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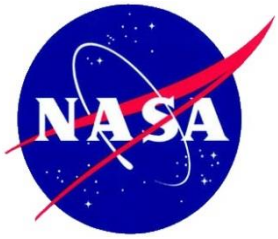
AUDIT OF SETI INSTITUTE

March 6, 2019

Report No. IG-19-011



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NASA Office of Inspector General
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RESULTS IN BRIEF

Audit of SETI Institute

March 6, 2019

IG-19-011 (A-18-010-00)

WHY WE PERFORMED THIS AUDIT

Supporting scientific and technological research to reveal the unknown about Earth, its Sun and solar system, and the universe for the benefit of humankind is an important part of NASA's mission. In 2017, NASA spent approximately $600 million on this type of research largely through grants and cooperative agreements. Among these recipients is the SETI Institute, a private, nonprofit organization established in 1984 to advance understanding of the universe through research into technosignatures, which includes the direct search for evidence of intelligent extraterrestrial civilizations using radio and optical telescopes. However, since that time the Institute's work has expanded beyond technosignatures research to include astronomy and astrophysics, exoplanets, astrobiology, climate and geoscience, and planetary exploration.

In this follow-up to our 2016 audit that examined 60 NASA-funded institutes (defined as academic institutions, research entities, and related organizations), we examined (1) the extent to which the SETI Institute supports NASA's science goals, whether the Institute used NASA funds for their intended purpose, and whether costs paid under the agreement were in accordance with applicable laws, regulations, and guidelines and (2) NASA's future involvement in technosignatures research.[1] In conducting this audit, we interviewed NASA and SETI Institute personnel; reviewed relevant federal and Agency laws, regulations, policies, and procedures; and evaluated the acquisition of, compliance with, and accounting for the Institute's NASA awards.

WHAT WE FOUND

At the time of our audit, the SETI Institute was engaged in 85 NASA grants and cooperative agreements valued at about $81 million spanning the planetary science, astrophysics, and heliophysics disciplines, as well as science, technology, engineering, and mathematics (STEM) research, education, and outreach. We selected 16 NASA awards for review and found 2 were relinquished by the Institute and the remaining 14 met required reporting requirements for performance and deliverables and aligned with the goals detailed in the research announcements and NASA Science Plan. The awards also produced useful data for the Agency and scientific community, including the discovery of extrasolar planets; information on bacteria, planetary satellites, and the development of biofuels from microbes; and the enhancement of STEM participation in America's youth. NASA's procurement files for the awards showed each contained well-documented records that supported the selection and award to the SETI Institute, and a review of the Institute's financial records and expense data indicated funds and costs were accounted for effectively, handled appropriately, and complied with federal and NASA regulations and guidance.

Over the past 25 years, NASA has, according to Agency officials, provided only three grants totaling $1.6 million for research associated with the direct search for extraterrestrial intelligent life through the use of electromagnetic signals. It is not clear whether this limited funding is simply because technosignatures research has not been an Agency priority or whether it is due to confusion related to a 1-year congressional prohibition on such research in 1993. The broader

[1] NASA Office of Inspector General, *Review of NASA-funded Institutes* (June 9, 2016, IG-16-023).

scientific community has expressed interest in the search for extraterrestrial intelligent life in the past, as did a House of Representatives NASA authorization bill voted out of Committee in April 2018.

WHAT WE RECOMMENDED

We made no recommendations in this report.

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

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Acronyms

CFR	Code of Federal Regulations
FRB	fast radio burst
HRMS	High Resolution Microwave Survey
NEO	Near-Earth Object
NRA	NASA Research Announcement
NRC	National Research Council
OIG	Office of Inspector General
ROSES	Research Opportunities in Space and Earth Sciences
SETI	search for extraterrestrial intelligence
SMD	Science Mission Directorate
STEM	science, technology, engineering, and mathematics

INTRODUCTION

Supporting scientific and technological research to reveal the unknown about Earth, its Sun and solar system, and the universe for the benefit of humankind is an important part of NASA's mission. NASA funds this type of research largely through grants and cooperative agreements valued at approximately $600 million in 2017. This research helps NASA meet its science goals and objectives; supports participation in science, technology, engineering, and mathematics (STEM); and drives research in a wide range of science and technology disciplines throughout the United States.

In June 2016, the NASA Office of Inspector General (OIG) examined 60 NASA-funded institutes (defined as academic institutions, research entities, and related organizations) to assess their alignment to Agency missions, their history and funding, and their contributions to NASA's mission.[1] Collectively, the 60 institutes received an average of about $800 million annually from NASA between 2013 and 2015, with 18 of the 60 receiving 95 percent or more of their total funding from the Agency. Since that overarching review, we have conducted a more detailed examination of several institutes that receive NASA funds. Among those organizations is the SETI Institute, a private, nonprofit research organization established in 1984 dedicated to advancing our understanding of the universe. In fiscal year 2018, the Institute was engaged in research related to 85 NASA awards valued at about $81 million spanning the planetary science, astrophysics, and heliophysics disciplines, as well as STEM research, education, and outreach. For the past 25 years, NASA has provided little funding for research by the Institute—or any other entity—associated with the direct search for extraterrestrial intelligent life through detection of electromagnetic signals (referred to as technosignatures research).[2] It is not clear whether this is simply because technosignatures research has not been an Agency priority or because of a 1-year prohibition on such research imposed by Congress in 1993.[3]

During this audit, we examined (1) the extent to which the SETI Institute supports NASA's science goals, whether the Institute used NASA funds for their intended purpose, and whether costs paid under the agreement were in accordance with applicable laws, regulations, and guidelines and (2) NASA's future involvement in technosignatures research. See Appendix A for details on the audit's scope and methodology.

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[1] NASA OIG, *Review of NASA-funded Institutes* (June 9, 2016, IG-16-023).

[2] According to Agency officials, NASA provided $1.6 million to two entities to develop instruments that augment technosignatures research. However, the direct search for extraterrestrial intelligence is privately funded. Electromagnetic radiation comprises the spectrum of energy ranging from radio and microwaves; infrared, visible, and ultraviolet light; and x-rays and gamma rays. Because this radiation is associated with electric and magnetic fields that transfer energy as they travel through space, it is called the electromagnetic spectrum. Because the term "search for extraterrestrial intelligence" is commonly abbreviated as "SETI" in the scientific community, we avoided using that term so as not to confuse it with references we make specifically about the SETI Institute.

[3] National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993, Pub. L. No. 102-588, Sec. 102 (a)(4) (1992).

Background

History of the Search for Extraterrestrial Intelligence and Establishment of the SETI Institute

Technosignatures research is a collective term for scientific searches for intelligent extraterrestrial life and includes—but is not limited to—monitoring electromagnetic radiation for signs of transmissions from civilizations on other planets.[4] The SETI Institute is only one organization within a broader community of practitioners that conduct technosignatures research. Moreover, the Institute conducts wide-ranging scientific research in multiple disciplines that goes well beyond the search for intelligent life outside of Earth.

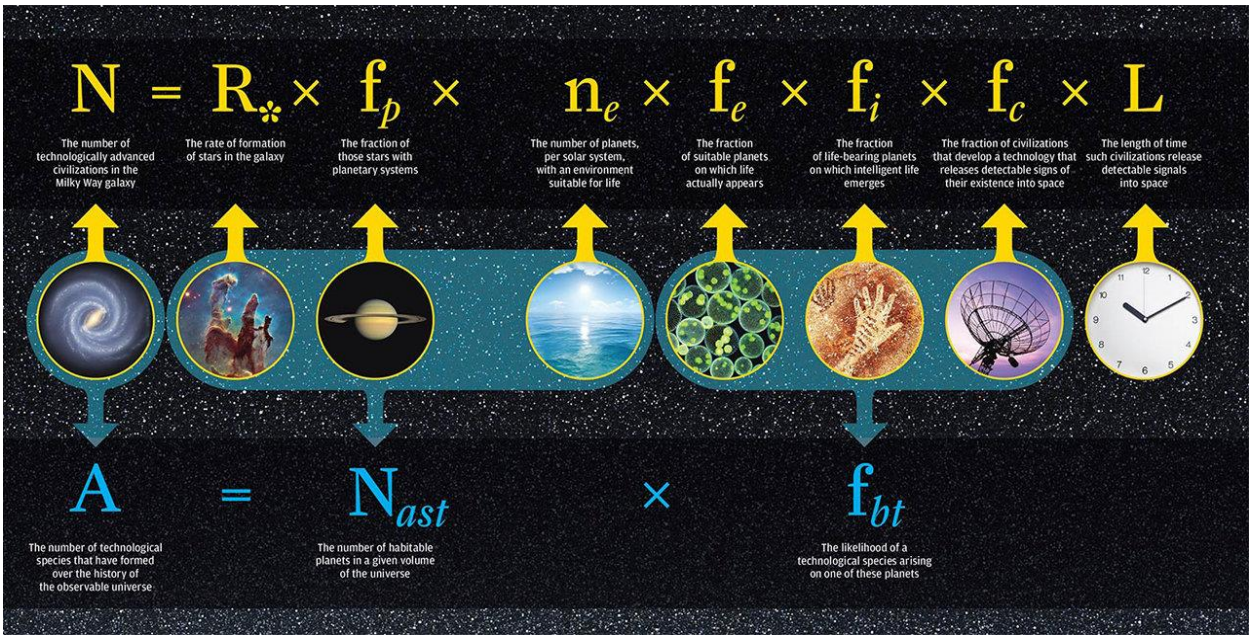
Experiments in technosignatures research first began in the early 20th century after scientific innovators such as Heinrich Hertz and Nikola Tesla began to understand how to manipulate electromagnetic radiation, with Tesla famously detecting radio waves in 1899 which he interpreted as interplanetary communication.[5] In the 1950s, astrophysicists Giuseppe Cocconi and Philip Morrison envisioned using the microwave portion of the electromagnetic spectrum to communicate at light speed over tremendous distances in our galaxy.[6] Shortly thereafter, Cornell University astronomer Frank Drake initiated Project Ozma at the National Radio Astronomy Observatory in West Virginia to search for signs of life in distant planetary systems by listening for interstellar radio waves. In 1961, Drake developed a formula, known as the Drake Equation, for estimating the number of intelligent civilizations in our galaxy. As illustrated in Figure 1, the Drake Equation seeks to answer one of NASA's and humanity's long-standing questions: are we alone in the universe?

[4] Technosignatures research can also include, for example, the search for complex hydrocarbons (smog) in the atmosphere of other planets. However, for the purposes of this report, we use the term "technosignatures research" to refer exclusively to the direct search for extraterrestrial intelligent life specifically through the detection of electromagnetic signals from advanced intelligent extraterrestrial civilizations.

[5] Heinrich Hertz was a German physicist who first conclusively proved the existence of electromagnetic waves. Nikola Tesla was a Serbian-American scientist and inventor whose work helped pave the way for alternating currents, electric motors, radios, fluorescent lights, lasers, and remote controls. He was posthumously awarded a U.S. patent for the radio in 1943.

[6] Giuseppe Cocconi was an Italian physicist who was director of the Proton Synchrotron at CERN [European Organization for Nuclear Research] in Geneva, Switzerland, and was known for his work in particle physics and for his involvement with technosignatures research. Philip Morrison was a professor of physics at the Massachusetts Institute of Technology who was involved with the United States' effort to build the first atomic bomb during World War II (the Manhattan Project) and chaired NASA's early technosignatures research. Cocconi and Morrison coauthored the article "Searching for Interstellar Communications," published in the science journal Nature in 1959.

Figure 1: Drake Equation



Source: NASA Exoplanet and Exploration Program.

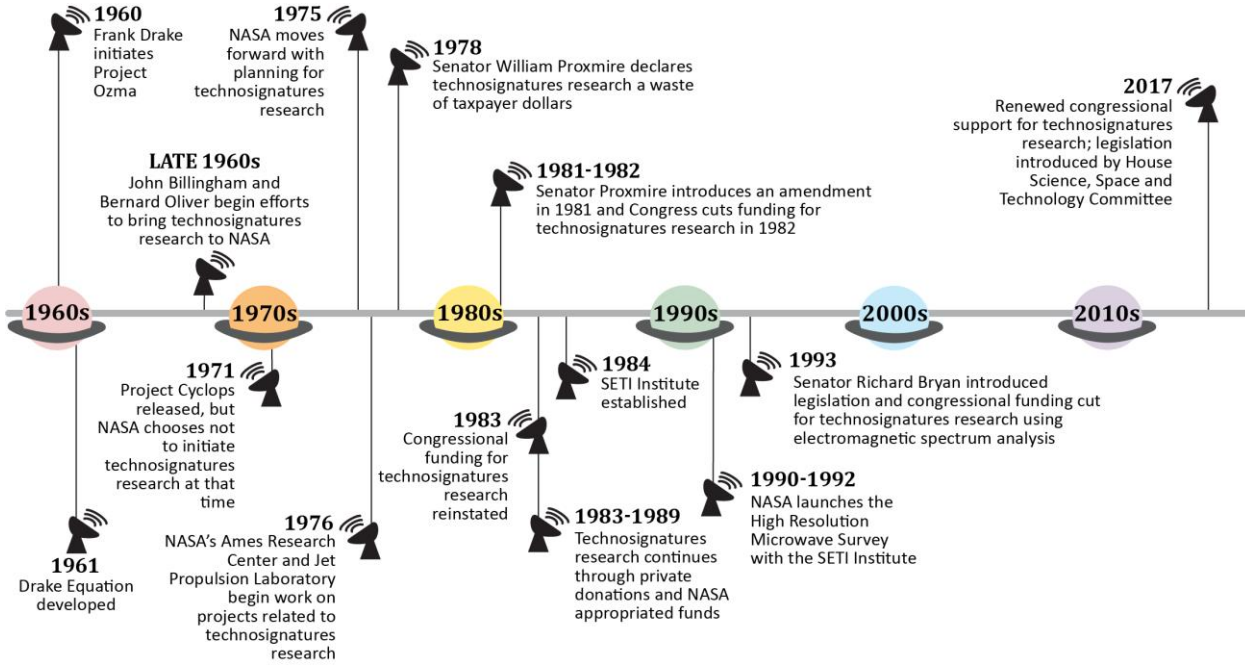
Note: The Drake Equation ($N = R_* \times f_p \times n_e \times f_e \times f_i \times f_c \times L$) is in yellow. A revised version of that equation ($A = N_{ast} \times f_{bt}$), described further in the paragraph below this figure, is in blue. The Drake Equation is broken down as follows: N is the number of civilizations we might someday contact; R_* is the rate at which stars are formed in our galaxy; f_p is the fraction of stars that are orbited by planets; n_e is the average number of habitable planets per star; f_e is the fraction of planets that could potentially sustain life; f_i is the fraction of planets that could potentially support intelligent life; f_c is the fraction of civilizations that build technology that we (or another civilization) might be able to detect from space; and L is the length of time that such a civilization would spend transmitting signals into space.

While the Drake Equation remains a conceptual framework used within NASA's science program, technological advancements and greater understanding of the universe since it was first developed has led to a scientific reexamination and revision of the equation, as depicted in Figure 1. The authors of this revised equation, Adam Frank and W.T. Sullivan III, stated, "Our results imply that our evolution has not been unique and has probably happened many times before."[7]

Since Drake initiated Project Ozma in 1960, technosignatures research has expanded through a series of initiatives as depicted in Figure 2.

[7] Adam Frank is a professor of physics and astronomy at the University of Rochester. W.T. Sullivan III is a professor of astronomy at the University of Washington.

Figure 2: Timeline of Notable Events and Activities



Source: NASA OIG presentation of information from "Searching for Good Science: The Cancellation of NASA's SETI Program," written by Stephen J. Garber of the NASA History Office and published in the *Journal of The British Interplanetary Society*, Vol. 52 (1999).

Promoted by the advancements made by Drake and the emergence of technosignatures research, John Billingham, former NASA Ames Research Center Life Scientist, and Bernard Oliver, former Vice President of Research at Hewlett Packard, attempted to bring this field of research to NASA in the late 1960s. Their efforts resulted in Project Cyclops, a 1971 study funded by NASA that detailed a plan to detect extraterrestrial intelligent life; however, due to the high costs associated with the project, the Agency did not invest in this area at that time.[8] Four years later, though, NASA management decided the science was mature enough to warrant investment and the Agency began funding-related design plans. The following year, the Ames Research Center with its biomedical research expertise and the Jet Propulsion Laboratory with its deep space communications experience began to work on the search for technosignatures utilizing NASA's Deep Space Network and the Arecibo, Parkes, Green Bank, and Nancay Observatories.[9]

The National Research Council's (NRC) 1972 astronomy and astrophysics decadal survey supported the concept of a concerted technosignatures research effort, stating that "a project with the goal of detection of intelligent life elsewhere may, in the long run, be one of science's most important and most profound contributions to mankind and to civilization."[10] Further, in 1979 an international community

[8] Project Cyclops was a 1971 NASA project that investigated how technosignatures research should be conducted. The project team created a design for coordinating large numbers of radio telescopes to search for Earth-like radio signals at a distance of up to 1,000 light-years to find intelligent life. NASA did not implement the proposed design due to its high costs; however, the report became the basis for much of the work later pursued within this scientific community.

[9] Radio telescope observatories that have been used for technosignature searches include the Deep Space Network (California), Arecibo (Puerto Rico), Parkes (Australia), Green Bank (West Virginia), and Nancay (France).

[10] NRC, *Astronomy and Astrophysics for the 1970's, Volume 1: Report of the Astronomy Survey Committee* (1972).

of scientists representing several Commissions of the International Astronomical Union met in Montreal, Canada. Building on discoveries made in ground- and space-based astronomy, the group laid the foundation for a new branch of astronomy—bioastronomy—dedicated to the study of life in the universe and the search for extraterrestrial life.

Beginning in 1983 with the renewed focus on the search for extraterrestrial intelligence within the scientific community, NASA officials and several prominent astronomers worked together to more efficiently manage research funding. The group determined that a nonprofit research organization would be the best method to manage such funding, and in 1984 established the SETI Institute.

In 1992, after several years of research and development, NASA launched the High Resolution Microwave Survey (HRMS) to search for microwave signals from extraterrestrial intelligent beings. HRMS consisted of an all-sky survey and a targeted search to explore the possibility there might be civilizations transmitting strong signals, possibly as interstellar beacons, as well as to look for weak signals originating near Sun-like stars within a distance of 100 light-years. The project began its observational phase in October 1992 at the NASA Goldstone Deep Space Communications Complex and the Arecibo Observatory. However, in October 1993, Congress discontinued funding for NASA's technosignatures research program and HRMS, which was set to receive $100 million over ten years, was subsequently canceled.[11]

Absent NASA support, technosignatures research continues with scientists relying on philanthropic donations. However, discoveries of a host of exoplanets and advances in technology over the past decade have sparked renewed interest within the scientific community.

The SETI Institute

While NASA no longer provides funding to the SETI Institute for the monitoring of radio transmissions for the purposes of searching for intelligent extraterrestrial life, the Agency has funded the Institute's research in other areas. Based in Mountain View, California, the SETI Institute is comprised of three divisions: the Carl Sagan Center for Research, the Center for Education, and the Center for Public Outreach.

- *The Carl Sagan Center for Research* conducts grant-funded research addressing questions around the development of life, where in the universe it exists, and how we might find it. Their research is focused in six areas (astronomy and astrophysics, exoplanets, astrobiology, climate and geoscience, planetary exploration, and technosignatures) and encompasses a wide set of disciplines such as observing and modeling the precursors of life in outer space and studying Earth and its biological history. SETI Institute scientists participate as investigators in NASA space flight missions performing scientific research and analysis.
- *The Center for Education* promotes STEM education through programs funded by NASA and the National Science Foundation aimed at teaching and inspiring children, young adults, and educators with an emphasis on space sciences and astrobiology.

[11] Pub. L. No. 102-588 imposed a 1-year prohibition on technosignatures research.

- *The Center for Public Outreach* shares scientific research performed by the Institute, such as STEM and space science education, through outreach activities including newsletters, online chats, and public lectures.

The SETI Institute conducts technosignature searches funded by private donations using its own Allen Telescope Array.[12] At the same time, the Institute submits proposals in response to the NASA Science Mission Directorate's (SMD) annual release of solicitations for research investigations and supports the Agency in a wide range of scientific endeavors including analyzing data collected by missions such as the Mars Rover, Kepler, K2 (the extended phase of the Kepler mission), and Cassini.[13] In fiscal year 2018, the Institute was conducting work funded by 85 NASA awards valued at about $81 million across the science missions listed below in Figure 3 and explained in further detail in Appendix B.

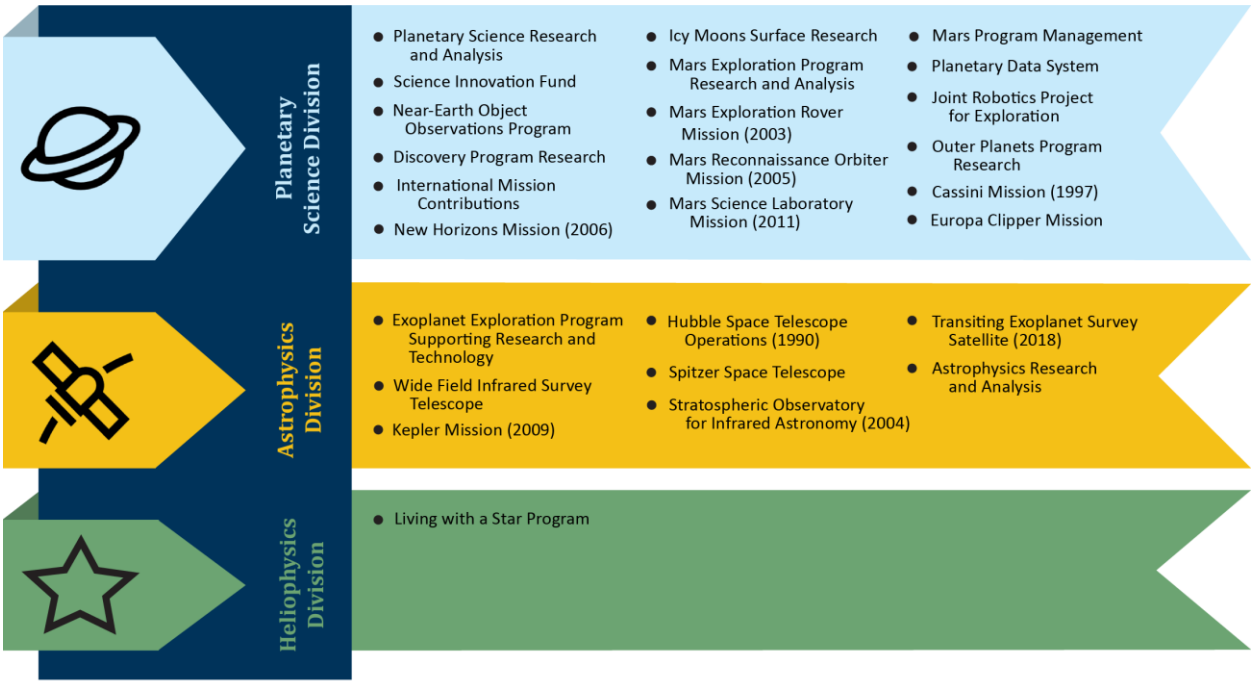
Allen Telescope Array at the Hat Creek Observatory in California

Source: NASA.

[12] The Allen Telescope Array is located at the Hat Creek Observatory in the Cascade Mountains just north of Lassen Peak in California. This array is used to conduct technosignatures research and is managed by a partnership between the SETI Institute and SRI International.

[13] Mars Rover, Kepler including its extended mission K2, and Cassini are NASA missions to explore the surface of Mars, discover transiting exoplanets, and expand our knowledge of Saturn's moon Titan, respectively. For more detail on these and the other SETI Institute-supported missions, see Appendix B.

Figure 3: NASA Science Missions Supported by the SETI Institute



Source: NASA OIG presentation of Agency information.

Science Research at NASA

NASA's science program seeks new knowledge and understanding of the Earth, Sun, solar system, and the universe back to its earliest moments of existence. Priorities for future NASA science missions are guided by decadal surveys developed by the National Academy of Sciences. These surveys serve as the primary source of input from the science community into the Agency's Science Plan and are considered by NASA along with direction received from the Executive Branch and Congress.

NASA's current Science Plan, released in 2014, identifies the main questions the Agency hopes to answer in its research:

- What drives variations in the Sun, and how do these changes impact the solar system and drive space weather?
- How and why are Earth's climate and environment changing?
- How did our solar system originate and change over time?
- How did the universe begin and evolve, and what will be its destiny?
- How did life originate and are we alone?

NASA has tasked SMD's four science divisions (Astrophysics, Earth Science, Heliophysics, and Planetary Science) to answer these questions, and the SETI Institute currently conducts research related to three of those four divisions. SMD uses open competition and scientific peer reviews to evaluate and select research projects and solicit individual scientist-led research investigations primarily through the release of Research Opportunities in Space and Earth Sciences (ROSES), SMD's annual compilation of NASA

Research Announcements (NRA).[14] SMD also considers unsolicited proposals, which allow unique and innovative ideas or approaches developed outside of the government to be made available to federal agencies for use in accomplishment of their missions.

Management of Government Funds for Scientific Research

Government-wide regulations for managing grants and cooperative agreements are set forth in the Code of Federal Regulations (CFR) and supplemented by NASA regulations. The CFR establishes administrative requirements governing grants and cooperative agreements awarded to nonprofit organizations.[15] The SETI Institute must comply with federal acquisition and cost principles with respect to its use of NASA funds and with federal requirements that stipulate all expenditures be allowable, allocable, and reasonable.

[14] Scientific peer reviews may be conducted by scientists within NASA, outside of the Agency, or consist of scientists both within and outside of NASA.

[15] Grants and cooperative agreements are under the authority of 14 C.F.R. Part 1260, "Grant and Cooperative Agreements" (1999); 2 C.F.R. Part 230, "Cost Principles for Non-Profit Organizations (OMB Circular A-122)" (2012); and 2 C.F.R. Part 215, "Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations (OMB Circular A-110)" (2012). The *NASA Grant and Cooperative Agreement Manual* provides guidance to NASA technical officers and grant officers for awarding and administering grants and cooperative agreements with educational and nonprofit organizations.

SETI Institute Is Meeting Performance and Financial Requirements While Helping Support NASA's Science Goals

At the time of our audit, the SETI Institute was engaged in 85 NASA grants and cooperative agreements valued at about $81 million. Through these awards, we found the Institute has delivered scientific research that supports a variety of NASA science missions and helps NASA meet the goals and objectives outlined in its Science Plan. NASA research awards are governed by Part 200 of the CFR and the Agency's science management policies that include specific reporting requirements for performance and deliverables.[16] These deliverables include published scientific articles and white papers peer reviewed by scientific journals.[17]

For this audit, we selected 16 NASA awards to the Institute for detailed review.[18] Two of the 16 awards were relinquished because the SETI Institute closed out these awards after the principal investigators were hired by NASA as civil servants. For the remaining 14 awards, we found the Institute submitted performance reports in a timely manner and provided required progress and closeout reports as specified in the solicitations. The 14 awards supported NASA missions in astrobiology and planetary science and, according to SMD officials, these awards have produced useful information and data to the Agency and scientific community, such as:

- Discovering extrasolar planets K2-97b and K2-132b while searching for transiting planets around oscillating red-giant branch stars.[19] This discovery was made while analyzing data produced by the Kepler Space Telescope during its K2 mission. Using data from Kepler, the Institute's scientists search for a tiny, telltale dip in the brightness of a star as a planet crosses in front of it.[20]

[16] NASA science management policies include those listed in *NASA's Science Mission Directorate Management Handbook*, *NASA Shared Services Center Delivery Guide: Grants and Cooperative Agreements*, and the *Guidebook for Proposers Responding to a NASA Funding Announcement*.

[17] In academic publishing, a scientific journal is a periodical publication intended to further the progress of science, usually by reporting new research. All journal publications undergo peer review, which helps ensure that published results are scientifically valid and grounded in evidence.

[18] The awards we reviewed were based on risk assessments using our ACL data analytic software tool and the period of performance of the award through their life cycle to include submission of progress and financial transaction reporting as well as final research deliverables. This was not a representative sample of awards but rather a sample selected based on our risk assessment criteria that included factors such as timing of payments, principal investigator workload, and rejected payment requests.

[19] A red giant is a luminous giant star of low or intermediate mass in a late phase of stellar evolution. The outer atmosphere is inflated and tenuous, making the radius large and the surface temperature around 8,500°F or lower. Oscillation is the regular variation in magnitude or position around a central point.

[20] The K2 mission is a continuation of the original Kepler mission launched in 2009, which had a critical failure but was brought back to operation by NASA scientists that allowed the Kepler Space Telescope to continue to collect valuable data.

- Furthering our understanding of synthesis of phototrophs in differing environments. Discoveries revealed unknown traits of bacteria, which helped better identify and understand the underpinnings of life that may be found in rock records collected in space.[21]
- Furthering our understanding of planetary satellites. Analyzing data revealed previously unknown "counter orbital" satellites, which provided a better understanding of planetary satellites while also helping to address potential risks posed to missions by satellites that go the opposite direction.[22]
- Furthering understanding in the development of biofuels from microbes. SETI Institute research is building data on sustainable energy sources from fermented microalgae that may be used for NASA's long-term missions to colonize other planets or on Earth as a more sustainable form of energy.
- Enhancing STEM participation in America's youth. The Institute has made strides in a Space Science Badge program for the Girl Scouts of America through a program that will reach approximately 2 million scouts and 800,000 volunteers nationwide over a 5-year period.

Review of the deliverables, including the data produced from the 14 awards, confirmed they align with the goals detailed in the NRA solicitation as well as the NASA Science Plan, both of which seek information to answer questions concerning the origins and future of the universe, the existence of other habitable worlds, and whether humans are alone.

In addition, our review of NASA's procurement files for the 16 awards showed each contained well-documented records that supported the selection and award to the SETI Institute. These records included the number of proposals submitted, proposal rankings, review panel members, and justification for the award. Three of the 16 awards resulted from unsolicited proposals supported by appropriate justifications.

In addition to reports on award procurement and performance, we reviewed the SETI Institute's financial records and found that relative to the approximately $81 million in awards they received from NASA, the Institute had adequate internal controls that effectively accounted for expenditures and complied with federal requirements to ensure that all expenditures are allowable, allocable, and reasonable. We also analyzed the Institute's expense data to determine if its grant and cooperative agreement funds and associated costs were handled appropriately and found the financial records complied with NASA and federal guidance. Further, we evaluated the Institute's expenses related to its NASA's awards to identify transactions that indicated patterns of internal control weaknesses or fraud. Of the 45 transactions selected for detailed review, all were determined to be allowable, allocable, and reasonable.[23]

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[21] Phototrophs are organisms capable of using light energy to synthesize sugars and other organic molecules from carbon dioxide. Green plants, algae, and cyanobacteria are phototrophs.

[22] A satellite is a companion body that orbits a planet. Earth's satellite is the Moon, whereas Venus and Mercury do not have satellites.

[23] We used the ACL data analytic tool to evaluate SETI Institute expenditures, which were separated into 70 cost categories consisting of 182,159 transactions from fiscal years 2013 through 2017. ACL is a data extraction and analysis software used for fraud detection, prevention, and risk management. By sampling large data sets, the software identifies irregularities or patterns in transactions that could indicate control weaknesses or fraud. Based on this analysis, we identified 45 transactions in cost categories related to Salaries, Depreciation, Lab Supplies and Research Costs, Unfunded Project Expense, Temporary Help/Consultants, Travel, and Subcontracts over $25,000 for further review.

NASA'S INVOLVEMENT IN TECHNOSIGNATURES RESEARCH

Technosignatures research uses radio and optical telescopes to search space for evidence of advanced extraterrestrial civilizations. Research first conducted in the 1950s led scientists to conclude the radio portion of the electromagnetic spectrum would be the easiest method to detect extraterrestrial intelligence because radio waves are capable of traveling the extreme distances between stars without being absorbed and can be generated using relatively minimal amounts of power. In addition to radio waves, scientists are attempting to detect laser light waves given the possibility that advanced civilizations may send brief but powerful pulses of laser light from other planetary systems rather than broadcasting by a radio transmitter.

The scientific community expressed general interest in the search for extraterrestrial intelligence in the past. For example, the astronomy and astrophysics decadal surveys issued by the NRC in the 1980s, 1990s, and in 2001 deemed this area a worthy long-term endeavor that could generate science to complement NASA's exploration efforts.[24] In addition, while this research area ultimately was not included in the 2010 decadal survey, a panel that informed the survey noted the utility of such research in identifying signs of intelligent life on exoplanets.[25] Research for extraterrestrial intelligence currently being conducted by the scientific community aligns with long-term NASA programs in space astronomy, astrobiology, deep space communication, and planetary science. For instance, recent identification of repeating fast radio bursts (FRB) from distant galaxies were discovered by the Breakthrough Listen team after employing machine learning algorithms to study radio signals captured at the Green Bank Observatory.[26] These efforts align with and complement NASA's long-standing objective to determine if we are alone in the universe.

In our discussions with SMD officials, they were uncertain whether the 1993 legislation restricting NASA's funding of technosignatures research resulted in the Agency's lack of investment in this area. Our legal and legislative research failed to identify any current legal restriction on such research. While it was not ultimately included in the final spending bill, the House of Representatives included language in its 2018 authorization bill directing the Agency to make available at least $10 million a year in fiscal

[24] NRC, *Astronomy and Astrophysics for the 1980's, Volume 1: Report of the Astronomy Survey Committee* (1982); *The Decade of Discovery in Astronomy and Astrophysics* (1991); and *Astronomy and Astrophysics in the New Millennium* (2001).

[25] NRC, *Panel Reports—New Worlds, New Horizons in Astronomy and Astrophysics*, "Report of the Panel on Radio, Millimeter, and Submillimeter Astronomy from the Ground" (2011).

[26] Machine learning is a field of computer science in which computers learn from large data sets, finding patterns that humans might not otherwise identify. Breakthrough Listen—the astronomical program searching for signs of intelligent life in the universe—has applied machine learning techniques to detect 72 new FRBs emanating from the "repeater" FRB 121102. FRBs are bright pulses of radio emission, just milliseconds in duration, thought to originate from distant galaxies. Most FRBs have been witnessed during just a single outburst. In contrast, FRB 121102 is the only one to date known to emit repeated bursts, including 21 detected during Breakthrough Listen observations made in 2017 with the Green Bank Telescope in West Virginia.

years 2018 and 2019 for technosignatures research.[27] According to SMD officials, NASA could potentially use the NRAs in the ROSES omnibus process to solicit partnerships with private and philanthropic organizations to fund searches for technosignatures if it decided to pursue such research.

In 2017, Congress directed NASA to enter into an arrangement with the National Academy of Sciences to develop a science strategy for astrobiology that would outline key scientific questions, identify the most promising research in the field, and indicate the extent to which the mission priorities in existing decadal surveys address the search for life's origin, evolution, distribution, and future in the universe. Issued in October 2018, the Academy's report emphasized the need for NASA to increase efforts in developing mission-ready life detection technologies to advance the search for extraterrestrial life.[28] The report noted that the search for extraterrestrial intelligence is a high risk, high reward approach to the search for life. The report also addressed how space missions and ground-based telescopes should be used to detect intelligent life and discussed the potential of partnerships between NASA and other agencies and organizations in the search for intelligent life. According to the scientific community and the National Academy of Sciences, technosignatures research by NASA would complement biosignature research by looking beyond biological life to a more focused search for intelligent life.[29]

[27] Consolidated Appropriations Act, 2019, Pub. L. No. 116-6 (2019). The House of Representatives' National Aeronautics and Space Administration Authorization Act of 2018, H.R. 5503 (2018) states, "NASA shall partner with the private sector and philanthropic organizations to the maximum extent practicable to search for technosignatures, such as radio transmissions, in order to meet the NASA objective to search for life's origin, evolution, distribution, and future in the universe." Further, it provides that "subject to the availability of appropriations, the Administrator shall make available at least $10,000,000 for each of fiscal years 2018 and 2019 for the search for technosignatures."

[28] National Academy of Sciences, *An Astrobiology Strategy for the Search for Life in the Universe* (2018).

[29] A whitepaper titled "Three Versions of the Third Law: Technosignatures and Astrobiology" was presented to the National Academy of Sciences in January 2018 by the following organizations: Breakthrough Listen, University of California at Berkeley, the International Academy of Astronautics, the International SETI Collaboration, and the SETI Institute.

CONCLUSION

The research conducted by the SETI Institute through its 85 awards with NASA has played an important role in advancing understanding of stars, planets, planetary satellites, and astrobiology, all of which reflect the Agency's science goals and objectives. We found that NASA followed its policies and federal guidelines when it solicited and selected the SETI Institute for these awards, and in turn, the Institute properly accounted for expenditures and complied with federal requirements. As a result, NASA and the Institute have forged a strong partnership and produced valuable data and research benefitting the scientific community.

MANAGEMENT'S RESPONSE AND OUR EVALUATION

Although we made no recommendations in this report, we provided a draft copy to NASA management who expressed concern that the overall tone of the report implies that NASA should fund searches for technosignatures, adding that it "was surprised that the OIG is commenting on prioritizing SMD's research program." We appreciate the Agency's concern and have revised the report accordingly. While it was not our intent to advocate for technosignatures research, we do point out that contrary to the understanding of some NASA officials, we found no legal prohibition against funding technosignature searches and that segments of the scientific community and Congress support technosignatures research. That said, the decision whether to prioritize one type of research over another is generally not in the OIG's purview.

Management's response to the draft report is reproduced in Appendix C. Technical comments provided by management have also been incorporated, as appropriate.

Major contributors to this report include Ridge Bowman, Space Operations Director; Vincent Small, Project Manager; Eugene Bauer; Ellis Lee; Chris Reeves; Lauren Suls; Shari Bergstein; and Cedric Campbell.

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.

Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from March 2018 through February 2019 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.

This review examined the extent to which the SETI Institute supports NASA's science goals; whether the Institute used NASA funds for their intended purpose; whether costs paid under the agreement were in accordance with applicable laws, regulations, and guidelines; and NASA's future involvement in technosignatures research. During this audit, we interviewed personnel from NASA's SMD, the NASA Shared Services Center, Ames Research Center, and the SETI Institute. We also reviewed relevant laws, regulations, policies, and procedures related to the SETI Institute subject area, such as:

- 2 C.F.R. Part 200, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, " January 1, 2014
- 2 C.F.R. Part 1800, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, " January 1, 2015
- 2 C.F.R. Part 1880, "Nonprocurement Debarment and Suspension," January 1, 2015
- 14 C.F.R. Part 1260, "Grants and Cooperative Agreements," January 1, 1999
- 2 C.F.R. Part 215, "Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations (OMB Circular A-110)," January 1, 2012
- 2 C.F.R. Part 230, "Cost Principles for Non-Profit Organizations (OMB Circular A-122)," January 1, 2012
- National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993, Pub. L. No. 102-588, November 4, 1992
- National Aeronautics and Space Administration Authorization Act of 2018, H.R. 5503, April 13, 2018
- Consolidated Appropriations Act, 2019, Pub. L. No. 116-6, February 15, 2019
- NASA, "NASA Grant and Cooperative Agreement Manual," May 24, 2017
- NASA, "Guidebook for Proposers Responding to a NASA Funding Announcement," March 2018
- NASA, "Science Mission Directorate Management Handbook," October 31, 2013
- NSSDG-5800-0001, Revision 6.0, "NASA Shared Services Center Delivery Guide: Grants and Cooperative Agreements," February 23, 2018
- SETI Travel Reimbursement Policy, June 2008
- SETI Fly America Act and Open Sky Agreements, June 2010

To evaluate the acquisition of SETI Institute awards, we identified 85 awards valued at about $81 million. We selected 16 for detailed review to evaluate NASA's compliance with acquisition requirements and determine whether the Institute complied with federal laws and regulations. We also verified whether the Institute followed grant terms and conditions, such as the completion of project work plans, and provided progress reports to NASA technical officers, as required.

To review transactions, we used the ACL data analytic tool to evaluate the SETI Institute's cost elements. The ACL tool highlights unusual transactions that require additional scrutiny when the transaction costs deviate from the amounts posted in the general ledger, which may indicate patterns of internal control weaknesses or fraud. Based upon this analysis, we identified 45 transactions in our audit for detailed analysis and determined whether these transactions complied with federal laws and regulations and were allowable, allocable, and reasonable.

Use of Computer-Processed Data

We used computer-processed data to perform this audit. To determine the data's validity, we compared and evaluated records from the NASA Procurement system, the NASA Shared Services Center system, and the SETI Institute's accounting system. We tested those records and identified 45 transactions for more detailed review. In addition, we compared computer records to invoices, billings, and other appropriate records for accuracy. Based upon these tests and analysis, we concluded that the computer-processed data was valid.

Review of Internal Controls

We reviewed and evaluated the internal controls included in 2 C.F.R. Part 200, 2 C.F.R. Part 1800, the *NASA Grant and Cooperative Agreement Manual*, the *Science Mission Directorate Management Handbook*, the *NASA Shared Services Center Delivery Guide: Grants and Cooperative Agreements*, and the SETI Institute's policies and procedures. Based upon our tests, we concluded that the internal controls were adequate.

Prior Coverage

During the last 5 years, the NASA OIG has issued 6 reports of significant relevance to the subject of this report. Unrestricted reports can be accessed at https://oig.nasa.gov/audits/auditReports.html.

NASA's Management of GISS: The Goddard Institute for Space Studies (IG-18-015, April 5, 2018)

Audit of the National Space Biomedical Research Institute (IG-18-012, February 1, 2018)

Review of NASA-funded Institutes (IG-16-023, June 9, 2016)

Audit of NASA's Cooperative Agreement with BioServe Space Technologies—University of Colorado at Boulder (IG-14-028, August 4, 2014)

Audit of Grant Awarded to North Carolina State University (IG-14-027, July 23, 2014)

Audit of NASA's Cooperative Agreement Awarded to Rockwell Collins (IG-14-025, July 14, 2014)

APPENDIX B: SETI INSTITUTE SUPPORTED EFFORTS

There were 26 NASA science missions and programs supported by the SETI Institute in fiscal year 2017 as illustrated in Figure 3. The missions and programs are listed under their respective SMD divisions.

Planetary Science Division

Planetary Science Research and Analysis. The primary role of Planetary Science Research and Analysis is to address NASA's strategic objectives for planetary science and the Planetary Science Division's science goals. This program supports a broad range of planetary science activities, including analysis of data from past and current spacecraft; laboratory research; theoretical, modeling, and computational studies; geological and astrobiological fieldwork in planetary analog environments on Earth; geological mapping of planetary bodies; analysis of data from Earth- and space-based telescopes; and development of flight instruments and technology needed for future planetary science missions.

Science Innovation Fund. The Science Innovation Fund provides funding to NASA Centers to invest in scientific research that will enhance scientific innovation, NASA's ability to meet future missions, NASA's ability to forge new collaborations, and recruitment and retention of scientists. The purpose of the Fund is twofold: (1) promote the conduct of highly innovative, exploratory, and high risk, high return scientific research in support of the strategic direction of the Agency and (2) promote the vitality of NASA Centers through strategic investments in scientific research, capabilities, and people. Searching for organics on Mars is one example of research supported by the Fund. Goddard Space Flight Center scientists demonstrated that cosmic rays can effectively degrade amino and carbolic acids in the top meter of the Martian surface in less than 100 million years. This finding affects where we are able to search for past life on Mars.

Near-Earth Object Observations Program. Since NASA's initiation of the Near-Earth Object (NEO) Observations program in 1998, NEO surveys have found more than 90 percent of the Near-Earth Asteroids larger than 1 kilometer and a good fraction of the NEOs larger than 140 meters. The majority of NEO discoveries are the result of NASA-supported ground-based telescopic surveys, which include the Catalina Sky Survey and Spacewatch near Tucson, Arizona; Lincoln Near-Earth Asteroid Research project near Socorro, New Mexico; Pans-STARRS1 telescope near the summit of Haleakala in Hawaii; Lowell Observatory Near-Earth-Object Search project near Flagstaff, Arizona; and the Near-Earth Asteroid Tracking program run by NASA and the Jet Propulsion Laboratory.

Discovery Program Research. The main objective of the Discovery Program is to enhance our understanding of the solar system by exploring the planets, their moons, and small bodies such as comets and asteroids. Through the Discovery Program, the scientific community conducts focused investigations that complement NASA's larger planetary science goals by launching smaller missions using fewer resources and shorter development times than past projects with comparable objectives.

International Mission Contributions. NASA funds instruments and scientific investigators and provides navigation and data relay services in exchange for participation. International missions in fiscal year 2017 include the Japanese Space Agency's Akatsuki and Hayabusa-2 missions. Akatsuki, also known as the Venus Climate Orbiter, inserted into Venus's orbit in December 2015 to study the planet for 2 years. Hayabusa-2, which launched in 2016, will arrive at asteroid Ryugu in 2020 and capture and return a sample.

New Horizons Mission (2006). The New Horizons spacecraft launched in 2006; swung past Jupiter for a gravity boost and scientific studies in 2007; and conducted a 6-month-long reconnaissance flyby study of Pluto and its moons in 2015, when it became the first spacecraft to reach Pluto. As part of an extended mission (pending NASA approval) the spacecraft is expected to head farther into the Kuiper Belt to examine another of the ancient, icy mini-worlds in that region, at least a billion miles beyond Neptune's orbit. Sending the spacecraft on this long journey is helping scientists to answer basic questions about the surface properties, geology, interior makeup, and atmospheres on these bodies.

Icy Moons Surface Research. Astrobiology is the study of the origin, evolution, distribution, and future of life in the universe, and icy moons in our solar system are some of the places astrobiologists are studying to search for signs of life beyond Earth. Several of the icy moons in our solar system have subsurface oceans that, combined, contain many times the volume of liquid water on Earth. Astrobiology at water-rock interfaces found on icy bodies such as Europa and Enceladus (one of multiple moons for Jupiter and Saturn, respectively), is a focus of the Icy Worlds team at the Jet Propulsion Laboratory.

Mars Exploration Program Research and Analysis. The focus of the Mars Exploration Program is to explore Mars and provide a continuous flow of scientific information and discovery through a carefully selected series of robotic orbiters, landers, and mobile laboratories interconnected by a high-bandwidth Mars/Earth communications network. The Program's three high-priority science goals for the exploration of Mars are to determine if life ever arose on Mars, understand the processes and history of climate, and determine the evolution of the surface and interior of an evolving Earth-like planet.

Mars Exploration Rover Mission (2003). A part of the Mars Exploration Program, NASA's twin robot geologists—the Mars Exploration Rovers—launched on June 10 and July 7, 2003, and landed on Mars in January 2004. Primary among the mission's scientific goals is to search for and characterize a wide range of rocks and soils that hold clues to past water activity on Mars.

Mars Reconnaissance Orbiter Mission (2005). Launched in 2005, the Mars Reconnaissance Orbiter is a multipurpose spacecraft designed to conduct reconnaissance and exploration of Mars from orbit. Since 2006, the orbiter has studied the Martian atmosphere and terrain from orbit and serves as a key data relay station for other Mars missions, including the Mars Exploration Rover Opportunity. Equipped with a camera that has aided in a number of discoveries, the orbiter has sent back thousands of images of the Martian surface that are helping scientists learn more about Mars, including the history of water flows on or near the planet's surface.

Mars Science Laboratory Mission (2011). Launched in 2011, the Mars Science Laboratory mission's Curiosity rover, the most technologically advanced rover ever built, landed in Mars' Gale Crater in 2012. Curiosity's mission is to determine whether Mars ever was, or is, habitable to microbial life. The rover, which is about the size of a MINI Cooper, is equipped with 17 cameras and a robotic arm containing a suite of specialized laboratory-like tools and instruments.

Mars Program Management. Mars Program Management provides for the broad-based implementation and programmatic management of the Mars Exploration program. Mars Program Management also supports independent panel reviews, studies regarding planetary protection, advanced mission studies and program architecture, program science, and telecommunications coordination and integration.

Planetary Data System. The Planetary Data System is a long-term archive of digital data products returned from NASA's planetary missions and other flight and ground-based data acquisitions, including laboratory experiments. The archive is managed by planetary scientists to help ensure its usefulness and usability by the planetary science community.

Joint Robotics Project for Exploration. A joint endeavor by NASA's SMD and Human Exploration and Operations Mission Directorate, research and analysis is performed in support of human spaceflight planning and robotic systems development. These activities will characterize exploration environments, identify hazards, and assess resources, which will inform the selection of future destinations, support the development of exploration systems, and reduce the risk associated with human exploration. This effort seeks to maximize the benefit to both science and exploration objectives, as was done successfully with the Lunar Reconnaissance Orbiter mission.

Outer Planets Program Research. NASA's planetary science missions to the outer planets (Jupiter, Saturn, Uranus, Neptune, and Pluto) help reveal secrets about the solar system by observing those outer distant worlds up close. Jupiter's moon Europa and Saturn's moon Enceladus are now thought to hide liquid water beneath their frozen surfaces and are high priority targets for NASA. Gathering more data on Europa and Enceladus as well as the outer planets will help scientists understand more about Earth and the formation and evolution of the solar system.

Cassini Mission (1997). A joint endeavor of NASA, the European Space Agency, and the Italian Space Agency, Cassini was a robotic spacecraft launched in 1997 to study Saturn and its complex system of rings and moons. Carried by Cassini, the Huygens probe parachuted to the surface of Saturn's largest moon, Titan, in 2005—the most distant landing to date in our solar system—and returned images and other science results during a 2 ½ hour descent through Titan's hazy atmosphere before coming to rest amid rounded cobbles of ice on a floodplain damp with liquid methane. Key discoveries during its 13 years at Saturn before the mission ended in 2018 included a global ocean with strong indications of hydrothermal activity within Enceladus and a liquid methane sea on Titan.

Europa Clipper Mission. The Europa Clipper mission, currently in development at NASA, will conduct detailed reconnaissance of Jupiter's moon Europa to see whether the icy moon could harbor conditions suitable for life. The mission will carry a highly capable, radiation-tolerant spacecraft that will perform repeated close flybys of the moon from a long, looping orbit around Jupiter. The payload of science instruments include cameras and spectrometers to produce high-resolution images of Europa's surface and determine its composition; an ice penetrating radar to determine the thickness of the moon's icy shell and search for subsurface lakes similar to those beneath Antarctica; and a magnetometer to measure strength and direction of the moon's magnetic field, which will allow scientists to determine the depth and salinity of its ocean.

Astrophysics Division

Exoplanet Exploration Program Supporting Research and Technology. The Exoplanet Exploration Program is NASA's science, technology, and mission management office for the exploration of exoplanets. The Program's primary goals are to discover planets around other stars, characterize their properties, and identify planets that could harbor life.

Wide Field Infrared Survey Telescope. The Wide Field Infrared Survey Telescope, currently in development at NASA, is an observatory designed to answer questions in the areas of dark energy, exoplanets, and infrared astrophysics. The telescope has a primary mirror 2.4 meters in diameter—the same size as the Hubble Space Telescope's primary mirror—and contains two instruments. The Wide Field Instrument will provide a field of view 100 times greater than Hubble, capturing more of the sky with less observing time; measure light from a billion galaxies; and perform a microlensing survey of the inner Milky Way to find approximately 2,600 exoplanets. The Coronagraph Instrument will perform high contrast imaging and spectroscopy of dozens of individual nearby exoplanets.

Kepler Mission (2009). Launched in 2009, the Kepler spacecraft was designed to survey our region of the Milky Way galaxy to discover hundreds of Earth-size and smaller planets in or near the habitable zone and determine the fraction of the hundreds of billions of stars in our galaxy that might have such planets. A critical failure on board the Kepler spacecraft in 2013 brought an end to the Kepler's mission to continuously monitor more than 150,000 stars to search for transiting exoplanets. Developed over the months following this failure, the K2 mission represents a new concept for spacecraft operations that enables continued scientific observations with the Kepler Space Telescope. K2 became fully operational in 2014.

Hubble Space Telescope Operations (1990). Launched into low Earth orbit in 1990, the Hubble Space Telescope is the first major optical telescope placed in space. Hubble's orbit above the distortion of Earth's atmosphere gives it an unobstructed view of the universe and allows it to take extremely high-resolution images, resulting in the observation of the most distant stars and galaxies as well as planets in our solar system. Many Hubble observations have led to breakthroughs in astrophysics, such as accurately determining the rate of expansion of the universe.

Spitzer Space Telescope. Launched in 2003, the Spitzer Space Telescope is a space-borne, cryogenically-cooled infrared observatory capable of studying objects ranging from our solar system to the distant reaches of the universe. Its highly sensitive instruments allow scientists to peer into cosmic regions hidden from optical telescopes, including dusty stellar nurseries, centers of galaxies, and newly forming planetary systems. Spitzer's infrared eyes also allows astronomers to see cooler objects in space, like failed stars, extrasolar planets, giant molecular clouds, and organic molecules that may hold the secret to life on other planets.

Stratospheric Observatory for Infrared Astronomy (2004). An 80/20 partnership of NASA and the German Aerospace Center, the Stratospheric Observatory for Infrared Astronomy consists of an extensively modified Boeing 747SP aircraft carrying a 2.7-meter reflecting telescope. It is the largest airborne observatory in the world, capable of making observations that are impossible for the largest and highest ground-based telescopes. Designed to observe the infrared universe, this observatory studies different kinds of astronomical objects and phenomena, including the birth and death of stars; formation of new solar systems; identification of complex molecules in space; planets, comets and asteroids in our solar system; nebulae and dust in galaxies; and black holes at the center of galaxies.

Transiting Exoplanet Survey Satellite (2018). Launched in 2018, the Transiting Exoplanet Survey Satellite is the first space-borne all-sky transit survey. This mission will be used to detect small planets with bright host stars in the solar neighborhood in order to perform detailed characterizations of the planets and their atmospheres. In a two-year survey, this satellite will monitor more than 200,000 stars for temporary drops in brightness caused by planetary transits.

Astrophysics Research and Analysis. The Astrophysics Research and Analysis Program solicits basic research proposals for investigations that are relevant to NASA's programs in astronomy and astrophysics and includes research over the entire range of photons, gravitational waves, and particle astrophysics.

Heliophysics Division

Living with a Star Program. The Living with a Star program focuses on the science necessary to understand aspects of the Sun's and Earth's space environment that affect life and society. It includes strategic missions, targeted research and technology development, space environment test-bed flight opportunities, and partnerships with other agencies and nations in order to provide the comprehensive research needed to understand the factors affecting the Sun-Earth system and the information necessary for improved forecasting of space weather. Living with a Star missions have been formulated to answer specific science questions about the links between the solar, Earth, and space systems that affect space weather.

APPENDIX C: MANAGEMENT'S COMMENTS

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-001

Reply to Attn of:

Science Mission Directorate

February 21, 2019

TO: Assistant Inspector General for Audits

FROM: Associate Administrator for Science Mission Directorate

SUBJECT: Agency Response to OIG Draft Report, "Audit of SETI Institute" (A-18-010-00)

NASA appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "Audit of SETI Institute" (A-18-010-00), dated November 26, 2018, and welcomes the OIG's recognition of the valuable contribution made by the SETI Institute in terms of its ongoing research efforts. We also appreciate that the OIG has found that the SETI Institute has properly accounted for all expenditures and has complied with applicable Federal requirements in the execution of its activities.

NASA's Science Mission Directorate (SMD) has, however, identified several inaccuracies in the draft report (noted below) that should be corrected.

The OIG's statement on the absence of NASA's funding for SETI research is misleading and the finding incorrect.[1] NASA has funded the development of several instruments that enable such searches: While the audit report's footnote 2 does state correctly that NASA has provided funds to develop instruments that augment technosignatures research, the body of the report states that NASA has not funded research associated with the direct search for extraterrestrial intelligent life. Research of technology that augments technosignatures research is indeed research associated with the direct search for extraterrestrial intelligent life.

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[1] Marcy, Geoffrey W., University of California, Berkeley, "A 2 Billion Channel Multibeam Spectrometer for SETI," Total award: $398,040, Duration (yrs): 2, Solicitation: NRA-01-OSS-01-ASTID; Stauduhar, Richard, SETI Institute, "Detection of Complex, Electromagnetic Markers of Technology," Total award: $660,079, Duration (yrs): 3, Solicitation: NRA-03-OSS-01-ASTID; Werthimer, Dan, University of California, Berkeley, "Instrumentation for the Search for Extraterrestrial Intelligence," Total award: $590,589, Duration (yrs): 3, Solicitation: NNH11ZDA001N-ASTID

[2] https://www.nap.edu/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth

[3] https://www.nap.edu/catalog/13060/solar-and-space-physics-a-science-for-a-technological-society

[4] https://www.nap.edu/catalog/13117/vision-and-voyages-for-planetary-science-in-the-decade-2013-2022

[5] https://www.nap.edu/catalog/9839/astronomy-and-astrophysics-in-the-new-millennium

[6] https://www.nap.edu/catalog/12951/new-worlds-new-horizons-in-astronomy-and-astrophysics

[7] https://www.nap.edu/catalog/1634/the-decade-of-discovery-in-astronomy-and-astrophysics

The OIG references National Research Council decadal surveys as support for claims in the draft report, however, neither of the two most recent decadal surveys, issued in 2018[2] and 2013[3], address extraterrestrial life. A decadal survey issued in 2011[4] did discuss searching for life within our solar system, but it does not contain the phrases "SETI," "intelligence," or "technosignature." Furthermore, although the 2001[5] and 2010[6] Astrophysics Decadal Surveys do express support for the development of SETI technology and approaches as well as looking "for signals produced by technologically advanced entities elsewhere in our galaxy," neither recommends NASA funding for this research, and in fact no recommendations for NASA investments in SETI research have been made in a decadal survey since 1991.[7] It is incorrect to imply - as the below-quoted text does - that prior decadal surveys generally support searches for technosignatures:

> "It is not clear whether the lack of funding is simply because technosignatures research has not been an Agency priority or because of a prohibition on such research imposed by Congress in 1993. In prior years, the National Academies decadal surveys have generally supported a sustained effort to search for extraterrestrial intelligence as did a House-sponsored NASA authorization bill voted out of Committee in April 2018."

Finally, while the OIG makes no formal recommendations in this report, SMD is concerned that the overall tone of the report implies that NASA should fund searches for technosignatures. The report states directly that it examined NASA's potential future support for technosignatures research and SMD is surprised that the OIG is commenting on prioritizing SMD's research program. NASA sets its science priorities by following the recommendations of the National Academies of Science, Engineering, and Medicine while simultaneously implementing national priorities established by the President and Congress. SMD will continue to evaluate technosignatures research in the context of the Directorate's overall portfolio through its standard scientific prioritization process.

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should be restricted from public release.

Once again, 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 Peter Meister at (202) 358-1557.

Thomas H. Zurbuchen, Ph.D.

cc:
Ames Research Center/Dr. Tu
Executive Director, NSSC/Ms. Harrell

APPENDIX D: REPORT DISTRIBUTION

National Aeronautics and Space Administration

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    Director, Office of Acquisition and Sourcing Management

President and CEO, SETI Institute

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 Aviation and Space

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 Reform
    Subcommittee on Government Operations

House Committee on Science, Space, and Technology
    Subcommittee on Investigations and Oversight
    Subcommittee on Space and Aeronautics

(Assignment No. A-18-010-00)