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Testimony for the Record
In Support of the National Science Foundation
and Its Investment
In Geoscience Research, Infrastructure, and Education
Before the
Subcommittee on Commerce, Justice, and Science
Committee on Appropriations
House of Representatives
April 27, 2018

The institutions listed in the margin of this statement are pleased to submit to the Subcommittee this statement in which we collectively argue that the investment in research and education made via the National Science Foundation (NSF) is essential to the long-term security of the Nation. In particular the support provided by NSF for geoscience research, infrastructure, and education is vital if our Nation is to address critical security issues related to national defense, economic competitiveness, and public health and safety. **The entities lending their name to this statement recommend that the Congress provide NSF with an appropriation of $8.45 billion for FY 2019.** This is consistent with recommendations contained in the Dear Colleague Letters led by Rep. G.K. Butterfield and Rep. David B. McKinley in the House and Senator Markey and others in the Seante, along with the Coalition for National Science Funding, the Association of American Universities, and the Association of Public and Land-grant Universities. Funding at this level will start to reverse the trend of the last 20 years that has left the United States on the verge of falling behind our international competitors.

Growth in the annual investment in American science by NSF is critical to support innovation, which is critical for national security, economic competitiveness, improvements in living standards, and support for public and societal well-being. Research and development (R&D) is a major driver of innovation, and R&D expenditures reflect a nation's commitment to expanding capabilities in Science & Engineering (S&E), which in turn drives innovation. On January 18, the National Science Board released the biennial *Science and Engineering Indicators 2018*. The report finds that the world's nations are continuing to accelerate the growth of their technology-intensive economies. It documents how the S&E landscape — historically concentrated in the U.S., Europe, and Japan — is rapidly shifting as China and other countries continue to increase their R&D investments. It makes clear that while the U.S. remains the global leader by many S&E measures, China has continued its rapid rise in the rankings.

Investments in research and education are essential for maintaining technological innovations and advancements that will help our society and a global population survive in a rapidly changing world. Investing in research returns economic prosperity many times over. If the U.S. is to meet the

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environmental and economic challenges facing this country, we must make the necessary investments in our research and education enterprise.

## Research and National Security

In response to questions for the record from the Senate Armed Services Committee in early 2017, U.S. Secretary of Defense James Mattis said, "… climate change is a challenge that requires a broader, whole-of-government response. If confirmed, I will ensure that the Department of Defense plays its appropriate role within such a response by addressing national security aspects." In making that statement, Secretary Mattis joined a long list of defense, national security, and intelligence leaders that have recognized the significant and unprecedented national and homeland security risks posed by the climate issue such as sea level rise and increased storm surges, which could inundate coastal military and civilian infrastructure. Drastic changes in food, water, and energy availability also increase the likelihood of instability and state failure across the globe. The gravity of these risks has been affirmed by a number of senior defense and intelligence leaders in the current Administration, in addition to Secretary of Defense Mattis. This list includes Vice Chairman of the Joint Chiefs of Staff, General Paul Selva; Secretary of the Navy, Richard Spencer; Assistant Secretary of Defense for Energy, Installations and Environment, Lucian Niemeyer; Chief of the National Guard Bureau, General Joseph Lengyel; Assistant Secretary of the Army for Civil Works, R. D. James; and Director of National Intelligence, Dan Coats. This issue was most recently addressed at the April 12, 2018 hearing before the House Appropriations Subcommittee on Military Construction and Veterans Affairs in an exchange between Subcommittee members and Assistant Secretary fo Defense (Energy, Installations, and Environment) Lucian Niemeyer.

In summer 2017, the first ship to traverse the Arctic Northern Sea Route without assistance from ice-breaking vessels completed its journey. That transformational moment drives home both the opportunity and the imperative for the United States, a Nation with an important Arctic presence, to ready itself for the new Arctic. The Arctic is warming at twice the rate of the rest of the Earth with far-reaching consequences for Arctic residents. Arctic change will fundamentally alter climate, weather and ecosystems globally in ways that we do not yet understand but that will have profound impacts on the world's economy and security. Rapid loss of Arctic sea ice and other changes will also bring new access to the Arctic's natural resources such as fossil fuels, minerals, and new fisheries, and this new access is already attracting international attention from industry and nations seeking new resources. NSF proposes, via its "Big Ideas"initiative called Navigating the New Arctic (NAA), to establish an observing network of mobile and fixed platforms and tools across the Arctic to document these rapid biological, physical, chemical and social changes, leveraging participation by other federal agencies. Current Arctic observations are sparse and inadequate for enabling discovery or simulation of the processes underlying Arctic system change or to assess their environmental and economic impacts on the broader Earth

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system. Among federal agencies, NSF is unique in its ability to fund bottom-up research driven by the U.S. academic research community across the physical, biological, social, engineering and computational sciences. Arctic research also offers greater opportunity for the next generation of Arctic researchers.

NSF has issued a Dear Colleague Letter in FY 2018 inviting research proposals related to the NNA focusing on: establishment of observational research sites, observational platforms, or networks of sites to document key aspects of the changing Arctic; studies to understand and forecast changes in biogeochemical, geophysical, ecological and social processes occurring in the new Arctic; studies of feedbacks between the design and engineering of urban and rural civil infrastructure and changes in natural ecosystems such as thawing permafrost and sea ice retreat and social systems such as increasing marine commerce; and studies that advance STEM education through Arctic research activities.

**Geoscience Research – Vital for Economic Security and Public Safety**

A series of articles that appeared in *Pacific Standard* identify other ramifications stemming from changes to our environment. Potential health risks are estimated to rise significantly because of higher temperatures and complications from natural disasters. An additional 250,000 people are projected to die every year between 2030 and 2050 as a result of these health risks, according to the World Health Organization. Malnutrition could affect nearly half a million adults globally by 2050 as a result of food and nutrition scarcity. The economies of the states in the South, Midwest, and mid-Atlantic are expected to suffer from predicted gross domestic product losses of up to 28 percent because of the effects of greenhouse-gas emissions on field production. Marine fisheries globally, which have been estimated to support the livelihoods of 10 to 12 percent of the world's population, are projected to show decreased yields and profits. Islands, inhabited by hundreds of residents, such as the Tangier Islands in the Chesapeake Bay, could be entirely consumed by rising sea levels by 2050, or sooner.

The Federal Government has a responsibility to meet these future challenges. To fulfill this responsibility, one important step the Nation should take is to enhance its investment in basic research and related infrastructure through NSF, with a particular focus on the geosciences and related areas. This investment will help to create the new knowledge and technological capabilities – along with the educated and trained workforce to use these new tools – to address these challenges and seize the strategic opportunities presented by such efforts. Investing in basic research related to the geosciences will not just support national security efforts, it will also contribute to the development of new knowledge and technologies that will contribute to the nation’s economic competitiveness and public safety.

In minerals development, NSF-funded research on magma systems in Antarctica led to a genetic ore deposit model that was vital to the discovery of the significant Nokomis copper-nickel-platinum group element deposit in northern Minnesota. The Nokomis deposit contains estimated metal resources of approximately 10 billion pounds of copper, 3.1 billion pounds of nickel, 165 million pounds of cobalt, 4 million ounces of platinum, 9 million ounces of palladium, and 2 million ounces of gold. Meanwhile, geoscientists have created large, high-quality synthetic diamonds and determined how to manipulate their toughness, hardness, and color. Synthetic diamonds are significantly harder than real diamonds, making them suitable for industrial applications, such as the production of cutting tools and faster

computer processors. They are also 30 percent cheaper than natural diamonds, which can cost upwards of $2,000 per carat.

Researchers have shown that geodetic networks can help to provide earthquake and tsunami early warnings that can save lives and limit damage. NSF/GEO operates and maintains the largest geodetic network for research in the United States and supports extended networks in the Americas and Caribbean. Besides understanding earth processes in the crust, ice, snow and atmosphere, these observing networks are critical for hurricane, severe weather, space weather, fire, floods, earthquakes, volcanoes, landslides and tsunamis monitoring. With the growth of other GPS-like constellations, the Global Navigation Satellite System (GNSS) ensures that these ground-based geodetic networks will gather more data from more satellites and will improve/enhance surveying, engineering, navigation (especially self-driving cars and the like), precision agriculture and timing (e.g. for financial markets).

Along the U.S. coast, storm surge is often the greatest threat to life and property from a hurricane. NSF-funded researchers are quantifying how future tropical storm surges may impact U.S. coastal properties, using past patterns of coastal sea-level change. From 1990 to 2008, population density increased by 32% in Gulf coastal counties, 17% in Atlantic coastal counties, and 16% in Hawaii, according to the U.S. Census Bureau. In 2011, 45% of our nation's GDP was generated in the Coastal Shoreline Counties along the oceans and Great Lakes. A storm surge of 23 feet has the ability to inundate 67% of interstate highways, 57% of arterial roads, almost half of rail miles, 29 airports, and virtually all ports in the Gulf Coast area. Information on coastal property risk is vital to owners, insurers, and government.

Rare violent storms on the Sun – the source of space weather – have the potential to knock out the entire electrical power grid, possibly for months, resulting in trillions of dollars of damage and bringing chaos to much of the country. NSF's investment in understanding, modeling, and observing space weather systems are developing predictive models to forecast and mitigate this catastrophic possibility.

## Concluding Thoughts

Each day NSF-supported advancements such as those highlighted above make our lives better and safer. NSF provides financial support for our nation's brightest minds to aid them in their endeavors to address challenging problems. Funding for the NSF results in investments that lead to the development of a competitive and resourceful workforce that will ensure our national security and enable our country to maintain and strengthen its leadership in science and technology. Therefore, we respectfully request your support to ensure that NSF receives at least $8.45 billion for Fiscal Year 2019. This level of funding will help ensure that future generations of Americans are prepared to help our nation remain a world economic leader.

Thank you for the opportunity to offer these recommendations.

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