

Signals in the Soil (SitS)

PROGRAM SOLICITATION

NSF 20-548

REPLACES DOCUMENT(S):

NSF 19-556



National Science Foundation

Directorate for Engineering
Division of Chemical, Bioengineering, Environmental and Transport Systems
Division of Civil, Mechanical and Manufacturing Innovation
Division of Electrical, Communications and Cyber Systems

Directorate for Biological Sciences
Division of Integrative Organismal Systems
Division of Environmental Biology

Directorate for Computer and Information Science and Engineering
Division of Computer and Network Systems

Directorate for Geosciences
Division of Earth Sciences
Office of Polar Programs

Directorate for Mathematical and Physical Sciences
Division of Chemistry



National Institute of Food and Agriculture

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

May 20, 2020

IMPORTANT INFORMATION AND REVISION NOTES

Last year, the SitS Program involved a joint call for proposals with the UKRI. This year, the UKRI will not be involved in the solicitation, so no US-UK collaboration is required. The 5 priority areas listed in the Program Description are the same as the previous solicitation. However, some additional language has been added to these areas. The funding limit for proposals is \$600,000 - \$1,200,000.000. The requested duration of awards is now 3-5 years.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) ([NSF 20-1](#)), which is effective for proposals submitted, or due, on or after June 1, 2020.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Signals in the Soil SitS

Synopsis of Program:

In 1935, President Franklin D. Roosevelt stated, "A nation that destroys its soils destroys itself." This statement remains true to this day. Soils form over hundreds of years, and yet can be destroyed in a single event. They are an often-overlooked natural asset despite being the foundation of terrestrial ecosystems that support food production, economic prosperity, and many other services that are essential for humanity. Soils are complex ecosystems composed of organic matter, minerals, water, air, and billions of organisms. Such ecosystems interact with the flora and fauna they support to mediate myriad biological, chemical, and physical processes essential for

plant growth, food and fiber production, and contaminant removal. Soils are also the foundation material for all structures not supported on rock, and, by orders of magnitude, are the most widely-used construction material in the world. Soils are the source of most of the antibiotics used to fight human diseases, control the movement of water and chemical substances between the Earth and atmosphere, and act as source and storage media for gases such as oxygen, carbon dioxide, and methane. As a result of their essential importance, soils are also part of our cultural heritage. Thus, as the Earth's population grows, we need a better understanding of soil ecosystems that will continue to play a critical role in supporting societies around the world.

The National Science Foundation (NSF) Directorates for Engineering (ENG) and Geosciences (GEO), the Divisions of Integrative Organismal Systems (IOS) and Environmental Biology (DEB), in the Directorate for Biological Sciences (BIO), the Division of Computer and Network Systems in the Directorate Computer and Information Science and Engineering (CISE/CNS), and the Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences, in collaboration with the US Department of Agriculture National Institute of Food and Agriculture (USDA NIFA) encourage convergent research that transforms existing capabilities in understanding dynamic soil processes, including soil formation, through advances in sensor systems and modeling. The Signals in the Soil (SitS) program fosters collaboration among the two partner agencies and the researchers they support by combining resources and funding for the most innovative and high-impact projects that address their respective missions. To make transformative advances in our understanding of soils, multiple disciplines must converge to produce environmentally-benign novel sensing systems with multiple modalities that can adapt to different environments and collect and transmit data for a wide range of biological, chemical, and physical parameters. Effective integration of sensor data will be key for achieving a better understanding of signaling interactions among plants, animals, microbes, the soil matrix, and aqueous and gaseous components. New sensor networks have the potential to inform models in novel ways, to radically change how data is obtained from various natural and managed (both urban and rural) ecosystems, and to better inform the communities that directly rely on soils for sustenance and livelihood.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Brandi Schottel, Division of Chemical, Bioengineering, Environmental, and Transport Systems, telephone: (703) 292-4798, email: SitSquestions@nsf.gov
- Richard J. Fragaszy, Division of Civil, Mechanical, and Manufacturing Innovation, telephone: (703) 292-7011, email: SitSquestions@nsf.gov
- Mohammad Ali, Division of Electrical, Communications, and Cyber Systems, telephone: (703) 292-4632, email: SitSquestions@nsf.gov
- Mamta Rawat, Division of Division of Integrative Organismal Systems, telephone: (703) 292-7265, email: SitSquestions@nsf.gov
- Ford Ballantyne, Division of Environmental Biology, telephone: (703) 292-8037, email: SitSquestions@nsf.gov
- Enriqueta C. Barrera, Division of Earth Sciences, telephone: (703) 292-7780, email: SitSquestions@nsf.gov
- Marc Stieglitz, Office of Polar Programs, telephone: (703) 292-4354, email: SitSquestions@nsf.gov
- Ann C. Von Lehmen, Division of Computer and Network Systems, telephone: (703) 292-4756, email: SitSquestions@nsf.gov
- Robin L. McCarley, telephone: (703) 292-7514, email: SitSquestions@nsf.gov
- James Dobrowolski, National Program Leader, Division of Environmental Systems, United States Department of Agriculture National Institute of Food and Agriculture, telephone: (816) 926-1630, email: jdobrowolski@usda.gov
- Daniel Cassidy, National Program Leader, Division of Environmental Systems, United States Department of Agriculture National Institute of Food and Agriculture, telephone: (816) 926-1490, email: patrick.cassidy@usda.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 10.310 --- USDA-NIFA Agriculture and Food Research Initiative
- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 5 to 10

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

Anticipated Funding Amount: \$8,000,000 to \$13,000,000

The total amount available for this solicitation is \$13,000,000. Of this amount, NSF anticipates contributing approximately \$8,000,000, and USDA NIFA anticipates contributing approximately \$5,000,000. Program funding is subject to the availability of funds.

Projects will request 3 to 5 years of support with a total budget no less than \$600,000, and no more than \$1,200,000 per project.

This is a partnership between NSF and USDA NIFA; therefore, meritorious proposals may be funded by one or more agencies at the option of the agencies, not the proposer. All agencies will contribute to and participate in a common review process.

Please note: All materials should be submitted to NSF and must conform to NSF PAPPG guidelines (including budgetary/overhead

considerations) at the time of submission. NSF will share all submitted materials with USDA/NIFA. If all or a portion of a submitted proposal is determined by NSF and USDA/NIFA to be funded by USDA/NIFA, the lead PI/organization or subawardee will be instructed to update those portions of the proposal that must conform to differing USDA guidelines. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency.

Eligibility Information

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An individual can only appear on 2 projects total in any one of the following roles: PI, co-PI, or Senior Personnel. Please be advised that violations of these rules will result in "return without review" for ALL proposals submitted that include the individual in violation of these rules.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

Please note that, while NSF and USDA NIFA have different instructions for indirect cost rates, at the time of submission, the proposal must comply with NSF indirect cost rate policy. If, after review, a proposal is selected for funding by USDA NIFA, a revised budget that complies with USDA NIFA indirect cost rate policy will be requested before an award is made.

In accordance with NSF policy, the applicable US Federally negotiated indirect cost rate(s) must be used in computing indirect costs for the proposal. If a proposal or part of a proposal is selected for funding by USDA/NIFA, PIs will receive further instruction. For awards made by USDA/NIFA see information and instructions regarding indirect costs, refer to Part V, section 7.9 of the NIFA Grants.gov Application Guide.

For NIFA awards, Section 1462(a) and (c) of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (NARETPA) limits indirect costs for the overall award to 30 percent of Total Federal Funds Awarded (TFFA) under a research, education, or extension grant. The maximum indirect cost rate allowed under the award is determined by calculating the amount of indirect costs using:

1. the sum of an institution's negotiated indirect cost rate and the indirect cost rate charged by subawardees, if any; or
2. 30 percent of TFFA (TFFA = Field K., Total Costs and Fee, on SF-424 R&R Budget).

The maximum allowable indirect cost rate under the award, including the indirect costs charged by the subawardee(s), if any, is the lesser of the two rates.

If the results of 1), is the lesser of the two, the grant recipient is allowed to charge the negotiated indirect cost rate on the prime award and the subaward(s), if any. Any subawards would be subject to the subawardee's negotiated indirect cost rate. The subawardee may charge its negotiated indirect cost rate on its portion of the award, provided the sum of the indirect cost rate charged under the award by the prime awardee and the subawardee(s) does not exceed 30 percent of the TFFA.

If the result of 2), is the lesser of the two, then the maximum indirect cost rate allowed for the overall award, including any subaward(s), is limited to 30 percent of the TFFA. That is, the indirect costs of the prime awardee plus the sum of the indirect costs charged by the subawardee(s), if any, may not exceed 30 percent of the TFFA.

In the event of an award, the prime awardee is responsible for ensuring the maximum indirect cost allowed for the award is not exceeded when combining indirect costs for the Federal portion (i.e., prime and subawardee(s)) and any applicable cost-sharing (see 7 CFR 3430.52(b)). Amounts exceeding the maximum allowable indirect cost is considered unallowable and will be handled accordingly. See sections 408 and 410 of 2 CFR 200.

- **Other Budgetary Limitations:**

Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

May 20, 2020

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria apply.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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I. INTRODUCTION

Soils support economic prosperity and sustain terrestrial life. Soils are complex ecosystems composed of organic matter, minerals, water, air, and billions of organisms that mediate myriad biological, chemical, and physical processes essential for plant growth, food and fiber production, and removing contaminants from water, and are, in turn, impacted and changed by the plants and animals they support. Soils are the source of most of the antibiotics used to fight human diseases, control the movement of water and chemical substances between the Earth and its atmosphere, and can be both a source and a sink for important compounds involved in global biogeochemical cycles. We need to improve our understanding of how rapidly changing environmental factors impact microbial transformation of soil carbon, soil minerals and the regolith, nitrogen, and phosphorous compounds across active soil layers and permafrost. Soils are also the foundation material for all structures not supported on rock, and are, by orders of magnitude, the most

widely-used construction material in the world. Underground structures such as pipelines, tunnels, and basements must resist soil movement, corrosion, and groundwater seepage to perform properly. Historically, solid and liquid waste materials have been disposed of in the ground, often resulting in significant soil pollution. Hundreds of billions of dollars have been spent in the U.S. to locate and treat soil contamination from nuclear weapons production, deliberate and accidental chemical releases, pipeline ruptures, and many other sources of hazardous materials. Thus, as human pressure on natural and managed ecosystems intensifies, a better understanding of the metabolic, biogeochemical, and pedogenic processes occurring in soil ecosystems is critical for feeding the world while maintaining ecosystem services and infrastructures. As global demand for food, fiber, and bioenergy increases, and as land degradation, driven by land use change, poor agricultural practices, contamination, and urbanization occurs, we require more from increasingly compromised soils. Furthermore, the use of soil resources mediates social, cultural, and economic processes. Therefore, advancing our understanding of soil ecosystems and our capacity to manage this vital resource is becoming increasingly urgent.

The National Science Foundation (NSF) Directorates for Engineering (ENG) and Geosciences (GEO), the Divisions of Integrative Organismal Systems (IOS) and Environmental Biology (DEB) in the Directorate for Biological Sciences (BIO), the Division of Computer and Network Systems in the Directorate for Computer and Information Science and Engineering (CISE/CNS), and the Division of Chemistry (CHE) in the Directorate for Mathematical and Physical Sciences, in collaboration with the US Department of Agriculture National Institute of Food and Agriculture (USDA NIFA), encourage convergent research that transforms existing capabilities in understanding dynamic soil processes, including soil formation, through advances in sensor systems and predictive, process-based, and mechanistic modeling. To accomplish this research, multiple disciplines must converge to produce novel sensors and/or sensing systems of multiple modalities that are adaptable to different environments and that collect data and report on a wide range of biological, chemical, and physical parameters. This type of approach will also be necessary to develop next generation soil models, the necessary wireless communication and cyber systems capabilities, and to grow a scientific community that is able to address complex problems through education and outreach. This program fosters collaboration among researchers from multiple fields by funding the most innovative and high-impact projects that address their respective missions.

II. PROGRAM DESCRIPTION

Understanding of dynamic changes in soils is hampered by the inability to make site-specific measurements of key variables, *in situ*, and by the lack of integration among dynamic measurements of biological, chemical, and physical properties at various spatial and temporal scales. Scientists and engineers use many geophysical, biogeochemical, and “omics” methods to evaluate the biological, chemical, and physical properties of soils and their interactions with the atmosphere, water, plants, and other matter. For many applications, the current state of the art is to collect and transport soil core samples from field sites to the laboratory for assessment. However, such an invasive and time-delayed approach prevents us from truly understanding processes occurring in natural soils.

In addition, researchers rely on modeling to predict soil states. However, these models are based on limited data, made over limited timeframes, and use assumptions that are not reliable across spatially-variable landscapes, ranging from forest and rangeland ecosystems, to temperate farmland, tropical ecosystems, arid/semi-arid regions, and to Arctic permafrost. Many smaller scale, high frequency measurements can be used to inform local management decisions and modeling efforts at much larger temporal and spatial scales. For example, measurements are needed to better understand the potential influence of thawing permafrost on soil organism activity, the carbon cycle, and the fundamental biogeochemical and hydrological processes in areas that are particularly sensitive to changes in water and climate. Environmental changes in soil and warming permafrost also can have significant deleterious effects on civil infrastructure, resulting in damage or collapse of buildings and structures, rupture of pipelines, changes in ground motions from earthquakes, and slope instability. In another example, agricultural soils and associated biota can change dramatically with environmental perturbations such as drought or other abiotic events. Measurements from emplaced sensors that can monitor and predict changes in the agroecosystem are needed. Such sensors can also be used for assessing phenotypic responses and interactions among organisms within the physical and chemical soil environment.

An essential challenge for researchers is to develop the underlying science and technologies for new sensing systems that advance our current understanding of spatially and temporally dynamic soil processes and organismal activity (microbial, plant, human, and other animals) and to engineer systems for monitoring these processes. Accomplishing this goal will require major advances in: 1) highly efficient, low-cost sensors and sensing systems for measuring changes in biological, chemical, and physical processes with minimal disturbance, 2) instrumentation that incorporates flow cells and microfluidics for monitoring biological, chemical and physical parameters, and that could potentially extract and sequence DNA/RNA *in situ* and in real time to characterize soil ecosystems, 3) data transmission protocols in semantic data storage, and 4) models to predict key soil ecosystem variables, as well as better ways to refine models with both current and new SitS-generated data. Recent advances in miniature, low power, wireless sensors show considerable promise for long-term *in situ* measurements of soil biological, chemical, and physical variables. In addition, multi-functional sensors that can be embedded in soils are needed to ground-truth remote sensing data, including geophysical and satellite measurements. However, many of these technological advances, which are occurring in other fields (e.g., health/medicine, energy, and transportation), have not yet been explored widely for novel uses in soil. Likewise, advances in the data sciences, such as cloud computing, the semantic web, data mining, and the internet of things, are being explored and advanced in other application areas, but they have been underutilized for studying soil systems.

This solicitation encourages research proposals that integrate basic science and engineering approaches in a convergent[i] manner to: 1) develop the next generation of sensors and/or instruments capable of measuring biological, chemical, and physical variables *in-situ* with minimal disturbance; and 2) improve our understanding of signaling molecules and interactions that occur in soil ecosystems and address significant questions about the mechanistic understanding of coupled soil processes that would allow prediction of large scale ecosystem behavior. The development of sensor systems that include all the needed components to operate the sensor, communicate its signals, integrate these signals with other information, and perform analytics needed to produce observations at desired temporal and spatial scales in managed and unmanaged soils is within the scope of the solicitation. Similarly, research that uses sensor technologies to address mechanisms of biological signaling between organisms in the soil (microbes, fungi, plants, animals, or any combination) are also within the scope of this solicitation. New sensor systems will require associated advances in data transmission, ground penetration, data analytics, dynamic modeling, and visualization tools. If successful, this research will advance basic understanding of soil dynamics and will enable others to develop new ways of managing soils and natural resources. Furthermore, successful sensors will lead to a deeper understanding of the rate of soil formation, degradation, and restoration, and the interactions between soil and the life it supports. Advances in measurement systems for ecological, environmental, and climate research will also provide data for existing models and for developing new models.

Results from innovative SitS research will enable practitioners to use these newly-developed sensors, models, analytics, and time series data for translational impacts. The outcomes will make major contributions to the future of sustainable management, protection, and efficient or higher use of soil resources in both managed and natural systems. In addition to reducing soil erosion, reducing contamination of soil and water supplies, and improving food security, this program addresses the National Academy of Engineering “Grand Challenge” of managing the nitrogen cycle[iii], and the National

Academy of Sciences (NAS) call for "Breakthroughs in Field-Deployable Sensors for Advancing Food and Agricultural Research"^[iii]. Internationally, research from this solicitation will also address aspects of the United Nation's 2030 Agenda Sustainable Development Goals for Land Degradation Neutrality^[iv], the Aichi Biodiversity Targets^[v], and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assessment programs^[vi].

No single measure can define soil health, and, indeed, there is no agreed upon definition of a "healthy soil". Thus, to assess, monitor, understand, and provide sustainable, resilient, and functional soils through appropriate and sustainable decisions requires interdisciplinary expertise from the ecological, biological, chemical, atmospheric, biogeochemical, hydrological, social, and geological sciences and engineering, and the use of established and new tools and technologies, or new and innovative applications of these tools and technologies.

Research Priorities:

Each proposal must address **at least one** of the following five priorities. Systems approaches and attention to NSF's cross-cutting themes described below the 5 priorities are particularly encouraged.

- 1. Development of novel sensors:** There is an urgent need for inexpensive sensors that can operate for long time periods in highly variable soil conditions. In this priority, novel sensors or other devices (including multifunctional, chemical, and biological sensors) will be developed for sensing soil biological, chemical, or physical characteristics to monitor soil functions, soil-organism interactions, and changes in properties. The energy needs that allow the deployment of numerous sensors of this kind must also be addressed. These may include, but are not limited to, novel sensor geometry or architecture, materials, devices, and or innovative manufacturing processes. Widely useful sensors based on new sensing principles are of interest. Sensors that are not buried, or otherwise minimally invasive, are also considered if they can fill the soil sensing capacity needs by providing multiscale and multitemporal data. Sensors that will be placed in the ground should be placed with minimal disturbance, be environmentally benign, and have minimal impact on land use and land management. This may include novel methods for deployment, operation, and removal of sensor systems as appropriate. Proposals with emphasis on sensor systems for measurement of soil properties that either cannot be measured or are difficult to measure, and/or proposals with an emphasis on developing non-intrusive real time monitoring of soil gas fluxes (O₂, CO₂, CH₄, NH₃, N₂O, N₂, etc.) at local (plot to field) and landscape scales, are welcome. **Please note that, proposals that emphasize the development of new sensors/sensor systems or adapting/repurposing existing sensors/sensor systems must present a plan to address the potential environmental impacts of the technology where appropriate.**
- 2. Biological/ chemical/ physical interactions:** There are major gaps in our knowledge of signaling and interactions among soil-supported organisms, plants and animals (including humans) and the soil matrix itself. This priority focuses on sensor innovations that enable monitoring of biological processes and physical properties of the soil matrix. Examples include, but are not limited to, *in situ* and real time extraction and sequencing of nucleic acids, quantification and chemical characterization of metabolites such as root exudates and signaling molecules, and assessment of redox state. The development of synthetic fungal, microbial, or plant systems that use receptors, combined with well-characterized signal transduction pathways and reporters for the monitoring of toxins, metals, chemicals, or metabolites, are encouraged.
- 3. Cross-disciplinary modeling:** This effort will utilize existing and/or newly generated data from sensors and other sources to adapt existing models or develop new models of soil functions, particularly those that take advantage of emerging streams of high-resolution data. These mechanistic models should address the coupling of biological, chemical and physical processes that operate in soils at different temporal and spatial scales as revealed by measurements. Models that can be used to generalize from place-based studies to principle-based understanding across a region are particularly encouraged. There is also a need for models that allow the assessment of soil interannual variations over decades and longer time scales and incorporate feedbacks and changes to soils from drivers such as climate and land use changes.
- 4. Data transmission and analysis:** Advanced wireless communications and internet of things (IoT) could be used to collect and transmit data from sensors buried in soils over extended periods of time; thus leveraging artificial intelligence (AI) for data analysis. For projects that focus on wireless systems, PIs must clearly explain the existing constraints to wireless signal transmission of low power signals through various soil types and conditions (e.g., relative permittivity, conductivity of soil due to variable moisture, salinity etc.), inadequacy of state-of-the-art solutions, and system approaches spanning circuits, signal processing, data fusion, and wireless networking aspects. Additionally, the proposal must describe how the project team will overcome those constraints, along with expected improvements in data-transfer and power-consumption performance. Fusion of data from soil-based sensors with remote sensing data to provide ground truthing and high-resolution spatial coverage of soil properties is encouraged. New cheminformatics approaches to extract information from large data sets are also of interest.
- 5. Cyber-infrastructure:** Real time sensing demands intensive cyber-infrastructure support. This priority emphasizes the development of real-time cyber systems for secure collection, storage, and sharing of massive data volumes from soils by many wireless sensors with long-life operation capabilities. Examples include, but are not limited to, innovative data analytics and visualization (i.e. geovis) tools to enable quantitative data from soil sensors to be represented and interpreted over space and time.

In addition, **all proposals must address the following:**

- All projects must engage and grow the scientific community's capabilities of addressing complex problems through education and outreach across disciplines using novel mechanisms. This priority could include, for example, undergraduate and graduate research and training programs and/or short training programs for professionals on manufacturing, calibration, and operation of next generation sensor systems. This might also include community or stakeholder engaged components with relevant communities. The focus should be on interdisciplinary scientific and engineering literacy measured by specific outcomes.
- **Projects must include collaborators from more than one background to help define the intellectual merits of the research and the visions for its applications and broader impacts.** These backgrounds can be, for example, some combination of soil microbiologists, chemists, physicists, soil mineralogists and geologists, plant biologists, plant-soil interaction specialists, engineers familiar with sensor development and deployment, engineers involved in research on properties for structural uses of soil, computer scientists, biophysical modelers of soil biological, chemical, and physical components, and social scientists with experience in co-production of knowledge, community engagement, and outreach.

Cross Cutting Themes

Proposals that address topics related to NSF's 10 Big Ideas, particularly "Understanding the Rules of Life"^[vii], "Navigating the New Arctic"^[viii], "Harnessing the Data Revolution"^[ix], and "The Future of Work at the Human-Technology Frontier"^[x] are strongly encouraged. For those addressing "Understanding the Rules of Life", collaborators are encouraged to focus on sensing of soil-organism dynamics and interactions, inter-organismal signals, root and microbial exudates, metabolic activity, etc. For proposals focused in the Arctic, investigators must demonstrate a clear understanding of the unique challenges associated with working and living in regions where winters are characterized by extreme and prolonged cold and high winds, and where soils experience significant freeze-thaw activity. Also welcome are proposals that emphasize soil

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sensors, models, etc., that will address cross-cutting themes in “Urban Systems and Communities in the 21st Century”^[xi].

Proposals are also encouraged that address topics central to the goal of sustainable agricultural systems, including forest and range systems. Examples relevant to sustainable ecosystems include improving soil health through understanding the physical, chemical, and biogeochemical processes affecting the fluxes, fate and transport, transformation, and storage of the critical components of the ecosystems, as well as understanding the chemicals and agents that threaten them. Considerations for soil sensors in these managed systems should address the extreme heterogeneity of the managed environment, and the interplay between natural heterogeneity and the disturbances introduced by management.

Proposers are encouraged to use: 1) NSF’s National Ecological Observatory Network (NEON) and/or 2) Critical Zone Observatory (CZO) and Critical Zone Network (CZNet) resources, i.e., projects that rely on data and/or samples collected by NEON and CZO/CZNet, co-locate research activities at NEON and CZO/CZNet sites, and/or develop soil sensors/instrumentation that will enhance the processing, use, and/or analysis of NEON and CZO/CZNet data or collections.

Other Considerations: Proposals that use current or planned data, samples, or assignable assets from NSF-, and USDA NIFA-supported activities, or those that enhance broader scientific infrastructure are encouraged. Where appropriate, investigators are encouraged to work in association with existing projects, observational networks (NEON), critical zone observatories and network sites (CZO/CZNet), long-term ecological research sites (LTER), long term agricultural research sites (LTAR, ARS), or research centers, or testing and evaluation facilities, whether supported by NSF or other agencies, such as the US Environmental Protection Agency (USEPA), the United States Geological Survey (USGS), USDA NIFA, the USDA Agricultural Research Service (USDA ARS) or the National Oceanic and Atmospheric Administration (NOAA). In such proposals, the project description should make clear how the proposed work differs from and/or augments activities already supported. In all cases, however, proposals must clearly demonstrate how the research will develop fundamental new knowledge and enhance theory. A letter stating the specifics of cooperation or support from the ongoing activity for the proposed project should be included as part of the Supplementary Documents (see “Proposal Preparation Instructions” section).

[i] For more information on convergent research approaches, see “Convergence Research at NSF” - <https://www.nsf.gov/od/oia/convergence/index.jsp> and the “Dear Colleague Letter: Growing Convergence Research at NSF” March 2018 - https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18058.

[ii] For more information on the NAE Grand Challenge for Engineering to “Manage the Nitrogen Cycle”, please see: <http://www.engineeringchallenges.org/challenges/nitrogen.aspx>.

[iii] National Academies of Sciences, Engineering, and Medicine. 2018. Science Breakthroughs to Advance Food and Agricultural Research by 2030. Washington, DC: The National Academies Press. <https://www.nap.edu/catalog/25059/science-breakthroughs-to-advance-food-and-agricultural-research-by-2030>.

[iv] For more information on the UN Land Degradation Neutrality Goals, see: <https://www.unccd.int/actions/achieving-land-degradation-neutrality>.

[v] For more information on the Aichi Biodiversity Targets, See: <https://www.cbd.int/sp/targets/>.

[vi] For more information on the IPBES assessment program, please see: <https://www.ipbes.net/assessment-reports>.

[vii] For information on “Understanding the Rules of Life”, see https://www.nsf.gov/news/special_reports/big_ideas/life.jsp and https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18031.

[viii] For information on “Navigating the New Arctic”, see https://www.nsf.gov/news/special_reports/big_ideas/arctic.jsp and https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18048.

[ix] For more information on “Harnessing the Data Revolution”, see https://www.nsf.gov/news/special_reports/big_ideas/harnessing.jsp and <https://www.nsf.gov/cise/harnessingdata/>.

[x] For more information on “Future of Work at the Human-Technology Frontier”, see https://www.nsf.gov/news/special_reports/big_ideas/human_tech.jsp.

[xi] For more information on “Urban Systems and Communities in the 21st Century”, see <https://www.nsf.gov/ere/ereweb/urbansystems/>.

III. AWARD INFORMATION

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 5 to 10

Anticipated Funding Amount: \$8,000,000 to \$13,000,000

The total amount available for this solicitation is \$13,000,000. Of this amount, NSF anticipates contributing approximately \$8,000,000, and USDA NIFA anticipates contributing approximately \$5,000,000. Program funding is subject to the availability of funds.

Projects will request 3 to 5 years of support with a total budget no less than \$600,000, and no more than \$1,200,000 per project.

This is a partnership between NSF and USDA NIFA; therefore, meritorious proposals may be funded by one or more agencies at the option of the agencies, not the proposer. All agencies will contribute to and participate in a common review process.

Please note: All materials should be submitted to NSF and must conform to NSF PAPPG guidelines (including budgetary/overhead considerations) at the time of submission. NSF will share all submitted materials with USDA/NIFA. If all or a portion of a submitted proposal is

determined by NSF and USDA/NIFA to be funded by USDA-NIFA, the lead PI/organization or subawardee will be instructed to update those portions of the proposal that must conform to differing USDA guidelines. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency.

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An individual can only appear on 2 projects total in any one of the following roles: PI, co-PI, or Senior Personnel. Please be advised that violations of these rules will result in "return without review" for ALL proposals submitted that include the individual in violation of these rules.

Additional Eligibility Info:

For NIFA awards, Eligible applicants for single-function Research Projects include:

a) State Agricultural Experiment Station; b) colleges and universities (including junior colleges offering associate degrees or higher); c) university research foundations; d) other research institutions and organizations; e) Federal agencies, f) national laboratories; g) private organizations or corporations; h) individuals who are U.S. citizens, nationals, or permanent residents; and i) any group consisting of two or more entities identified in a) through h). Eligible institutions do not include foreign and international organizations.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via FastLane, Research.gov, or Grants.gov.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via FastLane or Research.gov. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

Please note: All materials must be submitted to NSF, and NSF will share all submitted materials with USDA NIFA.

For all proposals, in addition to the required PAPPG sections, there are specific supplemental instructions regarding the Cover Sheet, the "Project Description", the "Budget", the "Results from Prior NSF Support", and the Supplementary Documents.

Cover Sheet

1. Title: The proposal must have "SitS: ..." at the beginning of the title.
2. If a proposal has an international dimension (research in an international setting OR an international collaborator), it must be identified on the cover sheet. Please note that NO international collaborators should appear on the cover sheet. All international collaborators should be listed as "non-funded" Senior Personnel.

Project Description

1. Proposals must include an explicit statement of research questions being addressed in the proposed project, addressing advances in both soil sciences and technological developments.
2. A successful SitS proposal should present a convergent research approach and address the following in the project description:
 - Describe the disciplines involved. Note that a successful proposal must propose research that could potentially be reviewed in at least TWO of the seven different NSF directorates (BIO, CISE, EHR, ENG, GEO, MPS, and SBE), or one NSF directorate and USDA NIFA.
 - A vision that is developed using a convergent process of technological and scientific advances enabled by the proposed research. The vision should relate to specific domains of research, including (but not limited to):
 - Increasing ability to monitor and understand key processes in the Arctic Tundra;
 - Agricultural production systems and precision agriculture;
 - Spatially-variable landscapes, ranging from forest and rangeland ecosystems, to temperate farmland, tropical ecosystems, arid/semi-arid regions, and to Arctic permafrost, "Understanding the Rules of Life", soil-organism interactions, inter-organism signals, root and microbial exudates, metabolic activity, and, evolution of soil organisms over short and long timescales;
 - Dynamic interactions between soil and organisms;
 - Novel understanding of the processes of soil formation and degradation in agricultural, urban, and natural settings;
 - Advanced methods of soil penetration to place, move, and retrieve sensors with minimal disturbance; and
 - Advanced capabilities for monitoring and understanding environmental risks of soil and water contaminants.
 - Provide a clear statement of variables to be sensed, the soil depth(s) to be investigated, and the technologies to be developed or evaluated for sensing them, and a justification for selecting these particular variables. Proposals should also identify the technology to be advanced in sensing, power sources, wireless communications, cyber systems, or modeling/data analytics.
 - For projects that focus on the development of new deployable sensors/sensing systems or repurposing existing sensors/sensor systems, the proposal should also address environmental impact, although this should not be the sole focus of the proposed study. The environmental impact focus should include methods to evaluate the potential environmental impact of such systems.
 - Proposals must include the rationale for selecting targeted soil measurements, the importance of these measurements in advancing basic science, and a vision of how the innovative science could make major contributions to future sustainable management and protection of soil resources in managed and/or natural systems.
 - For projects that focus on wireless systems, PIs must explain the existing constraints to wireless signal transmission of low power signals through soils, inadequacy of state-of-the-art solutions, and system approaches spanning circuits, signal processing, and wireless networking aspects. Additionally, the PI(s) must describe how they will overcome those constraints, along with expected gains in result in improved data-transfer and power-consumption performance.
3. The Results from Prior NSF Support Section typically contained with the Project Description should be moved to the Supplementary Documents Section (see below) and must not exceed 5 pages total.

Budget

In addition to the normal PAPPG budgetary requirements, the **budget should include a budget to send at least 1 project participant and at least one student to a program workshop in the UK in first year of their 3-5 year project span, and at least one project participant and at least one student to a program workshop in Washington D.C. in the second year of their project. Each workshop is expected to span 2.5-3 days.** These workshops will provide a venue for the SitS project personnel from the 2019 US-UK solicitation to interact with the awardees of this solicitation.

SUPPLEMENTARY DOCUMENTS

Document 1: Researcher Mentoring Plan for supported postdoctoral scholars (if Applicable) (up to 1 page)

Proposals that request funding to support postdoctoral researchers must include a description of the disciplinary and cross-disciplinary mentoring activities that will be provided for such individuals. Only one single-page mentoring plan is allowed per proposal even if multiple postdoctoral researchers from different organizations are involved. The SitS program wants to see activities that prepare the post-doc for conducting interdisciplinary and convergent science; leading and managing interdisciplinary science teams; and provide exposure across the environmental, engineering, and human sciences represented in the project. Training opportunities could include short courses, workshops, collaborations, laboratory exchanges, or other related activities (national or international). Sample topics might include leadership, large project management, team science, application of statistical methods for integrating data across disciplines, analytical methods useful for SitS studies, or computational techniques for dealing with large, complex, or interdisciplinary datasets.

The Postdoctoral Researcher Mentoring Plan must be submitted under the specific tab indicated in Supplementary Materials

Document 2: Data Management Plan

This plan should describe issues related to information exchange, intellectual property rights, derived products, databases, software, model output, and materials sharing. For example, if the proposed activity is expected to result in community resources (such as databases or collections of materials and samples), the "Data Management Plan" should present a clear plan for sharing of these resources not only among the network participants, but also with the scientific community at large. The "Data Management Plan" should also address plans for determining authorship or proper attribution of credit for peer-reviewed or other publications, internet resources, etc. that may be expected to result from the activity. It should not exceed 2 pages.

Document 3: Other Supplementary Documents (one PDF containing the three documents described below, preferably in this order).

Please note that NO Biographical Sketches should appear in this section.

1. Results from Prior NSF Support (not to exceed 5 pages - change in placement from the PAPPG requirements)

The Results from Prior NSF Support Section typically contained with the Project Description should be moved to the Supplementary Documents Section and must not exceed 5 pages total.

2. Project Management Plan (Addition to PAPPG Requirements): *Not to exceed 3 pages – must be in the “Supplementary Documents” Section of the Proposal.* At the beginning of the Management Plan, the research disciplines included in the proposal must be listed. Researchers from diverse fields are expected to work collaboratively and interdependently, creating shared visions, models, methods, and discoveries. Each proposal must contain a Management Plan that describes how the project will be managed across disciplines, institutions, and community entities. This plan should identify specific collaboration mechanisms that will enable cross-discipline and cross-sector integration of teams, and provide a timeline including principal tasks and associated interactions. Each proposal must provide a brief summary of expertise of the team members in the Management Plan. The plan must also address the specific roles and responsibilities of the collaborating PI, Co-PIs, other Senior Personnel, paid consultants, and stakeholder participants, and describe how tasks will be integrated over the course of the project.
3. Letters of Collaboration: Proposers needing to document collaborative arrangements (confirmatory of cooperation on the project) or other types of commitments must submit letters of collaboration (as Supplementary Documents). All letters of collaboration must be included at the time of the proposal submission. Letters should confirm that the organization/individual agrees to the responsibilities identified in the project description and the “Management Plan”. Letters of Collaboration that convey an excessive sense of enthusiasm for the project or highlight research team qualifications are not permitted. It should NOT be a letter of endorsement, but rather, a commitment to the participation as defined in the project description. Submission of a letter of collaboration is not the same as submitting a separately submitted collaborative proposal.

Other Considerations: Where appropriate, investigators are encouraged to work in association with existing projects, observational networks (NEON), long-term ecological research sites (LTER), long term agricultural research sites (LTAR, ARS) or research centers, or testing and evaluation facilities, whether supported by NSF or other agencies, such as the US Environmental Protection Agency (EPA), the United States Geological Survey (USGS), USDA NIFA, USDA Agricultural Research Service (USDA ARS), or the National Oceanic and Atmospheric Administration (NOAA). In such proposals, the project description should make clear how the proposed work differs from and augments activities already supported. A letter stating the specifics of cooperation or support from the ongoing activity for the proposed project should be included as Supplementary Documents.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Indirect Cost (F&A) Limitations:

Please note that, while NSF and USDA NIFA have different instructions for indirect cost rates, at the time of submission, the proposal must comply with NSF indirect cost rate policy. If, after review, a proposal is selected for funding by USDA NIFA, a revised budget that complies with USDA NIFA indirect cost rate policy will be requested before an award is made.

In accordance with NSF policy, the applicable US Federally negotiated indirect cost rate(s) must be used in computing indirect costs for the proposal. If a proposal or part of a proposal is selected for funding by USDA/NIFA, PIs will receive further instruction. For awards made by USDA/NIFA see information and instructions regarding indirect costs, refer to Part V, section 7.9 of the NIFA Grants.gov Application Guide.

For NIFA awards, Section 1462(a) and (c) of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (NARETPA) limits indirect costs for the overall award to 30 percent of Total Federal Funds Awarded (TFFA) under a research, education, or extension grant. The maximum indirect cost rate allowed under the award is determined by calculating the amount of indirect costs using:

1. the sum of an institution's negotiated indirect cost rate and the indirect cost rate charged by subawardees, if any; or
2. 30 percent of TFFA (TFFA = Field K., Total Costs and Fee, on SF-424 R&R Budget).

The maximum allowable indirect cost rate under the award, including the indirect costs charged by the subawardee(s), if any, is the lesser of the two rates.

If the results of 1), is the lesser of the two, the grant recipient is allowed to charge the negotiated indirect cost rate on the prime award and the subaward(s), if any. Any subawards would be subject to the subawardee's negotiated indirect cost rate. The subawardee may charge its negotiated indirect cost rate on its portion of the award, provided the sum of the indirect cost rate charged under the award by the prime awardee and the subawardee(s) does not exceed 30 percent of the TFFA.

If the result of 2), is the lesser of the two, then the maximum indirect cost rate allowed for the overall award, including any subaward(s), is limited to 30 percent of the TFFA. That is, the indirect costs of the prime awardee plus the sum of the indirect costs charged by the subawardee(s), if any, may not exceed 30 percent of the TFFA.

In the event of an award, the prime awardee is responsible for ensuring the maximum indirect cost allowed for the award is not exceeded when combining indirect costs for the Federal portion (i.e., prime and subawardee(s)) and any applicable cost-sharing (see 7 CFR 3430.52(b)). Amounts exceeding the maximum allowable indirect cost is considered unallowable and will be handled accordingly. See sections 408 and 410 of 2 CFR 200.

Other Budgetary Limitations:

For NIFA awards, you may not use grant funds awarded under this authority to renovate or refurbish research, education, or extension space; purchase or install fixed equipment in such place; or the plan, repair, rehabilitate, acquire, or construction of buildings or facilities.

Budget Preparation Instructions:

In addition to the normal PAPPG budgetary requirements, the **budget should include a budget to send at least 1 project participant and at least one student to a program workshop in the UK in first year of their 3-5 year project span, and at least one project participant and at least one student to a program workshop in Washington D.C. in the second year of their project. Each workshop is expected to span 2.5-3 days.** These workshops will provide a venue for the SitS project personnel from the 2019 US-UK solicitation to interact with the awardees of this solicitation.

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

May 20, 2020

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <https://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane or Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology,

engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i), contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Please note that SitS is an interdisciplinary solicitation, and thus, will require interdisciplinary review. There will NOT be separate review processes for different disciplines. The proposals, if paneled, will be placed on interdisciplinary panels. Submitters should prepare their proposals accordingly.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

All proposals will be assessed jointly by NSF and USDA NIFA. Program Officers from both agencies will be involved in selecting ad hoc reviewers and panelists, operating a joint panel, and, following joint discussion of overall feasibility, settling on recommendations to their respective leadership.

NSF Process: After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

USDA NIFA Process: Applicants selected for funding by USDA NIFA will be required to provide additional information in accordance with policies and procedures of the Agriculture and Food Research Initiative (AFRI) program. Applications selected for funding by USDA NIFA will be forwarded to the USDA NIFA Awards Management Division for award processing in accordance with the USDA NIFA procedures.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Special Award Conditions:

Please note that at least 1 personnel (PI, co-PI, or Senior Personnel) and at least one student, for a total of at least 2 US participants from each project is required to attend a program workshop in the U.K. in the first year of the 3-5 year project span, and to Washington D.C. in the second year of the project span. The travel to these workshops must be included in the proposal budget as described in the proposal preparation section.

USDA NIFA

USDA NIFA requires a Felony Convictions or Tax Delinquent Status certification. Additional information will be provided prior to award if selected for funding.

Responsible and Ethical Conduct of Research: For information, link to [Responsible and Ethical Conduct of Research](#).

The USDA NIFA authority for this solicitation is contained in section 2(b) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)), of the Agriculture and Food Research Initiative (AFRI). AFRI authorizes the Secretary of Agriculture to award competitive grants for fundamental and applied research, extension, and education to address food and agricultural sciences. AFRI awards are subject to the NIFA regulations found at 7 CFR Part 3430. NIFA's authority to participate in the issuance of a joint RFA is 7 U.S.C. § 3319b.

Awards issued by USDA NIFA as a result of this solicitation will have designated the Automated Standard Applications for Payment System (ASAP), operated by the Department of Treasury's Bureau of the Fiscal Service, as the payment system for funds. For more information, see Award List.

Several federal statutes and regulations apply to grant applications considered for review and to project grants awarded under this program. These may include, but are not limited to, the ones listed on the USDA NIFA web page (see <https://nifa.usda.gov/regulations-and-guidelines>).

The USDA NIFA Federal Assistance Policy Guide (see <https://nifa.usda.gov/policy-guide>) is a compendium of basic NIFA policies and procedures that apply to all NIFA awards, unless there are statutory, regulatory, or award-specific requirements to the contrary.

Other Requirements

USDA NIFA:

Delegation of Fiscal Responsibility

Unless the terms and conditions of the award state otherwise, awardees may not in whole or in part delegate or transfer to another person, institution, or organization the responsibility for use or expenditure of award funds.

Changes in Budget or Project Plans

In accordance with 2 CFR 200.308, awardees must request prior approval from NIFA for the following program or budget-related reasons:

- i. Change in the scope or the objective of the project or program (even if there is no associated budget revision requiring prior written approval).
- ii. Change in a key person specified in the application or the federal award.
- iii. The disengagement from the project for more than three months, or a 25 percent reduction in time devoted to the project, by the approved project director or principal investigator.
- iv. The inclusion, unless waived by the federal awarding agency, of costs that require prior approval in accordance with 2 CFR 200 Subpart E—Cost Principles of this part or 45 CFR Part 75 Appendix IX, "Principles for Determining Costs Applicable to Research and Development under Awards and Contracts with Hospitals," or 48 CFR Part 31, "Contract Cost Principles and Procedures," as applicable.
- v. The transfer of funds budgeted for participant support costs as defined in §200.75 Participant support costs to other categories of expense.
- vi. Unless described in the application and funded in the approved federal awards, the subawarding, transferring or contracting out of any work under a federal award, including fixed amount subawards as described in §200.332 Fixed amount subawards. This provision does not apply to the acquisition of supplies, material, equipment, or general support services.
- vii. Changes in the approved cost-sharing or matching provided by the non-federal entity.
- viii. The need arises for additional federal funds to complete the project.

The awardee will be subject to the terms and conditions identified in the award. See link to information about NIFA award terms: <https://nifa.usda.gov/terms-and-conditions>.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

USDA NIFA:

The output and reporting requirements are included in the award terms and conditions (see <http://www.nifa.usda.gov/business/awards/awardterms.html> for information about NIFA award terms). If there are any program or award-specific award terms, those, if any, will be identified in the award.

Additional Reporting Requirements

- For awards funded by NSF, US PIs will be required to include descriptions of their project milestones and their data management activities in

- their annual reports. Data reporting should conform to current NSF data policy guidelines; PIs should consult with the PAPPG.
- For awards funded by USDA NIFA, reporting requirements will conform to those specified by USDA NIFA.
 - For the US portion of projects that are funded by NSF and USDA NIFA, the annual report of the lead project in the collaborative must be resident at NSF and must include a description of the activities and milestones of the parts of the project that are funded by the other agencies.
 - When the US portion of a project is funded by both agencies, the NSF-lead organizations should submit a unified annual report and the USDA NIFA funded portion of the project should include the NSF-unified annual report as part of its USDA NIFA annual report (see also FAQ).

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Brandi Schottel, Division of Chemical, Bioengineering, Environmental, and Transport Systems, telephone: (703) 292-4798, email: SitSquestions@nsf.gov
- Richard J. Fragaszy, Division of Civil, Mechanical, and Manufacturing Innovation, telephone: (703) 292-7011, email: SitSquestions@nsf.gov
- Mohammad Ali, Division of Electrical, Communications, and Cyber Systems, telephone: (703) 292-4632, email: SitSquestions@nsf.gov
- Mamta Rawat, Division of Division of Integrative Organismal Systems, telephone: (703) 292-7265, email: SitSquestions@nsf.gov
- Ford Ballantyne, Division of Environmental Biology, telephone: (703) 292-8037, email: SitSquestions@nsf.gov
- Enriqueta C. Barrera, Division of Earth Sciences, telephone: (703) 292-7780, email: SitSquestions@nsf.gov
- Marc Stieglitz, Office of Polar Programs, telephone: (703) 292-4354, email: SitSquestions@nsf.gov
- Ann C. Von Lehmen, Division of Computer and Network Systems, telephone: (703) 292-4756, email: SitSquestions@nsf.gov
- Robin L. McCarley, telephone: (703) 292-7514, email: SitSquestions@nsf.gov
- James Dobrowolski, National Program Leader, Division of Environmental Systems, United States Department of Agriculture National Institute of Food and Agriculture, telephone: (816) 926-1630, email: jdobrowolski@usda.gov
- Daniel Cassidy, National Program Leader, Division of Environmental Systems, United States Department of Agriculture National Institute of Food and Agriculture, telephone: (816) 926-1490, email: patrick.cassidy@usda.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188
FastLane Help Desk e-mail: fastlane@nsf.gov.
Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on [NSF's website](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <https://www.grants.gov>.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

About the National Institute of Food and Agriculture

The National Institute of Food and Agriculture (NIFA) is an agency within the U.S. Department of Agriculture (USDA), part of the executive branch of the Federal Government. Congress created NIFA through the Food, Conservation, and Energy Act of 2008. NIFA replaced the former Cooperative State Research, Education, and Extension Service (CSREES), which had been in existence since 1994. NIFA's unique mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations. NIFA doesn't perform actual research, education, and extension but rather helps fund it at the state and local level and provides program leadership in these areas. Through grants offered by NIFA, the USDA enables researchers throughout the United States to solve problems critical to our farmers, consumers, and communities. NIFA is the USDA's major extramural research agency, funding individuals, institutions, and public, private, and non-profit organizations. NIFA's education programs supports and promotes teaching excellence, enhances academic quality, and develops tomorrow's scientific and professional workforce. In cooperation with public institutions, private sector partners, and the Land-Grant University System, NIFA provides national leadership to address critical educational issues. NIFA's extension projects deliver science-based knowledge and informal educational programs to people, enabling them to make practical decisions.

NIFA Web site:

<https://www.nifa.usda.gov/>
Phone: (202) 720-4423

Street Address:

USDA-National Institute of Food and Agriculture
6501 Beacon Drive
Kansas City, MO 64133

Mailing Address:

United States Department of Agriculture
National Institute of Food and Agriculture
1400 Independence Avenue SW., Stop 2201
Washington, DC 20250-2201

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <https://www.nsf.gov>

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
 - Send an e-mail to: nspubs@nsf.gov
 - or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See [System of Record Notices](#), NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
Alexandria, VA 22314

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