minimum, reducing the level of landscaping and road maintenance it performs in the zone. Finally, although several activities that could bring additional revenues to Plum Brook have been proposed, including establishing a wind farm and leasing land for commercial research, funding for these efforts has not materialized and it appears unlikely they will come to fruition.

## Utilization of Plum Brook's Test Facilities

---

Plum Brook's most significant and expensive-to-maintain testing facilities are the SPF and B-2. As of January 2015, NASA, the Department of Defense, and commercial launch providers are using or have plans to use the SPF through at least 2020 to test space-related hardware, including for NASA's Orion Multi-Purpose Crew Vehicle (see Figure 3).

**Figure 3: SPF Thermal Vacuum Chamber**



Source: NASA.

In contrast to the active utilization of the SPF, utilization of the B-2 is more limited. In 2014, the Solar Electric Propulsion Project utilized the B-2's thermal vacuum chamber approximately 75 percent of the year for testing in connection with a possible asteroid redirect mission.<sup>11</sup> Plum Brook received \$80,000 from Glenn's Center Management and Operations budget and \$275,000 from the Rocket Propulsion Test Program for this testing. In addition, NASA's Astrophysics Division plans to conduct high-altitude balloon testing and the U.S. Army has plans for testing related to its unmanned aerial vehicle program in the thermal vacuum chamber in 2015. However, future utilization of the B-2 to conduct hot-fire upper-stage launch vehicle and rocket engine testing is uncertain. The B-2 has not been used to conduct such testing for more than 15 years, and NASA personnel estimate that approximately \$15 million for basic refurbishment of the steam ejectors and pumps would be needed before such testing could resume. According to Rocket Propulsion Test Program officials, the Program does not have the funds to cover the renovations and any customers that want to conduct such testing would need to cover the costs of making the facility operational in addition to all program-specific test costs necessary to meet customer requirements. As of February 2015, no NASA program or outside entity had committed to funding the repairs.

<sup>11</sup> NASA's Solar Electric Propulsion project is developing technologies to enable cost-effective trips to Mars and to asteroids across the inner solar system, as well as to support a variety of commercial spaceflight activities. The project anticipates using energy from solar arrays converted into electricity, which would be used to ionize and accelerate propellant to produce thrust.

Program officials within NASA's Human Exploration and Operations Mission Directorate told us B-2 could be used to test the Space Launch System's (SLS) upper stage. According to these officials, the SLS Program has yet to decide where or how to conduct this testing but is expected to make a decision sometime in 2016. If NASA decides to use the B-2, the SLS Program would be expected to cover the estimated \$15 million in basic refurbishment costs as well as SLS Program-specific test costs, which could likely be significant.

In 2013, NASA and the Department of Defense conducted a joint review of the ability and readiness of existing domestic altitude test facilities to support the upper stage rocket propulsion testing needs of the commercial launch industry.<sup>12</sup> Although the study did not examine the specific needs of the SLS Program, it identified the B-2 as the most cost effective site with thermal capability to refurbish for commercial testing.<sup>13</sup> Even if NASA identifies the B-2 as the most economical option for the SLS Program upper stage testing, it may decide to use another site as past experience has demonstrated. For example, in a January 2014 report, the OIG found NASA chose a test stand at the Stennis Space Center (Stennis) for SLS core stage testing, although the Stennis test stand was not the most cost-effective or timely choice for meeting Program requirements.<sup>14</sup> Agency officials cited program risk as a major factor in the decision to use the Stennis test stand for the core stage testing; however, the OIG questioned some aspects of the risk assessments conducted. NASA's selection of the Stennis test stand also resulted in part from a strategic plan to consolidate rocket engine test facilities and resources at Stennis.<sup>15</sup>

In addition, NASA's Technical Capabilities Assessment Team is reviewing all of the Agency's technical capabilities in a series of reviews of specific mission areas. It has not yet reported the results of the Agency's rocket propulsion capabilities to weigh all options against NASA's long-term requirements and strategic vision. Until that report has been completed, the fate of Plum Brook's B-2 will remain uncertain.

In the past, the European Space Agency and commercial launch providers have also considered using the B-2 to test second stage engines on their rockets. However, according to NASA officials, the European Space Agency is planning to build a test stand in Europe to accommodate such tests and no commercial launch provider has yet come forward to fund the renovations necessary to make the B-2 usable.

With regard to Plum Brook's remaining facilities, the HTF and CCL have not been utilized for testing for at least 4 years and the CEC has not yet been used. As of February 2015, no customers for these facilities have been identified.

---

<sup>12</sup> The study reviewed five test stand facilities that could be used for upper stage engine simulated altitude testing: NASA's A-3 test stand at Stennis Space Center, B-2 test stand at Plum Brook, and 401 test stand at White Sands Test Facility; and the U.S. Air Force's 1-42B test stand at the Air Force Research Laboratory and J-4 test stand at the Arnold Engineering Development Center.

<sup>13</sup> Stennis officials disagreed with the 2013 study's estimate for the cost of refurbishing the Stennis test stand.

<sup>14</sup> NASA OIG, "NASA's Decision Process for Conducting Space Launch System Core Stage Testing at Stennis" (IG-14-009, January 8, 2014). This report found that of the options considered by the SLS Program, the Stennis test stand was in the lowest state of readiness, required the longest time to refurbish, and cost the most to refurbish.

<sup>15</sup> Plum Brook's B-2 does not have the capabilities that were needed for the core stage testing and appropriately was not one of the options considered in that particular test.



## Plum Brook Operations and Maintenance Costs

During fiscal years 2012 through 2014, total operations and maintenance costs for Plum Brook were approximately \$16.6 million, or an average of approximately \$5.5 million per year. Table 2 summarizes utilization and average operations and maintenance cost data for the five primary test facilities at Plum Brook during this timeframe. These five facilities account for approximately \$2.8 million (51 percent) of Plum Brook's \$5.5 million average annual operations and maintenance expenses.

**Table 2: Utilization and Cost Summary for Plum Brook Station Test Facilities**

Facility	Activation Date	Date Facility was Last Used for Testing	Book Value <sup>c</sup> as of October 2014	Number of Personnel Assigned to Facility in 2014	Percentage of Utilization for 2014	Average Annual Operations and Maintenance Cost, Fiscal Years 2012 through 2014 <sup>d</sup>
Space Power Facility	12/31/1968	Currently being used	\$139,644,012	31	100	\$2,120,422
Spacecraft Propulsion Research Facility (B-2) <sup>a</sup>	12/31/1964	2014 for thermal vacuum testing and 1998 for propulsion testing	\$13,958,909	30	75	\$559,640
Hypersonic Tunnel Facility	12/31/1967	2002	\$10,880,115	0	0	\$85,832
Cryogenic Components Laboratory <sup>b</sup>	04/29/2008	2011	\$14,048,823	7	0	\$63,797
Combined Effects Chamber	05/28/2014	Not yet used	\$446,525	0	0	no data

Source: OIG analysis of NASA utilization and cost data.

<sup>a</sup> The utilization rate for B-2 relates solely to thermal testing conducted in 2014. Additional thermal testing is scheduled the B-2 for the first half of calendar year 2015. In addition to the number of personnel assigned to the B-2, additional personnel may work on specific tests.

<sup>b</sup> For the CCL, as of February 2015 no testing was ongoing at the facility; however, according to Plum Brook officials, 7 employees are using some of the shop space.

<sup>c</sup> The book value of a property is the original cost of the property, as recorded in NASA's Real Property Management System, plus modifications, where appropriate, for improvements, removals, or other actions of \$5,000 or more. For purposes of this report, the book value includes the related facility components such as utility service buildings, storage buildings, and other structures.

<sup>d</sup> Operations and maintenance are day-to-day or recurring activities required to preserve facilities to perform their intended functions.

## Plum Brook May Be Able to Further Reduce its Footprint and Achieve Additional Savings

Over the past 10 years, Plum Brook has made progress reducing unneeded facilities. As of August 2014, Plum Brook had demolished more than 65 structures and infrastructure over the past 10 years and has plans for additional demolition, including eventual demolition of the igloos. For example, Plum Brook excessed one pump station – the Rye Beach Pump Station – associated with the now decommissioned nuclear reactor and is in the process of excessing a second – Big Island Pump Station (see Figure 4). The operations and maintenance costs for these stations for the past 3 years totaled approximately \$35,500. In 2012, Plum Brook completed demolition of its nuclear reactor, which was permanently shut down in 1973. Prior to its demolition, the reactor building had a total deferred maintenance value of approximately \$12.86 million.

**Figure 4: Rye Beach and Big Island Pump Stations**



*Rye Beach Pump Station*



*Big Island Pump Station*

Source: NASA.

Further reductions may be possible, but these reductions are dependent on the outcome of the decision regarding SLS testing. Engine testing at the B-2 requires a significant acoustic buffer. In April 2014, NASA completed a study that estimated the surrounding acoustic levels if the B-2 became fully operational. According to NASA engineers, it is preferable for decibel levels to be kept around 85 or below to avoid property damage to surrounding communities. At that standard, Plum Brook would need to maintain all of its current buffer zone, which is essentially the entire 6,400 acre installation, if the B-2 becomes fully operational. However, if NASA decides that the B-2 is not needed for future testing and no outside party comes forward to fund renovations to make the facility operational, Plum Brook's footprint could be significantly reduced. Moreover, even if the B-2 resumes operation and the buffer zone cannot be reduced, Plum Brook may be able to achieve additional savings by reducing the level of landscaping and road maintenance it conducts in the buffer zone.

# Proposed Projects to Offset the Costs of Operating Plum Brook are Unfunded and Unlikely to Come to Fruition

---

Over the years, Plum Brook has considered several projects aimed at improving facility utilization and reducing operational costs. However, Plum Brook officials have not secured funding for any of these projects and it is uncertain if there is sufficient demand to support them. Although these projects are included in Plum Brook's long-range master planning documents, there is no specific timeline for completion of any of the projects and their future is uncertain.

Plum Brook currently has three main proposed projects: a wind farm, a runway, and a Job-Ready site. According to Headquarters officials, NASA is not interested in funding these projects given other Agency priorities, and consequently, Plum Brook must look for funding elsewhere. Glenn and Plum Brook officials have indicated that budgetary constraints have forced them to put development of these projects on hold and shift focus to improving utilization of Plum Brook's existing test facilities, demolition of unneeded structures, and excessing of unused land.

## Wind Farm Project

The wind farm project involves a proposed 20- to 25-year partnership with a commercial wind energy developer that would fund the construction of up to 26 wind turbines on a 2,000-acre tract of land along the east-central portion of Plum Brook. The purpose of the project is to generate clean, renewable energy for NASA to meet requirements in the Energy Policy Act of 2005 and Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management." To comply with the Act and Executive Order 13423, 7.5 percent of all electrical energy provided to NASA must come from renewable sources and, to the maximum extent possible, the renewable energy generation projects should be implemented on Agency property for Agency use.

The wind farm project is currently on hold due to the need for a partner to come forward with funding. According to NASA Headquarters, Glenn, and Plum Brook officials, there are several potential issues with the project. For example, the project lacks a strong business case because current natural gas prices are far below the projected price of wind energy. Additionally, studies at Plum Brook have identified environmental issues with the proposed location of the wind farm, including an expected negative impact on the local bald eagle population. While the wind farm project is still on its long-range master plan, Plum Brook is looking for alternative ways to meet requirements for generating clean, renewable energy.<sup>16</sup>

## Runway Project

The runway project proposes a partnership with the local Erie County, Ohio, government to construct a 9,000-foot runway and associated infrastructure at Plum Brook. In 2010, the project was estimated to cost \$60.2 million. The goal of the runway project is to attract customers for Plum Brook's test facilities by eliminating the risks associated with surface transportation of large test items. According to the Plum Brook Director, constructing a runway at Plum Brook will improve its utilization since the nearest available airfield is 60 miles away, which adds to the transportation expense for a customer and

---

<sup>16</sup> NASA currently meets its renewable energy goals, in part, by purchasing energy credits rather than generating its own renewable energy, which accounts for approximately 65 percent of the Agency's goals.

potentially increases the risk of damage to a test article. However, NASA Headquarters and Rocket Propulsion Test Program officials do not view Plum Brook's lack of a runway as a significant hindrance to utilization of its test facilities and are unwilling to fund the project.<sup>17</sup>

## **Job-Ready Site Project**

The Job-Ready Site Program is administered by the Ohio Development Services Agency to help cultivate economic development in the State of Ohio. Sites improved under the Job-Ready Site Program are made ready for businesses seeking locations for new or expanded operations. Working with NASA, officials from Erie County proposed a job-ready site project that would create a commercial research and development complex just outside of Plum Brook. Plum Brook's Job-Ready Site Project aims to utilize approximately 1,264 acres of land NASA currently leases to agricultural tenants to build heavy research and development facilities and infrastructure to serve the needs of NASA and high-tech aerospace customers. The proposed site already has sufficient water lines and electric capacity, fiber optics and telecommunication infrastructure, and a NASA-owned natural gas distribution network to serve the proposed site. While there have been no obvious environmental issues or other obstacles identified to restrict development, the proposed site needs better road access, construction of a sanitary sewer, and an additional environmental study.

The Job-Ready Site Project is currently on hold and its future depends on Ohio's selection of Plum Brook as one of its job-ready sites. In 2008, Erie County applied for a grant from the State of Ohio for approximately \$2.75 million, or 25 percent of the estimated costs of approximately \$11 million; however, as of February 2015, the site has not been selected as a job-ready site.

---

<sup>17</sup> In recent years, NASA has leased or is in the process of leasing out airfields or runways at two other Centers in an effort to reduce operations and maintenance costs.

# CONCLUSION

Plum Brook is home to several unique test facilities, however, many of these facilities lack current customers and appear to have little chance of future use. For example, the site's rocket test facility – the B-2 – requires approximately \$15 million in basic refurbishment costs to restore it to full operational capability and it remains unclear whether NASA or any outside customer is willing to fund these needed repairs, which would be in addition to the potentially significant costs to meet their specific testing requirements, and therefore utilize the facility. Because Plum Brook depends on NASA programs or commercial customers choosing its facilities over other testing options, it struggles with uncertainty regarding whether its facilities are needed and where funding will come from to repair and maintain them.

Furthermore, while over the last several years Plum Brook has made progress reducing unneeded infrastructure and associated maintenance costs, additional progress depends in large part on NASA deciding whether it will utilize the B-2 for SLS testing – a decision that will in turn inform choices about Plum Brook's acoustic buffer zone. NASA is currently working to strategically address the technical capabilities required to support Agency goals as part of its Technical Capabilities Assessment Team effort. Depending on the determination for SLS testing and the results of the Technical Capabilities Assessment Team assessment, Plum Brook may be able to excess additional property and further reduce its operations and maintenance costs.

# RECOMMENDATIONS, MANAGEMENT'S RESPONSE, AND OUR EVALUATION

In order to assist NASA in ensuring that the Agency is effectively and appropriately utilizing its test facilities at Plum Brook, we recommended the NASA's Assistant Administrator for Strategic Infrastructure and the Director of Plum Brook Station do the following:

1. In coordination with the Associate Administrator of the Human Exploration and Operations Mission Directorate, the Glenn Research Center Director, and the appropriate Capability Leaders, determine a long-term strategy for Plum Brook, including identifying
  - a. which of the existing property and facilities NASA needs to retain,
  - b. alternatives to further reduce costs for operating and maintaining the facilities, and
  - c. required resources for making repairs to necessary facilities to ensure that the full capabilities are available to the Agency and others.
2. In coordination with the Glenn Research Center Director, evaluate and pursue plans to excess or demolish unneeded infrastructure at Plum Brook.

We provided a draft of this report to NASA management, who concurred with our recommendations and described planned corrective actions. Because we consider management's comments responsive to our recommendations, the recommendations are resolved. We will close the recommendations upon completion and verification of the proposed corrective actions. Management's full response to our report is reproduced in Appendix B. Technical comments provided by management have also been incorporated, as appropriate.

Major contributors to this report include: Laura Nicolosi, Mission Support Director; Karen VanSant, Project Manager; Troy Zigler, Auditor; GaNelle Flemons, Auditor; and Sashka Mannion, Analyst.

If you have questions about this report or wish to comment on the quality or usefulness of this report, contact Laurence Hawkins, Audit Operations and Quality Assurance Director, at 202-358-1543 or [laurence.b.hawkins@nasa.gov](mailto:laurence.b.hawkins@nasa.gov).



Paul K. Martin  
Inspector General

# APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from July 2014 through April 2015 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We reviewed Federal and NASA policies, regulations, and plans to determine the requirements and criteria for identifying and assessing the Agency's unneeded infrastructure. The documents we reviewed included:

- NPR 8820.2G, "Facility Project Requirements," June 2014
- NPR 8820.2D, "Design and Construction of Facilities," July 2013
- Office of Management and Budget M-11-22, "Realignment of Federal Real Estate," May 2011.
- General Services Administration, Office of Government-wide Policy, "General Reference Guide for Real Property Policy," October 2010
- NPR 8800.15B, "Real Estate Management Program," June 2010
- NPR 8810.2A, "Master Planning for Real Property," December 2009
- NPR 8831.2E, "Facilities Management and Operations Management," November 2008
- NASA Procedural Requirement (NPR) 8800.14D, "Policy for Real Estate Management," July 2004
- Executive Order 13327, "Federal Real Property Asset Management," February 2004

We interviewed NASA Headquarters and Center officials concerning the utilization and requirements for the facilities at Plum Brook, including officials-in-charge of the operation and management of Plum Brook Station, Glenn's Facilities Utilization Officer, Real Property Accountable Officer, as well as officials in the NASA Headquarters Mission Support Directorate and Human Exploration and Operations Mission Directorate. Further, we interviewed officials in the Rocket Propulsion Test Program Office at Stennis Space Center. We also reviewed various Agency studies concerning utilization and capabilities of Plum Brook's technical facilities.

## Use of Computer-Processed Data

We used computer-processed data to assess the costs of the Plum Brook Facilities. We obtained the applicable Work Breakdown Structure codes and ran queries of NASA's accounting system to obtain cost data on the test facilities, primarily the B-2, as well as tenant and lease costs. We compared the data in the accounting system to cost data obtained from NASA managers and other sources. From these efforts, we believe the information we obtained is sufficiently reliable for this report.

## Review of Internal Controls

We performed a preliminary assessment of the internal controls associated with our audit, including identifying controls that should be in place according to regulation. Throughout the audit we reviewed controls associated with the audit objectives and identified that NASA did not have sufficient controls to ensure that the property at Plum Brook was fully utilized and that NASA was appropriately funding activities at Plum Brook Station. We believe that our recommendations will assist the Agency in taking actions to address these weaknesses.

## Prior Coverage

During the last several years, the NASA OIG and the Government Accountability Office (GAO) have issued 15 reports of significant relevance to the subject of this report. Unrestricted reports can be accessed at <http://oig.nasa.gov/audits/reports/FY15> and <http://www.gao.gov>, respectively.

### ***NASA Office of Inspector General***

*NASA's Decision Process for Conducting Space Launch System Core Stage Testing at Stennis* (IG-14-009, January 8, 2014)

*NASA's Efforts to Reduce Unneeded Infrastructure and Facilities* (IG-13-008, February 12, 2013)

*NASA Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices* (IG-12-020, August 9, 2012)

*NASA Infrastructure and Facilities: An Assessment of the Agency's Real Property Master Planning* (IG-12-008, December 19, 2011)

*NASA Infrastructure and Facilities: Assessment of Data Used to Manage Real Property Assets* (IG-11-024, August 4, 2011)

*NASA's Hangar One Re-Siding Project* (IG-11-020, June 22, 2011)

*Audit of NASA's Facilities Maintenance* (IG-11-015, March 2, 2011)

*Audit of Requirements for Testing Facilities at Plum Brook* (IG-07-033, September 28, 2007)

*Observations on the Review and Approval of Glenn Research Center's Relocation of the Cryogenic Components Laboratory Facility* (IG-07-027, September 28, 2007 and related addendum, November 30, 2007)

### ***Government Accountability Office***

*Space Launch System: Resources Need to be Matched to Requirements to Decrease Risk and Support Long Term Affordability* (GAO-14-631, July 2014)

*High-Risk Series: An Update* (GAO-15-290, February 11, 2015)



*Federal Real Property: Strategic Partnerships and Local Coordination Could Help Agencies Better Utilize Space* (GAO-12-779, July 2012)

*Federal Real Property: National Strategy and Better Data Needed to Improve Management of Excess and Underutilized Property* (GAO-12-645, June 2012)

*Excess Facilities: DOD Needs More Complete Information and a Strategy to Guide Its Future Disposal Efforts* (GAO-11-814, September 2011)

*Federal Real Property: Proposed Civilian Board Could Address Disposal of Unneeded Facilities, Statement of David J. Wise, Director, Physical Infrastructure Issues, and Brian J. Lepore, Director, Defense Capabilities and Management Issues* (GAO-11-704T, Testimony given June 9, 2011)

# APPENDIX B: MANAGEMENT COMMENTS

National Aeronautics and Space Administration  
 Headquarters  
 Washington, DC 20546-0001



APR 21 2015

Reply to Attn of: Office of Strategic Infrastructure

TO: Assistant Inspector General for Audits

FROM: Assistant Administrator for Strategic Infrastructure  
 Director, Plum Brook Station

SUBJECT: Response to OIG Draft Audit Report, "Audit of NASA's Requirements for Plum Brook Station" (Assignment No. A-14-013-00)

NASA appreciates the opportunity to review your draft report entitled, "Audit of NASA's Requirements for Plum Brook Station" (Assignment No. A-14-013-00).

In the draft report, the OIG makes two recommendations addressed to the Assistant Administrator for Strategic Infrastructure and the Director of Plum Brook Station, intended to assist NASA in ensuring that the Agency is effectively and appropriately utilizing its test facilities at Plum Brook.

Management's response to the OIG NASA's recommendations, including planned corrective actions, follows:

**Recommendation 1:** In coordination with the Associate Administrator of the Human Exploration and Operations Mission Directorate, the Glenn Research Center Director, and the appropriate Technical Capabilities Assessment Team manager, determine a long-term strategy for Plum Brook, including identifying:

- a. which of the existing property and facilities NASA needs to retain,
- b. alternatives to further reduce costs for operating and maintaining the facilities, and
- c. required resources for making repairs to necessary facilities to ensure that the full capabilities are available to the Agency and others.

**Management's Response:** Concur. The chair of the Agency Mission Support Council initiated a Space Environments Testing Tiger Team to analyze NASA space environment testing facility requirements and available assets. This team is currently planned to brief its results and recommendations to the Agency Mission Support Council in September 2015. Recommendations from the Tiger Team will support NASA's 2018 budget cycle.

**Estimated Completion Date:** September 30, 2015.

**Recommendation 2:** In coordination with the Glenn Research Center Director, evaluate and pursue plans to excess or demolish unneeded infrastructure at Plum Brook.

**Management's Response:** Concur. NASA Headquarters and Glenn Research Center will continue their close cooperation to identify unneeded infrastructure and proceed with demolition or the appropriate action to dispose of unneeded infrastructure at Plum Brook. This coordination has produced a 65 percent reduction of facilities at Plum Brook Station since 2006, including a \$270 million cleanup of a nuclear reactor site to greenfield status. For over a decade, NASA Headquarters has conducted an annual review, working with Centers to identify unneeded facilities and initiate demolition or disposal. Since 2004, NASA has disposed of 1365 facilities, valued at \$2.9 billion. This includes Plum Brook facilities such as the research nuclear reactor, the B1 test stand, control buildings at H and K site, the cryogenics components laboratory, the high load tensile testing facility, and the development engineering building.

The results of the Space Environments Testing tiger team will enable NASA to better identify Plum Brook facilities that should be disposed or demolished. The 2016 annual review will incorporate this information to prioritize funding within the demolition program.

**Estimated Completion Date:** A summary of this review and recommendations will be available by December 31, 2016.

We have reviewed the draft report for information that we believe should not be publicly released. We have not identified any concerns regarding the public release of information contained in your report.

Thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Natasha McNeil at 202-358-2638.



Calvin F. Williams  
Assistant Administrator  
for Strategic Infrastructure



David L. Stringer  
Director  
Plum Brook Station

cc:

Deputy Associate Administrator/Ms. Roe  
Associate Administrator for Human Exploration and Operations/ Mr. Gerstenmaier  
Associate Administrator for Mission Support/Mr. Paquin  
Director, Glenn Research Center/Mr. Free

# APPENDIX C: REPORT DISTRIBUTION

## *National Aeronautics and Space Administration*

Administrator  
 Associate Administrator  
 Deputy Associate Administrator  
 Chief of Staff  
 Executive Officer  
 Associate Administrator for Mission Support  
 Assistant Administrator for Strategic Infrastructure  
 Associate Administrator for Human Exploration and Operations  
 Director, Glenn Research Center  
 Director, Plum Brook Station

## *Non-NASA Organizations and Individuals*

Office of Management and Budget  
     Deputy Associate Director, Energy and Space Programs Division  
 Government Accountability Office  
     Director, Office of Acquisition and Sourcing Management

## *Congressional Committees and Subcommittees, Chairman and Ranking Member*

Senate Committee on Appropriations  
     Subcommittee on Commerce, Justice, Science, and Related Agencies  
 Senate Committee on Commerce, Science and Transportation  
     Subcommittee on Space, Science, and Competitiveness  
 Senate Committee on Homeland Security and Governmental Affairs  
 House Committee on Appropriations  
     Subcommittee on Commerce, Justice, Science, and Related Agencies  
 House Committee on Oversight and Government Reform  
     Subcommittee on Government Operations  
 House Committee on Science, Space, and Technology  
     Subcommittee on Oversight  
     Subcommittee on Space

**(Assignment No. A-14-013-00)**