Geoinformatics (GI)

PROGRAM SOLICITATION
NSF 21-583

REPLACES DOCUMENT(S):
NSF 19-561

National Science Foundation

Directorate for Geosciences
    Division of Earth Sciences

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

August 16, 2021

August 15, Every Other Year Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

Revisions from NSF 19-561 include:

- Updated Award Information, including the anticipated funding amount, is provided.
- Updated introduction and description of the Geoinformatics program, detailing a new program emphasis on justice, equity, diversity, and inclusion (JEDI), is provided.
- Proposers are now required to identify whether their proposal is "Catalytic", "Facility" or "Sustainability" track in the beginning of the proposal title.
- The Essential Elements and Additional Solicitation Specific Review Criteria for proposals have been updated.
- Proposals may now include requests for cloud computing resources through an external cloud access entity supported by NSF's Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access) Program.
- Additional proposal preparation instructions now apply. Please see the full text of this solicitation for further information.
- Additional award conditions now apply. Please see the full text of this solicitation for further information.

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:

Geoinformatics (GI)

Synopsis of Program:

The Division of Earth Sciences (EAR) will consider proposals for the development of cyberinfrastructure (CI) for the Earth Sciences (Geoinformatics). EAR-supported geoinformatics opportunities will fit into three tracks: Catalytic Track, Facility Track, and Sustainability Track. These tracks broadly support the lifecycle of geoinformatics resource development, from pilots (Catalytic) to broad implementation (Facility) to sunsetting and long-term sustainability (Sustainability).

The **GI Catalytic Track** will support pilot geoinformatics development efforts that are intended to serve Earth Science research.

The **GI Facility Track** will support awards for implementation and operation of a cyberinfrastructure resource relied upon by one or more Earth Science communities to address science questions.

The **GI Sustainability Track** will support development and implementation of sustainable funding models to preserve data and software products of value to Earth Science research.

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.

- Raleigh Martin, telephone: (703) 292-7199, email: ramartin@nsf.gov

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

- 47.050 --- Geosciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant or Cooperative Agreement

Estimated Number of Awards: 5 to 10

The number of awards will depend on the quality of proposals, the amount of funding available, and the need for the proposed tools, software, and/or databases for the geoscience community(ies) to be served.

Anticipated Funding Amount: $5,300,000 annually, pending the availability of funds.

Award size will be variable with the amount depending on the quality of proposals, the amount of funding available, and the need for the proposed tools, software, and/or databases for the geoscience community(ies) to be served. It is anticipated that proposals over a wide spectrum of amounts will be entertained, from low-cost, single-investigator proposals to large, multi-investigator/institutional proposals.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

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:

There are no restrictions or limits.

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 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:**

    Not Applicable

- **Other Budgetary Limitations:**

    Not Applicable

C. Due Dates

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

    August 16, 2021

    August 15, Every Other Year Thereafter

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

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

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

NSF's Division of Earth Sciences (EAR) is committed to supporting efforts to preserve and share research products in accordance with NSF and EAR data policies, and to enable the findability and accessibility of these research products for research transparency and future reuse. To advance the frontiers of Earth Science research, geoscientists and others need tools to discover, manage, analyze, integrate, and reuse data on all aspects of the Earth system. Cyberinfrastructure for easy access to high-quality data, visualization tools, and modeling and analysis codes help scientists and educators maximize the value of Earth Science data and to generate transparent and reproducible research outcomes.

In 2020, the Committee on Catalyzing Opportunities for Research in the Earth Sciences of the National Academy of Sciences, Engineering, and Medicine published *A Vision for NSF Earth Sciences 2020-2030: Earth in Time*, hereafter, the "Earth in Time" report (National Academies of Sciences, Engineering, and Medicine 2020. A Vision for NSF Earth Sciences 2020-2030: Earth in Time. Washington, DC: The National Academies Press. https://doi.org/10.17226/25761). This report provides recommendations "to advance EAR research through improvements to cyberinfrastructure that support computing and modeling capabilities, as well as data integration, synthesis, and curation." In addition, responses to a community input questionnaire accompanying the Earth in Time report "call[ed] for improvements in access to high-performance computing, software and modeling, and for enhanced outreach to increase access to Earth science information and to grow diversity among Earth scientists."

This solicitation supports efforts to develop data resources, software tools, and computational infrastructure needed to facilitate studies of the structure, dynamics, and evolution of the Earth through time, as well as the processes that act upon and within the Earth from the surface to the core. Successful projects will develop community cyberinfrastructure to advance research and education goals in Earth Science. To serve geoinformatics projects at all stages of cyberinfrastructure development, the Geoinformatics solicitation includes multiple tracks for piloting, broadening, and sustaining cyberinfrastructure resources that serve Earth Science. The Geoinformatics Program encourages proposals that include and foster engagement with people and communities historically

underrepresented in Earth Science, such as women, persons with disabilities, and underrepresented groups, those from geographically underrepresented areas in science, technology, engineering, and mathematics, and veterans of the U.S. Armed Forces. The Program is also interested in activities focused on justice, equity, diversity, and inclusion (JEDI) that are tightly integrated with the development of cyberinfrastructure.

The tracks in the Geoinformatics Program are designed to support the lifecycle of typical cyberinfrastructure development in three distinct phases. The development phase is supported in the **Catalytic Track**; the implementation and operation phase is supported in the **Facility Track**; and the preservation and sustainability phase is supported in the **Sustainability Track**. These three tracks are defined in the Program Description below.

II. PROGRAM DESCRIPTION

This Geoinformatics Program Solicitation comprises three tracks with complementary focuses. None of these tracks will support hardware development or major hardware purchases.

- The **Catalytic Track** will focus on up to 3-year pilot geoinformatics development efforts that are intended to serve Earth Science research. This could be achieved through development of new community platforms (databases or modeling resources) or tools to be used by the research community, not a specific research group.
- The **Facility Track** will focus on implementation and operation of a CI resource relied upon by one or more Earth Science communities to address science questions. This may be achieved through operation of a community platform for Earth Science data analysis, visualization, and curation and/or shared community software and must include associated training, outreach, and engagement efforts. To ensure appropriate management and oversight, Facility Track proposals must clearly describe expected management roles, a timeline of work, and a budget breakdown across major activities (see "Essential Elements" below for details). Projects are intended to be 3-5 years in duration per award. Facility Track projects may be supported by the Geoinformatics program for no more than 10 years. Because of the importance of Facility Track projects to a broad range of Earth Science communities, proposers are strongly encouraged to contact the Program Officer(s) listed in this solicitation to discuss proposal plans and expected approaches to project management.
- The **Sustainability Track** will focus on development and implementation of sustainable funding models to preserve data and software products of value to Earth Science research. This may be achieved in a variety of ways, including, but not limited to, implementing a new sustainable operating plan for an existing resource, a federation of resources, or a merger into an institutional or other long-term resource. Projects in this track will demonstrate a reduction in NSF support over time. The emphasis is on preservation of valuable data and software products rather than on continuation of CI platforms or project teams themselves. These awards are intended to be up to 3 years in duration.

The Program seeks projects that attract diverse students and involve early career researchers. Successful projects will include creative, integrative, and effective broader impacts activities developed within the context of the mission, goals, and resources of the organizations involved. Broader impacts activities must be an integral part of the proposed activities and this should be reflected in the expertise of collaborators, the proposal budget, and budget justification. Proposers are encouraged to explore innovative outreach efforts that advance justice, equity, diversity, and inclusion (JEDI) in the research and educational and community outreach activities. Examples could include requested support for: 1) engaging representatives of historically underrepresented groups; 2) partnering with faculty at minority serving institutions and community colleges, 3) outreach to engage K-12 educators and students in project activities, 4) unique webcasting, social media, virtual reality experiences, or other activities to promote awareness of the Earth Sciences, or 5) travel to annual conferences of professional societies focused on fostering enhanced diversity in science (e.g., National Association of Black Geoscientists (NABG) – http://www.nabg-us.org/, Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) – http://www.sacnas.org/, American Indian Science and Engineering Society (AISES) – http://www.aises.org/).

Essential Elements

Proposers are required to include sections within the Project Description addressing each of the following six Essential Elements for this solicitation:

- **Modern cyberinfrastructure.** Adopt open data standards and open source codes, with a particular focus on improving user function for Facility Track proposals. Facility Track proposals should also address adoption of open metadata standards in anticipation of planned inclusion of metadata records for research data in NSF's Public Access Repository (PAR). (See NSF 20-068, "Dear Colleague Letter: Open Science for Research Data".)
- **Engagement.** Address how project activities will be implemented to achieve broad engagement with relevant scientific communities. Proposers are encouraged to include and proactively engage persons from historically underrepresented groups, varied institution types, and a range of career stages. Proposers should further address how planned activities contribute to advancing justice, equity, diversity, and inclusion (JEDI) across relevant Earth Science communities. All proposals must describe the community(ies) served, including size, expected science, and engagement throughout the project. The scope of engagement activities should be in proportion to the planned size of the award.
- **Science motivation.** Justify and demonstrate science questions that could be addressed through the project (including existing outcomes that resulted from past developments).
- **Metrics.** Provide specific metrics that will be adopted to demonstrate engagement, track progress on proposed activities, and measure impacts on the advancement of Earth Science. Proposals should describe plans for monitoring these metrics throughout the duration of the award.
- **Sustainability plan.** Describe plans for sustaining project outcomes beyond completion of the award (e.g., through establishing partnerships with existing institutions/facilities). Sustainability Track proposals should also highlight specific components (data, software, tools) to be sustained, describe sustainable funding models to support these components into the future and include Letters of Collaboration by the institutions/partners engaged for the plan.
- **Management plan.** This should include plans for project management, governance (science/community oversight), and scalability to adapt to expanding user capacity. The scope of the management plan should be in proportion to the planned size of the award. For Facility Track proposals, management plans must clearly describe personnel roles and responsibilities, a timeline of work, and a breakdown of work commitments, costs, and deliverables expected for each major activity that is proposed. Facility Track projects submitted as collaborative proposals must further describe clear plans for coordination of project management across collaborative organizations and distinctive roles for each organization.

In addition to these essential elements, PIs are encouraged to involve computational scientists and/or industry partners, as appropriate, as co-PIs, collaborators, and/or consultants.

PIs are encouraged to consider using the wide range of NSF-supported advanced shared computing resources for their computational needs, including the Frontera system at the Texas Advanced Computing Center (TACC) and the eXtreme Science and Engineering Discovery Environment (XSEDE). PAPPG Chapter II.D.7 provides additional information on accessing high-performance computing resources, data infrastructure, or advanced visualization resources.

Cloud Computing Resources

Proposals may request cloud computing resources to use public clouds such as Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure, and IBM Cloud. Cloud computing resources described in proposals may be obtained through CloudBank (CloudBank.org), an external cloud access entity supported by NSF's Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access) Program.

Proposers requesting cloud computing resources through CloudBank should describe the request in a Supplementary Document no longer than two pages with (a) anticipated annual and total costs for accessing the desired cloud computing resources, based on pricing currently available from the public cloud computing providers; and (b) a technical description of, and justification for, the requested cloud computing resources. The NSF Budget should not include any such costs for accessing public cloud computing resources via CloudBank.org. Proposers should include "CloudAccess" (one word without space) at the end of the Overview section as a key word (before the section on Intellectual Merit) of the Project Summary page if incorporating this request into the proposal. Proposers may contact CloudBank.org (see https://www.cloudbank.org/faq) for consultation on determining the budget estimate for using cloud computing resources.

General Information

To better understand current and recent NSF investments in Geoinformatics, it is recommended that proposers contact the Program Officer(s) listed in this solicitation. It is also strongly recommended that proposers discuss their idea(s) with Program Officers in the Division of Earth Sciences program(s) most closely affiliated with the proposed activity so synergies with already funded projects can be identified and so the merit review process can be coordinated.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant, Standard Grant, or Cooperative Agreement

Estimated Number of Awards: 5 to 10. The number of awards will depend on the quality of proposals, the amount of funding available, and the need for the proposed tools, software, and/or databases for the geoscience community(ies) to be served.

Anticipated Funding Amount: $5,300,000 annually, pending the availability of funds. Award size will be variable with the amount depending on the quality of proposals, the amount of funding available, and the need for the proposed tools, software, and/or databases for the geoscience community(ies) to be served. It is anticipated that proposals over a wide spectrum of amounts will be entertained, from low-cost, single-investigator proposals to large, multi-investigator/institutional proposals.

Catalytic and Sustainability Track awards shall be up to 3 years in duration. Facility Track awards shall be 3 to 5 years in duration, with the possibility for renewal up to a total of 10 years.

Estimated program budget, number of awards, and average award size/duration are subject to the availability of funds. It is anticipated that proposals over a wide spectrum of amounts will be entertained, from low-cost, single-investigator proposals to large, multi-investigator/institutional proposals.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

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:

There are no restrictions or limits.

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 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 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. 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.

The following provides additional guidance beyond that contained in the PAPPG or NSF Grants.gov Application Guide.

Cover Sheet:

- **Proposal Title:** Provide a short informative title for the proposed project. To assist NSF staff in sorting proposals for review, proposal titles must include "Catalytic:", "Facility:" or "Sustainability:".

Project Summary:

- The final line of the Overview portion of the Project Summary must be a list of no more than five key words preceded by the phrase or heading **Key Words**. Proposers requesting cloud resources through CloudBank.org should include "CloudAccess" (one word without space) as one of these Key Words if incorporating this request into the proposal.

Project Description:

- The Project Description must include sections addressing each of the six Essential Elements for this solicitation.
- Maximum page lengths for the Project Description for **Catalytic Track** and **Sustainability Track** proposals are 15 pages. Maximum page lengths for the Project Description for **Facility Track** proposals are 20 pages including all figures and charts.

Additional Supplementary Documents:

- **Cloud Computing Resources:** If requesting cloud computing resources through CloudBank.org, include a description of your requests (not to exceed 2 pages) that includes: (1) title of the proposal; (2) the total cost of computing resources, with yearly breakdown; (3) which public cloud providers will be used; and (4) a technical description and justification of the request, along with how the cost was estimated.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Additional Budget Preparation Instructions

Cloud Computing Resources: The total cost of the cloud computing resources requested from Cloudbank.org should not be included in the NSF budget, and should be specified only in the associated supplementary document.

C. Due Dates

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

  August 16, 2021

  August 15, Every Other Year Thereafter

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 other underrepresented groups 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.

Additional Solicitation Specific Review Criteria

Proposals will be evaluated on how effectively they address the Essential Elements listed in the Program Description:

- **Modern cyberinfrastructure**
- **Engagement**
- **Science motivation**
- **Metrics**
- **Sustainability plan**
- **Management plan**

B. Review and Selection Process

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

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.

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.

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:

Some awards associated with this solicitation may be made as Cooperative Agreements (CAs) that fund annual awardee operations in accordance with Annual Program Operating Plans approved by NSF prior to each year of work. Any special requirements not stated herein will be negotiated at the time of award. NSF reserves the right to initiate annual site reviews of the awardee and to conduct a mid-term management review.

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.

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:

- Raleigh Martin, telephone: (703) 292-7199, email: ramartin@nsf.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.

The Geoinformatics Program complements other NSF activities. EarthCube, a partnership between the Geosciences Directorate (GEO) and the Office of Advanced Cyberinfrastructure (OAC), supports projects that promote integration and interoperability of existing GEO cyber resources. OAC programs support basic technological and infrastructural development for cyberinfrastructure. EAR disciplinary programs support small-scale computational and data products associated with research projects, and the EAR Instrumentation and Facilities (IF) program supports cyberinfrastructure directly associated with physical infrastructure. NSF's Harnessing the Data Revolution (HDR) Big Idea supports foundations and applications of data science across research domains. NSF's Artificial Intelligence (AI) Institutes program, a joint effort of NSF, the US Department of Agriculture, Department of Homeland Security, Department of Transportation, and several industry partners, funds Institutes focused on advancing the research frontiers of AI.

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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 (FASED) 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.

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>
> - **Location:**   2415 Eisenhower Avenue, Alexandria, VA 22314
>
> - **For General Information**   (703) 292-5111
>   (NSF Information Center)**:**

- **TDD (for the hearing-impaired):** (703) 292-5090

- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-8134

- **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
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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