BUDGET JUSTIFICATIONS

The United States Department of the Interior

and Performance Information
Fiscal Year 2022

U.S. GEOLOGICAL SURVEY

NOTICE: These budget justifications are prepared for the Interior, Environment and Related Agencies Appropriations Subcommittees. Approval for release of the justifications prior to their printing in the public record of the Subcommittee hearings may be obtained through the Office of Budget of the Department of the Interior.

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Overview

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Overview and Executive Summary

Bureau Overview

The United States Geological Survey (USGS) was established in 1879 (43 U.S.C. 31) for "the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." In 1962, Congress amended the USGS Organic Act to include examinations outside the national domain. The USGS is the Nation's largest water, earth, and biological science and civilian mapping agency, and is the primary Federal source of science-based information on ecosystem science, land use, energy and mineral resources, natural hazards, water use and availability, and updated maps and images for the Earth's features available to the public. The USGS works in partnership with the Interior bureaus, other Federal agencies, Tribes, States, local jurisdictions, and the private sector to provide the best available science to provide scientific information to resource managers and planners, emergency response officials, and the public.

The USGS is also a leading scientific agency on climate science, playing an essential role in understanding the Earth's past, present, and future climate. For more than a century, the USGS has identified the local to global implications of climate change on our lands, waters, wildlife, and the lives and livelihoods of all people—including on underserved and marginalized populations.

The USGS serves the public through a diverse range of activities to support 21st century science needed by decision makers to make informed land and natural resource decisions, and to support the U.S. economy and the health and safety of our Nation. Through monitoring, measuring, and observing changes to our climate, as well as modeling the impacts of past change and plausible futures, the USGS's multi-disciplinary science brings a broad range of capabilities to address climate change, one of the greatest threats to the Nation and the world in the 21st century.

USGS science on natural hazards helps keep us safe from earthquakes, landslides, volcanoes, and other hazards. As climate change increases the frequency of natural disasters and as sea levels rise, the USGS's science on coastal change and resilience, through the Coastal and Marine Hazards and Resources Program, can continue to inform both long- and short-term planning and mitigation of impacts to our coastlines.

The USGS Climate Adaptation Science Centers deliver science to help land, water, fish, and wildlife resource managers understand and adapt to a changing climate. Through activities with Native communities; climate science on Earth systems changes such as drought, wildfire, and permafrost; study of biological changes such as wildlife disease, biological threats, invasive species, and species at risk, the USGS continues to bring diverse scientific expertise toward understanding and mitigating the impacts of climate change.

The American the Beautiful Initiative – A key component of the Administration's investment strategy to address climate impacts on-the-ground through land stewardship and conservation is to leverage the power of Americans across the country. The Administration recently released a preliminary report to the National

Climate Task Force titled Conserving and Restoring America the Beautiful, recommending a ten-year, locally led campaign to conserve and restore America's lands and waters. The report provides an overarching framework to implement the President's goal to conserve 30 percent of U.S. land and waters by 2030, which will help address the climate crisis and its impacts on nature, improve equitable access to the outdoors, and strengthen the economy. The report recognizes and celebrates the voluntary conservation efforts of farmers, ranchers, and forest owners; the leadership of sovereign Tribal Nations in caring for lands, waters, and wildlife; the contributions and stewardship traditions of America's hunters, anglers, and fishing communities; and the vital importance of investing in playgrounds, trails, and open space in park-deprived communities.

The "America the Beautiful" initiative is intended to serve as a call to action to support locally led conservation and restoration efforts across public, private, State, and Tribal lands and waters. The initiative welcomes all communities wishing to steward their lands and waters and boost the economy and support jobs. The guiding principles—which include a commitment to collaboration, support for voluntary and locally led conservation, and honoring of Tribal sovereignty and private property rights—are essential to building and maintaining broad support, enthusiasm, and trust for this effort. Supporting these principles, the 2022 budget includes increases across Interior to support local partnership programs, improve targeted conservation efforts, restore damaged lands, and promote locally led efforts of all kinds wherever communities wish to safeguard the lands and waters they know and love.

USGS science on carbon sequestration and reduction of greenhouse gas emissions will support the America the Beautiful initiative by maximizing the ability to capture, store, and use carbon on Federal lands and by providing scenario analysis tools and inventories to support mitigation of greenhouse gas emissions on Federal lands. The ambition of 30 by 30 reflects the urgency of the challenge the Nation faces—the need to fight climate change with the natural solutions while supporting communities to ensure equitable access to clean air, clean water, and the wonders of nature.

Natural resource managers depend upon USGS science to improve understanding and management of lands, waters, and wildlife to inform decisions on public health and environmental stewardship. The Nation also relies on USGS science to understand the location, supply, and use of energy and mineral resources, which are critical to the U.S. economy and national security. Moreover, accurate, foundational geospatial data and remotely sensed imagery provided by the USGS can be applied to a variety of uses, ranging from land change science, to infrastructure management, to monitoring and responding to natural disasters. The diversity of USGS scientific expertise enables the bureau to carry out large-scale, multidisciplinary investigations and provide objective, scientific information to resource managers and planners, emergency response officials, and the public.

Budget Highlights

The 2022 budget request for the USGS is $1.6 billion, an increase of $326.9 million from the 2021 budget. The USGS estimates that staffing is 8,196 full-time equivalents (FTEs), an increase of 475 FTEs from 2021.

The following three tables highlight the USGS FY 2022 budget request.

Budget Authority	2020	2021	2022
Current	1,270,957	1,315,527	1,642,437
Supplemental	0	0	0
Total Current	***1,270,957***	***1,315,527***	***1,642,437***
Permanent	1,439	1,036	1,036
Total Current and Permanent	**1,272,396**	**1,316,563**	**1,643,473**
Direct FTEs	*4,511*	*4,667*	*5,142*

Mission Area/Subactivity/Programs	2020	2021	2022	2022
Ecosystems	251,527	259,077	358,217	+99,140
Energy and Minerals Resources	90,041	90,041	139,973	+49,932
Natural Hazards	170,870	175,484	207,748	+32,264
Water Resources	234,120	263,120	288,394	+25,274
Core Science Systems	246,688	252,688	341,874	+89,186
Science Support	96,828	95,734	121,421	+25,687
Facilities	180,883	179,383	184,810	+5,427
Grand Total	***1,270,957***	***1,315,527***	***1,642,437***	***+326,910***

FTE	2020	2021	2022
Direct	4,511	4,667	5,142
Reimbursable	2,931	2,931	2,931
Working Capital Fund	102	102	102
Allocations	17	17	17
Contributed Funds	4	4	4
Total	***7,565***	***7,721***	***8,196***

Administration Priorities

The 2022 budget reflects the USGS's enduring responsibilities as it addresses the priorities of the new Administration. The budget unleashes science by promoting climate resilience and conservation, while also advancing research and development to support economic growth and security, inform balanced decisions regarding resources, and ensure the well-being of the Nation. The budget also includes investments to address inequities in the sciences, support scientific integrity, and strengthen the information systems and other enterprises that support research and development.

Promoting Climate Resilience and Conservation

In line with President Biden's Executive Order 14008 on *Tackling the Climate Crisis at Home and Abroad*, the budget includes investments to address climate change while laying the foundation for economic growth, creation of good-paying jobs, and ensuring that those benefits accrue to marginalized and overburdened communities. The budget addresses climate change with $205 million in new climate science investments.

The new investments include $42.5 million for Climate Adaptation Science Centers (CASCs) and Tribal climate science, $25 million to support Interior bureaus with conservation science and research on climate impacts, and $10 million to understand and quantify ecosystem services. The budget also includes $5 million to study the effects of climate change on biodiversity split between CASCs and the Science Synthesis, Analysis, and Research Program in Core Science Systems, $5 million for research on climate-driven biological threats and invasive species, $10 million to improve response to coastal hazards, and $10 million to improve water prediction and water availability assessments.

The budget also invests $60 million in collaborative research with the new Advanced Research Projects Agency for Climate (ARPA-C) within the Department of Energy. The ARPA-C collaboration invests in high-risk, accelerated research to achieve transformational advancement in climate adaptation and resilience. The USGS investment will develop and deliver actionable science products by investing in mission-spanning infrastructure to reduce barriers between science production and user application. This will be first demonstrated in five focal areas: planning tools for habitat and biodiversity, models for drought prediction, predictive tools for fire and post-fire risk management, coastal change and vulnerability

forecasts for planning and disaster response, and models to assess potential and risks for geologic storage of hydrogen, including hydrogen produced using renewable energy.

As part of tackling the climate crisis, the budget investments also support the Administration's commitment to a cleaner energy future. A $20 million increase to research biologic, geologic, and coastal ("blue") carbon sequestration will help reduce the legacy impact of fossil fuels and mitigate the effects of ongoing use as the world transitions to cleaner energy sources. A $20 million increase supports the inventory of greenhouse gases on Federal lands, develops scenario analysis tools for reducing those gases, and monitors progress to achieving reduction targets and goals. An additional $5 million increase will provide decision tools to support clean energy deployment on Federal lands and waters.

Advancing Science and Expanding Research and Development

The budget reflects the Administration's strong commitment to science. This includes an $83 million investment to mission driven USGS research and development (R&D), which will provide actionable and accessible information and decision support tools to Interior bureaus, other agencies, and the public.

The budget strengthens natural hazard science with a $13 million increase that includes support for subduction zone science, modernizing infrastructure in support of earthquake analysis, improvements to the National Volcano Early Warning System, volcano hazard assessments, actionable landslide hazard science, and expansion of geomagnetism observatories to improve warnings of catastrophic space weather events. The budget continues to support the ShakeAlert® earthquake early warning system with a total investment of $25.7 million.

An increase of $25 million helps secure America's prosperity by locating domestic reserves of critical minerals, researching materials supply chains, and supporting mine reclamation with research to determine those that have valuable supplies of critical minerals. An increase of $5 million supports geospatial data collection and research on Tribal lands to ensure that they can participate in the benefits that the 3D Elevation Program (3DEP) and geologic mapping provide. This work will be coordinated to ensure meeting Tribal priorities. An increase of $10 million contributes to improvements in monitoring surface water with the Next Generation Water Observing System and Federal Priority Streamgages.

The 2022 budget supports the Administration's America the Beautiful vision for conservation with an increase of $15 million for tools allowing Interior bureaus and others to target conservation investments accurately and cost effectively. This includes improved visualizations of the Nation's public lands and open spaces through the U.S. Protected Areas Database and revolutionary ways to compare remote sensing data over time to monitor long-term land surface change at local to national scales. Many of those tools are made possible through imagery from Landsat satellites. The next satellite, Landsat 9, launches in 2021, and the USGS and NASA have begun development on next-generation space-based land imaging. Satellite Operations is funded at $84.8 million.

Supporting the Science

The USGS provides world-class science. To ensure that quality science continues unhindered, the USGS must support the critical functions behind that science that allow it to thrive. These are administrative functions that include acquisitions, human resources services, budget and planning functions,

communication and publications services, information management and technology, science quality and integrity, diversity, international programs, financial management, and facilities management.

The budget includes an increase of $15 million to address inequities in the sciences, support scientific integrity, and strengthen the information systems and other enterprises that support research and development.

Science programs bear a share of the costs necessary to operate and manage an entity in compliance with statute, regulatory requirements, and good business practices expected of a Federal agency. In recent years these costs have averaged about 12 percent of the science program appropriations and are not fully paid out of the Science Support subactivities. Additionally, science programs fund lease, occupancy agreements, and operations and maintenance of facilities costs that are in excess of the funding in the Rental Payment, Operations, and Maintenance subactivity. Additional information is provided in the Account and Sundry Exhibits Chapter.

The American Jobs Plan

The 2022 budget request includes the American Jobs Plan legislative proposal which calls for significant investments to create jobs, bolster the Nation's infrastructure, and help make America more competitive in a changing world. The plan invests in much needed brick-and-mortar infrastructure, climate response and resilience, clean energy infrastructure, and Tribal Nations and underserved communities. Working with other Federal agencies, USGS will contribute to the following governmentwide initiatives.

Investing in Climate Resilience—President Biden's American Jobs Plan includes $50.0 billion to protect and, where necessary, restore nature-based infrastructure—our lands, forests, wetlands, watersheds, and coastal and ocean resources. Families and businesses throughout the United States rely on this infrastructure for their lives and livelihoods. President Biden is calling on Congress to invest in protection from extreme wildfires, coastal resilience to sea-level rise and hurricanes, support for agricultural resources management and climate-smart technologies, and the protection and restoration of major land and water resources, such as Florida's Everglades and the Great Lakes.

An example of how USGS would contribute is expanded digital, high-resolution elevation collection mapping within the 3D Elevation Program. The 3DEP program works collaboratively with State and private partners to improve elevation maps of the United States. Improved elevation maps are essential for hazard planning, including informing flood and mudslide risk. This improved mapping will support climate resilience as communities plan for infrastructure improvements that will be resilient in the face of a changing climate.

Advancing Research and Development and the Technologies of the Future—Public investments in R&D lay the foundation for the future breakthroughs that over time yield new businesses, new jobs, and more exports. More investment is needed to maintain our economic edge in today's global economy. The United States is one of the few major economies whose public investments in R&D have declined as a percentage of GDP in the past 25 years, whereas other countries are investing aggressively in R&D. For America to win the 21st century economy, President Biden believes we must get back to investing in the researchers, laboratories, and universities across our Nation—but this time, it must be done with a commitment to lift up workers and regions left out of past investments. The American Jobs Plan calls for $180 billion to

advance United States leadership in critical technologies, upgrade America's research infrastructure, and establish the United States as a leader in climate science, innovation, and R&D.

In support of the President's goal of transitioning to a fully Zero Emission Vehicle Federal fleet, the USGS budget includes $7,150,000 for zero emission vehicles (ZEV) and deploying vehicle charging and refueling infrastructure. These acquisitions are a significant step towards eliminating tailpipe emissions of greenhouse gases (GHG) from the fleet and the goal of achieving a fully ZEV Federal fleet. Tailpipe emissions are currently the leading source of GHG emissions that threaten the planet and harm U.S. communities.

The ZEV acquisitions may include vehicles for both agency-owned and GSA-leased segments of the fleet, including incremental costs of leased vehicles and lease payments to GSA for conversion of agency-owned vehicles to GSA's leased fleet where appropriate. To ensure effective and efficient deployment of ZEVs, USGS will undertake preparation and planning for arriving ZEVs at its facilities, prioritizing transition to ZEVs where it is simplest and allow time for additional planning where mission demands pose a challenge to transitioning. Integral to this preparation is growth in the number of agency-accessible re-fueling points (vehicle charging stations). In installing this infrastructure on-site, USGS will ensure efficiencies and wise infrastructure decisions that limit total expenditures. USGS will undertake a process that relies on a cross-functional team of staff from fleets, operations, facilities, finance, and acquisition departments with executive leadership support. The collaboration will not stop with initial deployment, as the fleet and facility managers will work closely and employ existing training and tools to control utility costs by managing the overall charging load and thereby ensuring a seamless operation that now will involve building systems and vehicles together. USGS will ensure training of personnel as the advanced vehicle technologies roll into the fleet. DOI is coordinating all of these efforts to meet or exceed the ZEV-related goals set forth in the comprehensive plan developed pursuant to E.O. 14008, Section 205(a). Funds for these activities are part $600 million requested in the President's Budget for ZEVs and charging infrastructure contained within the individual budgets of 18 Federal agencies, including dedicated funds at GSA. This investment complements Department of Energy funding for technical assistance to agencies through the Federal Energy Management Program. This investment serves as a down payment to support a multiyear, whole-of-government transformation to convert the Federal motor vehicle fleet to ZEVs and thereby reduce carbon emissions.

The USGS budget includes $800,000 as part of a Departmentwide Diversity, Equity, Inclusion, and Accessibility budget initiative to address identified high-priority needs in support of Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, and Executive Order 13988, Preventing and Combating Discrimination on the Basis of Gender Identity and Sexual Orientation. As part of this initiative, the Department, bureaus, and offices will jointly conduct a review of the Diversity, Equity, Inclusion, and Accessibility program across Interior to identify gaps, challenges, and best practices and to examine Department and bureau roles, responsibilities, and governance.

The Good Accounting Obligation in Government Act (GAO-IG Act, P.L. 115-414) enacted January 3, 2019, requires that Agencies report the status of each open audit recommendation issued more than one year prior to the submission of the Agency's annual budget justification to Congress. The Act requires Agencies to include the current target completion date, implementation status, and any discrepancies on

closure determinations. The Department of the Interior leadership takes audit follow-up very seriously and considers our external auditors, to include the Government Accountability Office (GAO) and Office of the Inspector General, valued partners in not only improving the Department's management and compliance obligations but also enhancing its programmatic and administrative operations. As stewards of taxpayer resources, the Department applies cost-benefit analysis and enterprise risk management principles in recommendation implementation decisions. The Department's GAO-IG Act Report is available at the following link: https://www.doi.gov/cj.

Additional Information

The USGS is always working to expand the information it has available about our programs and our science. For additional information about USGS programs, please visit the USGS website (www.usgs.gov).

Budget at a Glance

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Budget at a Glance Dollars in Thousands ($000)	2020 Actual	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 Request
Environmental Health Program	**23,495**	**24,745**	**494**	**+500**	**0**	**25,739**
Contaminant Biology	***10,397***	***10,397***	***203***	***+500***	***0***	***11,100***
Integrated Sensor Grants	[0]	[0]	[0]	+500	0	[500]
Toxic Substances Hydrology	***13,098***	***14,348***	***291***	***0***	***0***	***14,639***
Species Management Research Program	**53,714**	**53,914**	**1,004**	**-500**	**+12,500**	**66,918**
Integrated Sensor Grants	[250]	[500]	-	-500	-	
Decision Support Science for Clean Energy Development on Federal Lands and Waters	[3,816]	[3,816]	-	-	+5,000	[8,816]
Applied Science in Support of Interior Bureau Conservation and Adaptation	[25,000]	[25,000]	-	-	+7,500	[32,500]
Land Management Research Program	**56,681**	**56,681**	**1,122**	**0**	**+17,500**	**75,303**
Understanding and Quantifying Ecosystem Services	[1,100]	[1,100]	-	-	+10,000	[11,100]
Applied Science in Support of Interior Bureau Conservation and Adaptation	[28,340]	[28,340]	-	-	+7,500	[35,840]
Biological Threats and Invasive Species Research Program	**36,149**	**38,249**	**702**	**0**	**+5,000**	**43,951**
Reducing Threats of Invasive Species and Wildlife Disease in a Changing Climate	[190]	[190]	-	-	+5,000	[5,190]
Cooperative Research Units Program	**24,000**	**25,000**	**506**	**0**	**0**	**25,506**
Climate Adaptation Science Center and Land Change Science Program	**57,488**	**60,488**	**812**	**0**	**+59,500**	**120,800**
Land Change Science	***19,153***	***19,153***	***244***	***0***	***+17,000***	***36,397***
Biologic Carbon Sequestration	[0]	[0]	-	-	+2,000	[2,000]
Monitoring Greenhouse Gas Reduction Process	[0]	[0]	-	-	+5,000	[5,000]
Climate Impacts on Physical and Biological Systems	[15,097]	[15,168]	-	-	+10,000	[25,168]

Budget at a Glance Dollars in Thousands ($000)	2020 Actual	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 Request
National and Regional Climate Adaptation Science Centers	***38,335***	***41,335***	***568***	***0***	***+42,500***	***84,403***
Tribal Climate Adaptation Science	[500]	[500]	-	-	+10,000	[10,500]
Support for Climate Adaptation Science Centers	[3,147]	[3,147]	-	-	+25,000	[28,147]
Facilitate Synthesis of Regional Findings to National Level	[500]	[500]	-	-	+5,000	[5,500]
Assessment of Biodiversity	[0]	[0]	-	-	+2,500	[2,500]
Total, Ecosystems	**251,527**	**259,077**	**4,640**	**0**	**+94,500**	**358,217**
Mineral Resources Program	**59,869**	**59,869**	**1,368**	**0**	**+25,000**	**86,237**
Supply Chain Research for Green Technologies	[1,670]	[1,670]	-	-	+5,000	[6,670]
Mine Waste Research and Assessments in Support of Reclamation	[1,274]	[1,274]	-	-	+15,000	[16,274]
Critical Minerals (Location, Forecasting)	[1,991]	[1,991]	-	-	+5,000	[6,991]
Energy Resources Program	**30,172**	**30,172**	**564**	**0**	**+23,000**	**53,736**
Geologic Carbon Sequestration	[1,477]	[1,477]	-	-	+4,500	[5,977]
Geophysical Data Acquisition in Areas with Potential for Geologic Carbon Sequestration	[75]	[75]	-	-	+3,500	[3,575]
Inventory of Greenhouse Gases Emissions and Sinks on Federal Lands	[50]	[50]	-	-	+10,000	[10,050]
Scenario Analysis Tools for Greenhouse Gas Reduction on Federal Lands	[250]	[250]	-	-	+5,000	[5,250]
Total, Energy and Mineral Resources	**90,041**	**90,041**	**1,932**	**0**	**+48,000**	**139,973**

Budget at a Glance Dollars in Thousands ($000)	2020 Actual	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 Request
Earthquake Hazards Program	**84,903**	**85,403**	**1,234**	**0**	**+6,000**	**92,637**
Subduction Zone Science	[3,500]	2,700	-	-	+2,000	[4,700]
Induced Seismicity	[1,100]	1,100	-	-	+2,000	[3,100]
Modernization/Hardening of IT Infrastructure in Support of Earthquake Analysis	[2,000]	2,000	-	-	+2,000	[4,000]
Volcano Hazards Program	**30,266**	**30,266**	**766**	**0**	**+2,500**	**33,532**
Next Generation Volcanic Hazard Assessments	[520]	[520]	-	-	+1,000	[1,520]
National Volcano Early Warning System: National Volcano Center Improvements	[300]	[300]	-	-	+1,500	[1,800]
Landslide Hazards Program	**4,038**	**8,038**	**141**	**0**	**+3,000**	**11,179**
Actionable Landslide Hazard Data and Science	[0]	[0]	-	-	+3,000	[3,000]
Global Seismographic Network Program	**7,153**	**7,153**	**59**	**0**	**0**	**7,212**
Geomagnetism Program	**4,000**	**4,114**	**59**	**0**	**+1,500**	**5,673**
Expansion of Magnetometer Observatories	[2,274]	[2,388]	-	-	+1,500	[3,888]
Coastal/Marine Hazards and Resources Program	**40,510**	**40,510**	**1,005**	**0**	**+16,000**	**57,515**
Coastal Hazards	[10,674]	[10,674]	-	-	+10,000	[20,674]
Coastal Blue Carbon	[1,000]	[1,000]	-	-	+4,000	[5,000]
Risk Reduction and Community Resilience	[800]	[800]	-	-	+2,000	[2,800]
Total, Natural Hazards	**170,870**	**175,484**	**3,264**	**0**	**+29,000**	**207,748**

Budget at a Glance Dollars in Thousands ($000)	2020 Actual	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 Request
Water Availability and Use Science Program	**47,487**	**57,987**	**1,514**	**0**	**+10,000**	**69,501**
Integrated Water Prediction	[0]	[9,500]	-	-	+4,000	[13,500]
Integrated Water Availability Assessments	[5,621]	[3,725]	-	-	+6,000	[9,725]
Groundwater and Streamflow Information Program	**84,173**	**100,673**	**1,978**	**0**	**+10,000**	**112,651**
Next-Generation Water Observing System	[8,500]	[24,500]	-	-	+6,400	[30,900]
Federal Priority Streamgages	[24,715]	[24,715]	-	-	+3,600	[28,315]
National Water Quality Program	**92,460**	**93,460**	**1,782**	**0**	**0**	**95,242**
Water Resources Research Act Program	**10,000**	**11,000**	**0**	-	**0**	**11,000**
Total, Water Resources	**234,120**	**263,120**	**5,274**	**0**	**+20,000**	**288,394**

National Geospatial Program	**79,454**	**79,454**	**1,144**	**0**	**+5,000**	**85,598**
Geospatial, 3DEP, and Geologic Research and Collection on Tribal Lands	-	-	-	-	+5,000	[5,000]
National Cooperative Geologic Mapping Program	**34,397**	**40,397**	**534**	**-350**	**0**	**40,581**
National Cooperative Geologic Mapping Program Projects and 3D Geologic Mapping	34,397	40,397	-	-350	-	[40,047]
Science Synthesis, Analysis and Research Program	**25,972**	**25,972**	**381**	**+350**	**+72,100**	**98,803**
National Geological and Geophysical Data Preservation Program (NGGDPP)	[1,332]	[1,332]	-	+350	-	[1,682]
Tools Supporting Conservation Planning, Monitoring and Projection	[900]	[900]	-	0	+9,600	[10,500]
Assessment of Biodiversity	[0]	[0]	-	0	+2,500	[2,500]
Collaborative Climate Adaptation and Resilience Research (ARPA-C)	[0]	[0]	-	0	+60,000	[60,000]

Budget at a Glance Dollars in Thousands ($000)	2020 Actual	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 Request
National Land Imaging Program	**106,865**	**106,865**	**627**	**0**	**+9,400**	**116,892**
Science Research and Investigations	***14,557***	***14,557***	***75***	***0***	***0***	***14,632***
Satellite Operations	***84,337***	***84,337***	***451***	***0***	***0***	***84,788***
Land Cover Monitoring and Assessments	***7,971***	***7,971***	***101***	***0***	***+9,400***	***17,472***
Tools Supporting Conservation Planning, Monitoring and Projection	[3,858]	[3,858]	-	-	+5,400	[9,258]
Biologic Carbon Sequestration	[0]	[0]	-	-	+4,000	[4,000]
Total, Core Science Systems	**246,688**	**252,688**	**2,686**	**0**	**+86,500**	**341,874**
Administration and Management Program	**74,881**	**73,787**	**2,468**	0	**+14,950**	**91,205**
Scientific Integrity and Diversity and Support for Enterprise Science	[1,628]	[1,628]	-	0	+7,000	[8,628]
DOI Diversity, Equity, Inclusion, and Accessibility Initiative	[0]	[0]	-	0	+800	[800]
Federal Zero Emission Vehicle Fleet	[0]	[0]	-	0	+7,150	[7,150]
Information Services Program	**21,947**	**21,947**	**269**	0	**+8,000**	**30,216**
IT Support for R&D, including Cloud and High-Performance Computing	[2,500]	[2,500]	-	-	+8,000	[10,500]
Total, Science Support	**96,828**	**95,734**	**2,737**	**0**	**+22,950**	**121,421**
Rental Payments and Operations & Maintenance Program	**104,719**	**104,719**	**5,427**	0	**0**	**110,146**
Deferred Maintenance and Capital Improvement Program	**76,164**	**74,664**	**0**	0	**0**	**74,664**
Total, Facilities	**180,883**	**179,383**	**5,427**	**0**	**0**	**184,810**
Total, Surveys, Investigations, and Research	**1,270,957**	**1,315,527**	**25,960**	**0**	**+300,950**	**1,642,437**

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Ecosystems

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Ecosystems

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Environmental Health Program	**23,495**	**24,745**	**494**	**0**	**0**	**25,739**
Contaminant Biology	**10,397**	**10,397**	**203**	**+500**	**0**	**11,100**
Integrated Sensor Grants	*[0]*	*[0]*	*0*	*+500*	*0*	*[500]*
Toxic Substances Hydrology	**13,098**	**14,348**	**291**	**0**	**0**	**14,639**
FTE	***121***	***121***	***0***	***0***	***0***	***121***
Species Management Research Program	**53,714**	**53,914**	**1,004**	**-500**	**12,500**	**66,918**
Integrated Sensor Grants	*[250]*	*[500]*	*0*	*-500*	*0*	*[0]*
Decision Support Science for Clean Energy Development on Federal Lands and Waters	*[3,816]*	*[3,816]*	*0*	*0*	*5,000*	*[8,816]*
Applied Science in Support of Interior Bureau Conservation and Adaptation	*[25,000]*	*[25,000]*	*0*	*0*	*7,500*	*[32,500]*
FTE	***246***	***246***	***0***	***0***	***22***	***268***
Land Management Research Program	**56,681**	**56,681**	**1,122**	**0**	**17,500**	**75,303**
Understanding and Quantifying Ecosystem Services	*[1,100]*	*[1,100]*	*0*	*0*	*10,000*	*[11,100]*
Applied Science in Support of Interior Bureau Conservation and Adaptation	*[28,340]*	*[28,340]*	*0*	*0*	*7,500*	*[35,840]*
FTE	***275***	***275***	***0***	***0***	***30***	***305***
Biological Threats and Invasive Species Research Program	**36,149**	**38,249**	**702**	**0**	**5,000**	**43,951**
Reducing Threats of Invasive Species and Wildlife Disease in a Changing Climate	*[190]*	*[190]*	*0*	*0*	*5,000*	*[5,190]*
FTE	***170***	***172***	***0***	***0***	***10***	***182***
Cooperative Research Units Program	**24,000**	**25,000**	**506**	**0**	**0**	**25,506**

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
FTE	***121***	***124***	***0***	***0***	***0***	***124***
Climate Adaptation Science Center and Land Change Science Program	**57,488**	**60,488**	**812**	**0**	**59,500**	**120,800**
Land Change Science	**19,153**	**19,153**	**244**	**0**	**17,000**	**36,397**
Biologic Carbon Sequestration	*[0]*	*[0]*	*0*	*0*	*2,000*	*[2,000]*
Monitoring Greenhouse Gas Reduction Process	*[0]*	*[0]*	*0*	*0*	*5,000*	*[5,000]*
Climate Impacts on Physical and Biological Systems	*[15,097]*	*[15,168]*	*0*	*0*	*10,000*	*[25,168]*
National and Regional Climate Adaptation Science Centers	**38,335**	**41,335**	**568**	**0**	**42,500**	**84,403**
Tribal Climate Adaptation Science	*[500]*	*[500]*	*0*	*0*	*10,000*	*[10,500]*
Support for Climate Adaptation Science Centers	*[37,355]*	*[40,355]*	*0*	*0*	*25,000*	*[65,355]*
Facilitate Synthesis of Regional Findings to National Level	*[500]*	*[500]*	*0*	*0*	*5,000*	*[5,500]*
Assessment of Biodiversity	*[0]*	*[0]*	*0*	*0*	*2,500*	*[2,500]*
FTE	***194***	***199***	***0***	***0***	***105***	***304***
Ecosystems Total	**251,527**	**259,077**	**4,640**	**0**	**94,500**	**358,217**
FTE	***1,127***	***1,137***	***0***	***0***	***167***	***1,304***

The 2022 budget request for the Ecosystems Mission Area is $358,217,000 and 1,304 FTE, an increase of $94.5 million from the 2021 Enacted level.

Mission Area Overview

The Ecosystems Mission Area provides science to help America achieve sustainable management and conservation of biological resources in wild and urban spaces. Ecosystems scientists examine consequences of climate and environmental change; effects of management actions on communities, lands, and species; and risks and solutions to harmful invasive species, wildlife diseases, and contaminants in the environment.

The Ecosystems Mission Area works with many partners to sustain the outdoor-related recreation needs of the public by providing data, research, and monitoring that informs and supports outdoor recreation in the United States, a $459.8 billion industry in 2019 (U.S. Department of Commerce, 2021). In 2019, over half of the U.S. population ages six and older, or over 153.6 million Americans, enjoyed participating in outdoor

recreation activities such as hunting, hiking, camping, fishing, canoeing, bird watching, among others (Outdoor Industry Association, 2019).

Ecosystems Mission Area science is essential for resource management decisions that protect and conserve lands and waters enjoyed by communities across the Nation and that provide critical habitat for fish, wildlife, and plant species. Ecosystems scientists provide innovative and forward-thinking science and develop new management tools and techniques using remote sensing, artificial intelligence/machine learning, data visualization, and crowdsourcing, to produce timely information to meet diverse stakeholder needs.

The Ecosystems Mission Area is the principal biological science organization of the Department of the Interior. The quality of life and economic strength of the United States hinges on healthy ecosystems that support living things and natural processes. The lands managed by Interior represent a significant investment for the Nation in those ecosystems and the Ecosystems Mission Area provides the impartial tools, science, and decision support to the resource managers entrusted with the stewardship of those lands. However, the Mission Area is sought out by partners across the United States for its expertise in sustainable management and conservation of biological resources.

The work of the Mission Area ranges from molecular to ecosystem level studies, but the common thread across the Mission Area programs is science to advance understanding of biological resources. The six programs of the Ecosystems Mission Area support 16 Ecological Science Centers, a national Climate Adaptation Science Center and nine regional Climate Adaptation Science Centers, 40 Cooperative Research Units, and 50 Biological Field Stations where USGS scientists work directly with resource managers to address high priority management questions.

Selected Mission Area Accomplishments

- Wildfires in the United States can be devastating, with 2017, 2018, and 2020 being particularly damaging and costly. A 5-year USGS Wildland Fire Science Plan was released in February 2021. The Plan was developed with extensive input by the USGS's approximately 150 scientists across all Mission Areas and interviews with dozens of stakeholder organizations. The new plan guides USGS research on wildfires in the 21st century. It prioritizes the production of innovative science, tools and resources that inform land management and provide an understanding of fire's role in ecosystems and in human communities, before, during and after wildfires.
- The USGS has begun the process to implement a ninth Climate Adaptation Science Center in the Midwest. The selection process should be completed in FY 2021. In the interim, the USGS has implemented a number of scientific projects in the Midwest, focused on the Great Lakes and inland lakes, important tribal food and culture resources and the impacts of climate on forest related management issues.
- Managing the world's freshwater supply to meet societal and environmental needs in a changing climate is one of the biggest challenges for the 21st century. Dams provide water security, however, the allocation of dwindling water supply among reservoirs could exacerbate or ameliorate the effects of climate change on aquatic communities. USGS scientists modeled fish distribution and thermal

tolerances to assess species response under varying climate scenarios. The results highlight the sensitivity of river thermal regimes. Integrating environmental considerations into ongoing water storage negotiations may lead to outcomes that reduce future management and mitigation costs.

- USGS species biologists published studies on potential risks to flying animals from their interactions with wind energy facilities, providing resource managers information they can use to guide renewable energy siting, permitting, and operational decisions. For example, studies of migrating whooping cranes in the central flyway showed that whooping cranes avoid wind-energy infrastructure when selecting stopover habitat. Studies of bats at wind turbines confirm the seasonality of fatality risk to bats based on their behavioral patterns. This research can further inform clean energy siting decisions and technological solutions that avoid or reduce risk to sensitive species from wind energy development.
- The USGS is integrating per- and polyfluoroalkyl substances (PFAS) science across several regions and science centers that builds on an existing broad array of laboratory and field capabilities and expertise in PFAS science. In response to science needs compiled from a variety of partners in Federal (e.g. USEPA, DOD, NIEHS), State and academia, major new investments have been made at the Eastern Ecological Science Center to establish a laboratory capable of analyzing fish and wildlife tissue and plasma. This is a complement to the PFAS water methods recently developed at the USGS National Water Quality Laboratory for environmental transport, bioaccumulation, and other specialized research on a wide range of environmental PFAS that will significantly expand the scope and type of future studies. Recent accomplishments inform mitigation and risk management decision makers by addressing factors that control the prevalence and magnitude of PFAS as these contaminants move through land and water resources to tap water, ecosystems, and as they accumulate in fish and wildlife. Human and ecological harm potentially caused by PFAS exposures as well as science to inform mitigation of contaminated sites are emerging national concerns. A report that defines the strategic science vision for PFAS science is forthcoming and will be used as a resource for future stakeholder workshops as we continue to align USGS science to meet their needs.
- The USGS is working to establish a new cooperative fish and wildlife research unit in Nevada. The USGS is working with local cooperators including the University of Nevada Reno and the Nevada Division of Wildlife to finalize a cooperative agreement that will formally establish the unit. Plans are to have the first Federal employees at the unit by the end of FY 2021.
- USGS scientists recently collaborated with the Navajo Nation Department of Water Resources to examine patterns of drought in the Chuska Mountains and documented a series of severe snow droughts during the last 300 years. This research met needs of Navajo water managers for a longer-term context to evaluate recent severe droughts and declines in snow-fed water to inform their future decision-making.
- The USGS conducted a rapid risk assessment for SARS-CoV-2 in native bats and big brown bats, in both cases finding no virus in the animals. The USGS National Wildlife Health Center developed an experimental vaccine to protect USFWS captive endangered black-footed ferrets from SARS-CoV-2 and stood up wildlife surveillance efforts for this virus, supporting USDA's National Animal Health Laboratory Network and the response to mink farm outbreaks.

For additional information about these programs, please visit the USGS website (www.usgs.gov).

Ecosystems
Environmental Health

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Environmental Health Program	**23,495**	**24,745**	**494**	**500**	**0**	**25,739**
Contaminant Biology	**10,397**	**10,397**	**203**	**500**	**0**	**11,100**
Integrated Sensor Grants	*[0]*	*[0]*	*0*	*500*	*0*	*[500]*
Toxic Substances Hydrology	**13,098**	**14,348**	**291**	**0**	**0**	**14,639**
FTE	***121***	***121***	***0***	***0***	***0***	***121***

2022 Program Changes

The 2022 budget request for Environmental Health is $25,739,000 and 121 FTE, no change from the 2021 Enacted level.

Internal Transfer for Integrated Sensor Grants (+$500,000/0 FTE) – The USGS is proposing to transfer $500,000 from the Species Management Research Program to the Environmental Health Program. This transfer will shift the funding to the program, Environmental Health, where the work is conducted.

Program Overview

The health of our land, water, and living resources can be affected by environmental exposures to toxicological or pathogenic disease agents (collectively referred to as “environmental contaminants”). The Environmental Health Program brings together interdisciplinary teams of science expertise and laboratory capabilities (hydrologists; geologists; chemists; toxicologists; biologists, ecologists; microbiologists; and geospatial, process, and statistical modelers) to address scientific understandings of environmental contaminants, how they move through and interact with the environment, and how to mitigate existing health hazards.

The work focuses on potential environmental contaminants such as mercury, arsenic, hormones, per- and polyfluoralkyl substances (PFAS), and pesticides; pathogens such as avian influenza, viruses, and antibiotic-resistant bacteria; and naturally occurring contaminants such as algal toxins. The integration of natural-science disciplines produces extensive, comprehensive, peer-reviewed science and actionable data.

The program also provides decision tools for situational awareness, planning, and forecasting that show how environmental contaminants originate and move through the environment to points of exposure, and

whether they pose a health hazard. In this way, the program's science approach produces a foundation of knowledge for a range of land and resource management and related economic decisions such as maintaining the safety of harvested fish and wildlife species; the re-use of solid and liquid wastes from municipal, energy, and mineral activities; protection of recreational and drinking water resources; and other ecological and public health matters potentially related to environmental contaminants.

The Environmental Health Program supports integrated natural science expertise and capabilities across the USGS related to environmental contaminants and pathogens. The Program supports science to address the full range of questions related to contaminant and pathogen sources, environmental transport, exposure/transmission pathways, uptake, biological effects, and human health implications. This science informs stakeholder decisions to manage fish and wildlife health and provides environmental exposure information to partners in public health.

Ecosystems
Species Management Research

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Species Management Research Program	**53,714**	**53,914**	**1,004**	**-500**	**12,500**	**66,918**
Integrated Sensor Grants	*[250]*	*[500]*	*0*	*-500*	*0*	*[0]*
Decision Support Science for Clean Energy Development on Federal Lands and Waters	*[3,816]*	*[3,816]*	*0*	*0*	*5,000*	*[8,816]*
Applied Science in Support of Interior Bureau Conservation and Adaptation	*[25,000]*	*[25,000]*	*0*	*0*	*7,500*	*[32,500]*
FTE	***246***	***246***	***0***	***0***	***22***	***268***

2022 Program Changes

The 2022 budget request for Species Management Research is $66,918,000 and 268 FTE, an increase of $12.5 million and 22 FTE from the 2021 Enacted level.

Internal Transfer for Integrated Sensor Grants (-$500,000/0 FTE) – The USGS is proposing to transfer $500,000 from the Species Management Research Program to the Environmental Health Program. This transfer will shift the funding to the program, Environmental Health, where the work is conducted.

Decision Support Science for Clean Energy Development on Federal Lands and Waters (+$5,000,000 /+10 FTE) – Accelerating deployment of clean energy facilities while ensuring robust protection of sensitive species, habitat, and biodiversity will require science that informs strategies to avoid or reduce harmful impacts to fish and wildlife and their habitats, and incorporates climate change and clean energy needs and considerations.

With these funds, USGS fish and wildlife biologists and ecologists will work with regulatory agencies and the clean energy industry to produce science-based tools and strategies that will help decision-makers determine optimal placement of clean energy infrastructure on lands and in waters where risks and harmful impacts to protected species and habitats can be minimized or mitigated, helping to streamline siting and permitting of clean energy projects. Expected products include maps of desert tortoise connectivity for guiding solar energy development in the southwest and novel high resolution models and GIS tools identifying high and low risk areas for protected species, developed in collaboration with Federal research

laboratories such as the Department of Energy labs (e.g. National Renewable Energy Laboratory and others).

Applied Science in Support of Interior Bureau Species Conservation and Adaptation (+$7,500,000 / +12 FTE) – The Species Management Research Program (SMRP) will expand work on threats to fish and wildlife like climate change, drought, extreme storm events, and invasive species and disease. The program will develop new tools and technologies to help managers consider species responses to alternative management scenarios and incorporate uncertainty about outcomes into decision-making at broad scales. For example, the SMRP will provide science to inform the Effort to Conserve and Restore America the Beautiful, also known as the 30 x 30 initiative. Decades of thoughtful stewardship by ranchers, farmers, and property owners have demonstrated that the most effective and enduring conservation strategy is one that reflects the priorities, needs and perspectives of the communities that know, live, work, and care for the lands and water. Science can provide those communities sound information about important habitats to sustain at-risk, commercially, and recreationally important fish and wildlife. Species and their habitats are interdependent and complex in their relationships; the SMRP will work in tandem with the Land Management Research Program to direct resources to participatory science supporting the full spectrum of management information needs for species and their habitats, including, climate change, climate change adaptation, and species and ecosystem response to land use, land change and resource management.

Program Overview

USGS science is used for conservation and management decisions related to how climate is impacting wildlife such as sea birds; trust responsibilities in conserving Native and Indigenous cultural resources such as salmon; impacts of drought and development on fisheries; and protection for at risk species such as grizzly bears at all stages of Endangered Species Act decision making. Source: USGS.

Biodiversity is declining at significant rates, both nationally and on a global scale, and climate change and other natural and manmade stressors are exacerbating biodiversity trends and leading to uncertainty about species resilience and sustainability. Now, more than ever, land and water resource managers need targeted science to make strategic and informed decisions about species management. The Species Management Research Program approaches global stressors like climate change from the perspective of resource management agency responsibilities for the conservation of species and biodiversity. Federal and State management agencies rely on the Species Management Research Program for information on a range of management actions related to legal requirements, permitting, habitat conservation plans, mitigation practices, Endangered Species Act compliance, etc. This information is essential for the execution of agency actions in a

manner that is consistent with societal needs in the face of a complex array of stressors and projected changes in environmental conditions.

The Species Management Research Program produces actionable information that improves the ability of managers to anticipate, adapt, and alleviate the impacts of natural and manmade stressors, and to make better decisions about sensitive species management, hunting and fishing regulations, land use, and water allocation. The SMRP conducts research to address key uncertainties in aquatic and terrestrial species population status. This work often involves co-production of scientific information with Department of the Interior and State fish and wildlife management agencies, Tribal entities, and other stakeholders and partners. Currently, the SMRP is conducting work on over 160 at-risk species to address information needs associated with identifying and addressing stressors and threats, preserving biodiversity, supporting U.S. Fish and Wildlife Service Species Status Assessments to inform listing and recovery, conducting species risk and vulnerability assessments, predicting species adaptations to climate change, and prioritizing lands and waters for protection and conservation actions.

The SMRP maintains robust research portfolios on numerous species in support of Department of the Interior's management responsibility and concern related to global change and other species stressors. While too numerous to list, examples include amphibians, bats, manatees, sea otters, walrus, and polar bears. For example, SMRP science was used to inform recent U.S. Fish and Wildlife Service Endangered Species Act determinations not to list walrus, to down-list manatees from Endangered to Threatened, and to keep species like Sage Grouse from needing Federal protection.

The SMRP provides the management-relevant scientific information to support management of harvested species, including migratory bird populations and trends used by Flyway Councils to develop recommendations on waterfowl harvest, and technical support for multi-jurisdictional fisheries, harvest, and allocation. The SMRP develops advanced technologies such as remote sensing and genetics to assess population status and health, and models that incorporate stressors such as climate change to predict biodiversity response. These tools will help managers develop a more comprehensive understanding of species population trajectories and distribution shifts in the coming decades.

USGS Science on Migratory Birds

Nearly a hundred USGS scientists conduct migratory bird research work to meet the needs of Federal and State agencies, and the newly published "U.S. Geological Survey Migratory Bird Science, 2020-21" summarizes current studies. This portfolio will help make USGS science more accessible to a broad range of partners working together in migratory bird management and conservation. USGS scientists lead activities that are central to bird conservation today—such as the activities spearheaded by the North American Bird Banding Laboratory (crucial to supporting thousands of research activities annually in and out of government), and the North American Breeding Bird Survey, on which our knowledge of continental bird populations is largely based. The breadth of research activity includes many new approaches for measuring the health of bird populations, for assessing threats to birds, and for addressing those threats. By helping connect partners with science needs directly to USGS researchers working on specific problems, species, or habitats, the migratory bird research portfolio is a tool that will help maximize the value of this Federal science.

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Ecosystems
Land Management Research

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Land Management Research Program	**56,681**	**56,681**	**1,122**	**0**	**17,500**	**75,303**
Understanding and Quantifying Ecosystem Services	*[1,100]*	*[1,100]*	*0*	*0*	*10,000*	*[11,100]*
Applied Science in Support of Interior Bureau Conservation and Adaptation	*[28,340]*	*[28,340]*	*0*	*0*	*7,500*	*[35,840]*
FTE	***275***	***275***	***0***	***0***	***30***	***305***

2022 Program Changes

The 2022 budget request for Land Management Research is $75,303,000 and 305 FTE, an increase of $17.5 million and +30 FTE from the 2021 Enacted level.

Understanding and Quantifying Ecosystem Services (+$10,000,000 / +18 FTE) – Science has made remarkable gains in understanding the complicated natural systems that support human communities, particularly in the face of climate change. This investment would build a stronger understanding of the benefits that ecosystems offer and what ecosystem services are most beneficial to communities, with quantitative analysis of benefits and trade-offs across the range of land management alternatives. This would help to better measure the value of green infrastructure - using nature as part of our infrastructure system (e.g., natural wetlands for purifying water), which can be incorporated into a portfolio of solutions to increase water storage capacity, flood risk mitigation, coastal storm protection, carbon sequestration, and climate change adaptation. This would allow the USGS to provide better information to land managers and decision makers achieve conservation and restoration goals, such as the America the Beautiful initiative.

New USGS research on ecosystem services will support NEPA planning and empower all stakeholders with the unbiased information to prioritize and achieve multiple conservation outcomes and integrate land and species conservation research into adaptive management. The USGS ecosystem services research will also inform the development of public-private partnerships and investment in green infrastructure to enhance ecosystem services. This will also assist communities and land managers who face a growing threat from wildfire, drought, climate change impacts on biodiversity and the ongoing socio-economic transition to sustainable energy, manage lands and natural resources for multiple uses.

Applied Science in Support of Interior Bureau Conservation and Adaptation (+$7,500,00 /+12 FTE) – The USGS would expand work on science to support understanding of climate adaptation, mitigation, and impacts to natural resources to provide actionable science in support of policy and management decisions to assist natural resource managers, particularly at Interior bureaus, adapt to future climate related changes. This work will be conducted in partnership with the Species Management Program and focus effort on better understanding the complex linkages among ecosystems, land and resource management, climate change, and habitats for fish and wildlife.

The USGS would also build capacity to expand work with decision makers within the DOI land management bureaus and create targeted adaptation planning frameworks linked to explicit conservation goals and outcomes. The USGS will go beyond traditional lists of conservation actions to work with scientists and decision-makers to study the efficacy of management and restoration actions. The USGS would employ advanced predictive modeling to compare alternative management scenarios for managers to understand policy, trade-offs, and management implications, saving time and resources on actions. We will use targeted monitoring as a critical adaptive management approach to land and waters with complex, interacting, and dynamic challenges. These approaches will allow us to develop a guiding framework to incorporate species refugia into natural resource management to inform land and species conservation, invasive species management, recreation management, and other decisions.

The LMRP conducts research to improve the effectiveness of land and watershed management and inform restoration of ecosystems on millions of acres including public lands such as National Parks, National Wildlife Refuges, and other critical landscapes that support the biodiversity of fish, wildlife, and plant species, as well as thriving economies. Source: USGS.

This work will assist decision makers as they choose among possible actions, maximizing the likelihood of achieving the stated goals and allowing resource management to target scarce resources to actions with the highest probability of success. It will also enable the USGS to produce the biodiversity and ecosystem components of the National Climate Assessment, explicitly assessing linkages between climate and biodiversity to identify effective mechanisms to support conservation. This will also improve integration of climate change effects in environmental planning and will benefit Federal and State agencies, the public, and industry through improved program efficiencies and reduced costs.

Program Overview

The Land Management Research Program (LMRP) provides science for understanding natural and human influences on lands, waters, and ecosystems under management responsibility of Interior bureaus and other Federal, State, and Tribal partners. This information is indispensable for achieving the goal of the America the Beautiful initiative and for managing carbon sequestration on public lands. The program supports research to identify, reduce or avoid resource management conflicts,

support the transition to sustainable energy, enhance and maintain public lands for future generations, and keep U.S. communities safe.

The USGS works with land managers to identify priority information needs and conducts research to predict and assess the potential effects of current and future land uses. Scientific assessment and prediction are the foundation for decision support tools that help managers understand risk and make cost-effective resource management decisions. The USGS develops methods to improve degraded lands, identify and mitigate threats to people and ecosystems, and provide needed information on the benefits and potential liabilities of management actions. Information and tools resulting from studies help streamline permitting decisions by Interior bureaus by helping managers identify potential effects of climate change, invasive species, insect and disease outbreaks, drought, and development and evaluate management alternatives.

Looking to the future, the LMRP is working to transform the ability of Tribal Nations, land-management agencies, landowner organizations, and local communities to plan and make informed decisions by co-producing integrated, scenario-based modeling and monitoring approaches. Land management science brings together the information resulting from ecosystem, socio-economic, remote-sensing, and management research. Using new state-of-the-art integrated data and models, the effort improves the quality and timeliness of current estimates of carbon sequestration, land change, fire, hydrology, and other ecosystem services to provide consistent, cross-disciplinary science products that can project the impact of land management decisions that are of importance to land managers.

Release of the USGS's First Wildland Fire Science Plan

Wildland fire science is an emerging emphasis across the USGS and coordinated from the LMRP. The USGS recently released its first Wildland Fire Science Plan (https://doi.org/10.3133/cir1471) that guides USGS research for the next 5 years. It prioritizes the production of innovative science, tools, and resources that inform land management and provide an understanding of fire's role in ecosystems and in human communities, before, during, and after wildfires. The USGS wildland fire plan emphasizes working with stakeholders to identify, develop, and share essential information that supports critical decision-making by fire, resource, and emergency managers. These decisions include threat characterization and management planning before a fire, as well as providing real-time satellite and field data to incident commanders and others during a fire. It also includes assessing fire's impacts on infrastructure, terrain, water supply, ecosystems, species, and other vital resources after the smoke clears.

Floodplain and wetland areas provide critical ecosystem services to local and downstream communities by retaining sediments, nutrients, and floodwaters. This image depicts a healthy floodplain inundated with water. Source: USGS.

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Ecosystems
Biological Threats & Invasive Species Research

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Biological Threats and Invasive Species Research Program	**36,149**	**38,249**	**702**	**0**	**5,000**	**43,951**
Reducing Threats of Invasive Species and Wildlife Disease in a Changing Climate	*[190]*	*[190]*	*0*	*0*	*5,000*	*[5,190]*
FTE	***170***	***172***	***0***	***0***	***10***	***182***

2022 Program Changes

The 2022 budget request for Biological Threats & Invasive Species Research is $43,951,000 and 182 FTE, an increase of $5.19 million and +10 FTE from the 2021 Enacted level.

Reducing Threats of Invasive Species and Wildlife Disease in a Changing Climate (+$5,000,000 / +10 FTE) – The USGS would address the interacting effects of climate change and biological threats using a systematic risk-based approach to surveillance, risk reduction, and mitigation of these threats. A changing climate brings additional pathways for the introduction and spread of invasive species and wildlife diseases; range shifts for native and invasive species; and phenological mismatches between species' needs and habitat (e.g., critical food resources being too large to consume or no longer available when needed because of warming temperatures). This effort will initially focus on three regions that are expected to be disproportionately affected by climate change (Alaska, Hawaii and U.S. insular territories in the Pacific, and the Northeast) and that support critical habitat and species of conservation concern. In these locations, the USGS will connect biosurveillance, risk reduction, and mitigation tools with key stakeholders in Tribal Nations and other underserved communities in addition to traditional Federal and State partners.

The USGS will engage stakeholders to identify information gaps and research needs. With stakeholder consensus on prioritized science needs, the USGS will implement research and surveillance activities to support an adaptive management approach to changing climates in the prioritized regions. Although causal relationships are uncertain, warming oceans and freshwater ecosystems have coincided with mortality events and disease outbreaks in fish and other aquatic organisms. Warmer than average temperatures and changes in temperature fluctuations will result in northward expansion of invasive terrestrial and aquatic plants and fishes. Earlier emergence and northward expansion of ticks and mosquitoes as well as the introduction of disease carrying invasive species have challenged traditional approaches to disease management (e.g., avian malaria and Lyme disease). Melting of Arctic sea ice is causing polar bears to

spend more time on land, exposing them to novel pathogens. Warming temperatures are allowing for expansion of disease ranges, resulting in outbreaks among muskoxen and other subsistence species. There is a clear need for an integrated, coordinated approach to surveillance and mitigation of biological threats in the face of a changing climate. With these additional funds, the USGS will bring to bear expertise across the bureau to meet our stakeholders' most pressing needs for situational awareness and biological threat reduction in a changing climate.

Program Overview

USGS science is used for diagnostics of wildlife diseases such as white-nose syndrome; control of disease spread such as chronic wasting disease; containment of spreading species such as invasive carps; and detection of elusive invasives such as Burmese pythons. Source: USGS & iStock license.

The harm done by biological threats such as invasive species and wildlife disease affects every State in the country, including urban centers and wilderness areas. Invasive species costs the United States more annually than all natural disasters combined. Approximately 60 percent of emerging human infectious pathogens like SARS-CoV-2 are zoonotic (shared between animals and humans). Over 70 percent of these zoonoses originate in wildlife. The effects of emerging wildlife diseases are global and profound, often resulting in economic and agricultural impacts, declines in wildlife populations, and ecological disturbance. The Biological Threats Program develops decision-support tools and technologies to detect, monitor, assess risk, and control nationally significant invasive species and fish and wildlife diseases. Research and technology development focus on species that have potential to cause significant economic or ecological concerns. A strong emphasis of the program is technology transfer to management agencies.

The USGS optimizes traditional monitoring and develops new tools for early detection to reduce the damage and spread of invasive species. A focus of USGS research is to integrate control strategies to empower land and water managers to respond quickly and effectively to a wide variety of new invasions.

The program conducts multi-scale, integrated assessments to map and monitor infestations of invasive plants in the West to predict the most vulnerable areas. In addition, the program examines the effects of management practices and natural disturbances on invasive species and evaluates how invasive plants alter the frequency and intensity of wildfires. Results will allow managers to reduce the risks posed by wildfire.

The program also assesses fish and wildlife mass mortalities and develops disease management tools for species such as salmon, sturgeon, trout, whitefish, and mussels. This work enhances biosurveillance of aquatic diseases by improving information and data delivery on monitoring and species occurrences through field and lab research, online databases, and information systems to advance our understanding of the complex interactions that influence disease outbreaks.

The USGS investigations into marine diseases impacting coral and other organisms, supports FWS, NPS and National Oceanic and Atmospheric Administration (NOAA) species management. By understanding disease patterns and processes, the science is being used by managers to take actions to improve the health of threatened or endangered fish populations.

The USGS is investigating vector-borne diseases of concern to Interior and other Federal agencies. Sylvatic plague, a flea-borne bacterial disease, was one of eight zoonotic diseases prioritized by Centers for Disease Control and Prevention (CDC), US Department of Agriculture (USDA), and Interior that need to be addressed by the Federal government with a One Health approach. Endangered black-footed ferrets, prairie dogs, domestic and wild cats, as well as humans, can die from sylvatic plague. The USGS is investigating the ecology of plague and harnessing that information to develop and adapt integrated pest management tools, such as a novel vaccine, for natural resource managers for this and other wildlife diseases. The technology behind the plague vaccine is being used by the USGS to develop a White Nose Syndrome (WNS) vaccine for bats. WNS has killed millions of bats across the United States causing significant negative effects on agriculture and potentially increasing the spread of insect-borne diseases.

Controlling the Spread of Invasive Species

Research on invasive carps support early detection, risk assessment, and development and assessment of control tools. Removal efforts using a USGS-developed method in Barkley Lake, Kentucky removed tens of thousands of pounds of invasive silver and bighead carp. Similar efforts in the upper Mississippi River along the Minnesota/Wisconsin border removed a small number and demonstrated the value of the method as an early detection tool in new environments. Research testing the effectiveness of an acoustic deterrent system at Lock and Dam 19 on the Mississippi River will support stopping upstream expansion of Invasive carps. Research on other deterrents, such as carbon dioxide, have proven effective in laboratory tests against grass carp.

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Ecosystems
Cooperative Research Units

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Cooperative Research Units Program	**24,000**	**25,000**	**506**	**0**	**0**	**25,506**
FTE	***121***	***124***	***0***	***0***	***0***	***124***

2022 Program Changes

The 2022 budget request for Cooperative Research Units is $25,506,000 and 124 FTE, no change from the 2021 Enacted level.

Program Overview

The Cooperative Research Units (CRU) program is a unique cooperative relationship between the USGS, State fish and wildlife agencies, host universities, and the Wildlife Management Institute. The U.S. Fish and Wildlife Service is also a formal cooperator at most of the individual Units. Since 1935, this cooperative relationship has provided a strong connection between the USGS, State and Federal fish and wildlife management agencies, and the national university community. The individual resources of each cooperator are leveraged to deliver program outcomes that far exceed what any one cooperator could achieve alone.

The goals of the CRU program are to sustain and maintain:

- A cost-effective, national network of Federal, State, and university partnerships pursuant to the Cooperative Research and Training Units Act of 1960 (P.L. 86-686), with a legislated mission of research, education, and technical assistance focused on fish, wildlife, ecology, and natural resources.
- A customer-oriented network of expertise for actionable science, research, teaching, and technical assistance that is responsive to information needs of State and Federal resource agency decision makers.
- Science capabilities responsive to resource management needs of Interior bureaus.
- A premier program for graduate education, mentoring, and training of future natural resources professionals from diverse backgrounds having skills to serve the broad natural resource management community successfully.

The CRU program is composed of 40 cooperative units located at universities in 38 States. The program is designed to leverage cooperative partnerships with Federal and State agencies to address mutual needs of all partners in a cost-effective manner. The USGS stations Federal scientists at universities to help identify and respond to natural resource information needs through pooling of resources among agencies; participate in advanced scientific training and mentoring of university graduate students to represent the various agencies workforce of the future; and provide Federal and other natural resource managers' access to university expertise and facilities.

Federal support of the CRUs is multiplied by State and university cooperator contributions of expertise, equipment, facilities, and project funding, thereby enhancing the program's cost- effectiveness. The program's appropriated dollars continue to be matched by Federal, State, university, and other entities' contributions at a ratio of three matching dollars to each appropriated dollar. Through university affiliations, CRU scientists train a diverse group of future natural resource professionals and provide opportunities through graduate education to diversify the Federal workforce.

Each CRU is directed by a Coordinating Committee composed of Federal, State, university, and Wildlife Management Institute representatives. Each Coordinating Committee establishes goals and expectations for its unit within the program's mission of research, education, and technical assistance. The mix of priorities is established locally and is updated annually based on the needs of cooperators and available funding. Program accountability measures, performance standards, and oversight of Federal scientists are used to ensure research and the resulting scientific information products support the goals of the USGS and Interior.

Ecosystems
Climate Adaptation Science Centers & Land Change Science

Ecosystems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Climate Adaptation Science Center and Land Change Science Program	**57,488**	**60,488**	**812**	**0**	**59,500**	**120,800**
Land Change Science	**19,153**	**19,153**	**244**	**0**	**17,000**	**36,397**
Biologic Carbon Sequestration	*[0]*	*[0]*	*0*	*0*	*2,000*	*[2,000]*
Monitoring Greenhouse Gas Reduction Process	*[0]*	*[0]*	*0*	*0*	*5,000*	*[5,000]*
Climate Impacts on Physical and Biological Systems	*[15,097]*	*[15,168]*	*0*	*0*	*10,000*	*[25,168]*
National and Regional Climate Adaptation Science Centers	**38,335**	**41,335**	**568**	**0**	**42,500**	**84,403**
Tribal Climate Adaptation Science	*[500]*	*[500]*	*0*	*0*	*10,000*	*[10,500]*
Support for Climate Adaptation Science Centers	*[3,147]*	*[3,147]*	*0*	*0*	*25,000*	*[28,147]*
Facilitate Synthesis of Regional Findings to National Level	*[500]*	*[500]*	*0*	*0*	*5,000*	*[5,500]*
Assessment of Biodiversity	*[0]*	*[0]*	*0*	*0*	*2,500*	*[2,500]*
FTE	***194***	***199***	***0***	***0***	***105***	***304***

2022 Program Changes

The 2022 budget request for Climate Adaptation Science Center & Land Change Science Program is $120,800,000 and 304 FTE, an increase of $59.5 million and +105 FTE from the 2021 Enacted level.

Biologic Carbon Sequestration (+$2,000,000 / +10 FTE) – The USGS would restart research that ended in 2019, using this funding to improve the understanding of how changing climate and resource management activities influence the sequestration of carbon. Biological carbon storage and fluxes are central controls over the Earth's climate and are highly susceptible to environmental factors such as increasing temperatures, fire, drought, and a broad range of climate and land use stressors. New research by the USGS would address the significant needs of resource managers to understand ways to sustain carbon sequestration in the face of change, and to increase carbon storage under different climate and management

scenarios. An improved understanding of carbon management challenges and opportunities would provide the Nation powerful options for addressing the climate crisis, both now and into the future.

New studies would expand research to provide actionable information on how physical, biological, and ecological processes interact to control carbon sequestration and to improve models used to anticipate changes in carbon based on various resource management scenarios. These studies include: development of spatially-explicit, landscape-scale models of wetland vegetation and biogeochemical processes; comparison of carbon storage and flux rates in wetlands throughout the Nation, including coastal, inland, and permafrost sites; development of a novel approach to determine how climate change affects the cycling of carbon in dryland soils of the Southwest; analyses of impacts of droughts, floods, and land management on aquatic export of carbon from terrestrial systems through rivers to estuaries and oceans; and the impacts of changing climate and receding glaciers on the transport of carbon and nutrients to downstream ecosystems and oceans.

Monitoring Greenhouse Gas Reduction Process (+$5,000,000 / +25 FTE) – The USGS would provide biologic information to further the Federal Lands greenhouse gas (GHG) emissions inventory and sequestration assessment. Specifically, the activities would include development of a methodology to measure, monitor, report, and verify carbon sequestration and greenhouse gas reductions to monitor progress in meeting goals on Federal lands. The U.S. Federal Lands GHG Emissions and Sequestration assessment would be updated to include an inventory of greenhouse gases on Federal lands. A geographic information system (GIS) database of identified geologic sources of GHG (e.g. CO_2 and methane seeps) would be compiled, and tools would be developed for Interior bureaus and other Federal agencies to identify restoration targets and methods that could optimize the protection of carbon resources and sequestration rates.

Climate Impacts on Physical and Biological Systems (+$10,000,000 / +50 FTE) – In support of DOI bureaus and other partners, the USGS would expand and accelerate research that integrates coupled physical and biological observations over multiple temporal and spatial scales, conduct targeted experiments to determine the changing controls over systems, and modeling activities to better anticipate the impacts of a range of climate and land management scenarios

Specifically, the USGS would lead regional- to national-scale research efforts to understand and forecast responses of coastal, wetland, dryland, forest, Arctic, and aquatic ecosystems to changing climates and environments. These activities would combine long-standing USGS expertise in geology, hydrology, ecology, biogeochemistry, and geography to provide high-resolution records of past and on-going changes over regional to national scales. The proposed increase would facilitate the integration of historic, instrumental, experimental, and monitoring records with land-cover and climate modeling activities to improve capabilities that project potential impacts of different management and climate scenarios. By providing decision makers the information needed to evaluate the impacts of various management plans, USGS research would help decrease the vulnerability and increase the resilience of critical ecosystems throughout the Nation.

Tribal Climate Adaptation Science (+$10,000,000 / +1 FTE) – The USGS would build upon existing partnerships with Tribal and indigenous communities to integrate traditional knowledge into climate research, and expand capacity building efforts so that Tribal communities, including remote communities

such as those in Alaska and the western Pacific, can more easily participate in research endeavors and access needed information.

The USGS is uniquely positioned to develop and manage the leading edge of institutional mechanisms to promote co-production of knowledge processes while ensuring that agencies maintain appropriate validation standards for data quality and dissemination. The USGS is currently collaborating with the Bureau of Indian Affairs to host Tribal Resilience Liaisons at the regional Climate Adaptation Science Centers; these liaisons work across the boundary between the USGS and American Indian Tribes and Alaska Native villages. USGS scientists have established relationships with many American Indian and Alaska Native Tribes and indigenous communities in the Pacific islands and would use this increase to build a science portfolio that provides information directly responsive to their needs.

Support for Climate Adaptation Science Centers (+$25,000,000 / +15 FTE) – With this increase, the USGS would accelerate the work conducted by the network of university-based Climate Adaptation Science Centers. The effort would be along two complementary approaches: development of climate adaptation services and furthering ongoing work in support of the climate science needs identified in the DOI Climate Action plan; and ramping up efforts by our regional Climate Adaptation Science Centers (CASC) stakeholder advisory committees to support DOI and their partners' science priorities. Specifically, the USGS would develop new scientific approaches to use and integrate climate information and model output into management and planning efforts, furthering our ability to provide actionable science to help natural resource managers adapt to future climate related changes. The USGS would focus basic scientific efforts on regional partner priorities, such as climate change in the Arctic, climate driven changes in wildfire and drought, understanding how the loss of winter impacts natural resources in northern climates and how coastal and nearshore resources will be impacted by climate change. Additionally, the USGS would expand our efforts to provide support in the intersection between climate science and natural and cultural resource management through development of climate adaptation services. This service would provide for example, single points of contact to identify appropriate climate science for use in natural and cultural resources management planning and management, developing training for individuals in management communities to assure that best practices are used to incorporate climate in plausible futures, and develop broad approaches to integrating climate science in management actions. Once implemented, these services would ensure management agencies could integrate the best available climate science into everyday activities.

Water cascades down Gibbon Falls in Yellowstone National Park, where resource managers use decision making frameworks such as Resist-Accept-Direct (RAD) to incorporate climate data into their management strategies. (Credit: Alan Cressler, USGS)

Facilitate Synthesis of Regional Findings to National Level (+$5,000,000 / +2 FTE) – The CASCs provide valuable adaptation science at a regional level, but leveraging that information at a national level improves the quality of science and decision support in multiple ecoregions. Synthesizing a series of national science projects allows a broader understanding of the potential impacts and adaptation measures that will work across a variety of different geographies, thus sharing best practices from the work of the regional CASCs. The goal of this effort will be twofold, (1) directly support managers by providing a broader understanding of how climate impacts and adaptation can be used in a risk management framework for Federal, State, and Tribal partners decision processes, and (2) develop further understanding of broad climate driven impacts such as fire, drought, and sea level rise, and integrating that with a variety of fish and wildlife management "on the ground" projects to increase knowledge of management actions that may help us adapt to or mitigate climate impacts.

Among the various products will be a guidebook on (1) how managers incorporate aspects of risk of management choice associated with climate driven changes into adaptation and mitigation efforts, and (2) a series of reference case-studies focused on ecological transformation and ways for managers to effectively incorporate risk from climate into management strategies for underlying biodiversity and services that nature provides. Another outcome is the development of models that combine landscape properties (for example, land use, land cover, condition), climate, hydrology, biogeochemistry, and ecology to forecast change for specific ecosystems across different scales. Additionally, the USGS intends to produce a series of assessments focused on synthesizing findings of the climate impacts to fire, drought, ecological flows and other high priority topics identified by resource managers. These syntheses will include policy relevant options for various management agencies to consider when planning activities and regulatory approaches.

Assessment of Biodiversity (+$2,500,000 / +2 FTE) – Biodiversity provides the underlying support for nature's contributions to people, providing, for example, food and water security, hazard protection, and serves as an important component of cultural identity. Understanding the key linkages between climate and biodiversity, and how climate may impact future contributions to people will be critical to help mitigate or adapt to climate driven change. The USGS has extensive expertise in leading the National Climate Assessments chapters on biodiversity, ecosystems, and ecosystems services over the last 10 years. These extensive capabilities will be used to develop science to allow us to understand the key linkages between climate change and biodiversity. The primary focus of this work will focus on understanding the linkages between biodiversity and climate change, development of scientific approaches to help reverse the decline of biodiversity and perform the first National Assessment of Biodiversity and Ecosystems, modeled after the recently completed global assessment of biodiversity and ecosystem services. The final products will include an assessment in the United States of the linkages between Climate and Biodiversity and identify policy support mechanisms to conserve biodiversity

Program Overview

The Climate Adaptation Science Center and Land Change Science program provides information, tools, and applications to meet current and emerging challenges that threaten the sustainability of natural resources. The program serves as an interface between Federal researchers, academic partners, land managers, and front-line stewards of natural and cultural resources.

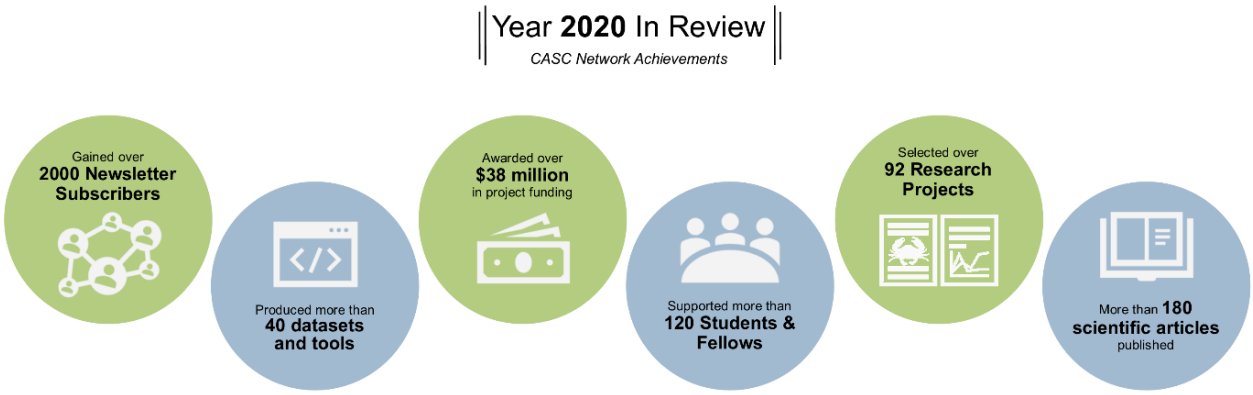
The scientific work conducted is responsive to the following guiding principles:

- Meets the needs of resource managers
- Prioritizes evaluation, translation, and synthesis of climate-impact research findings
- Promotes rigorous and integrated research to advance fundamental understanding of climate impacts to fish and wildlife resources
- Develops approaches to ensure broad dissemination of results to the public and foster professional scrutiny, critique, and learning
- Promotes institutional efficiencies through partnerships to avoid duplication of effort and leverage opportunities in climate-impact research

Researcher holds an ablation stake and winter snow probe during spring mass balance field work on Gulkana Glacier, AK. Source: USGS.

The Climate Adaptation Science Centers synthesize and analyze the effects of a changing climate on terrestrial and aquatic communities and natural resources at regional to national scales. The Centers focus on the highest priorities of Interior, such as wildfires, wildlife disease, drought, and their effects on federally listed species or critical habitat, recreational fisheries, migratory corridors, and Tribal lands and waters. The Climate Adaptation Science Centers work collaboratively with scientific expertise found throughout the Ecosystems Mission Area and in other programs within the USGS, along with scientific expertise available within University partners.

The program also covers changes in land use, environment, and precipitation and temperatures that can have significant impacts on our Nation's natural resources, infrastructure, and water, energy, and food security. The program currently focuses on: long-term patterns and impacts of droughts and floods; response of coastal regions to changing land use, water management, and sea level; patterns and impacts of drought, fire, and other stressors on mountain ecosystems; and patterns and impacts of change on Arctic habitats. These efforts provide data to better understand how different forces shape the landscape, distinguish between changes resulting from natural forces from those associated with land management, and provide the scientific basis for land use decisions that affect the safety and prosperity of communities and our Nation's natural resources.


Year 2020 In Review
CASC Network Achievements
Gained over 2000 Newsletter Subscribers
Produced more than 40 datasets and tools
Awarded over $38 million in project funding
Supported more than 120 Students & Fellows
Selected over 92 Research Projects
More than 180 scientific articles published

Energy and Mineral Resources

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Energy & Mineral Resources

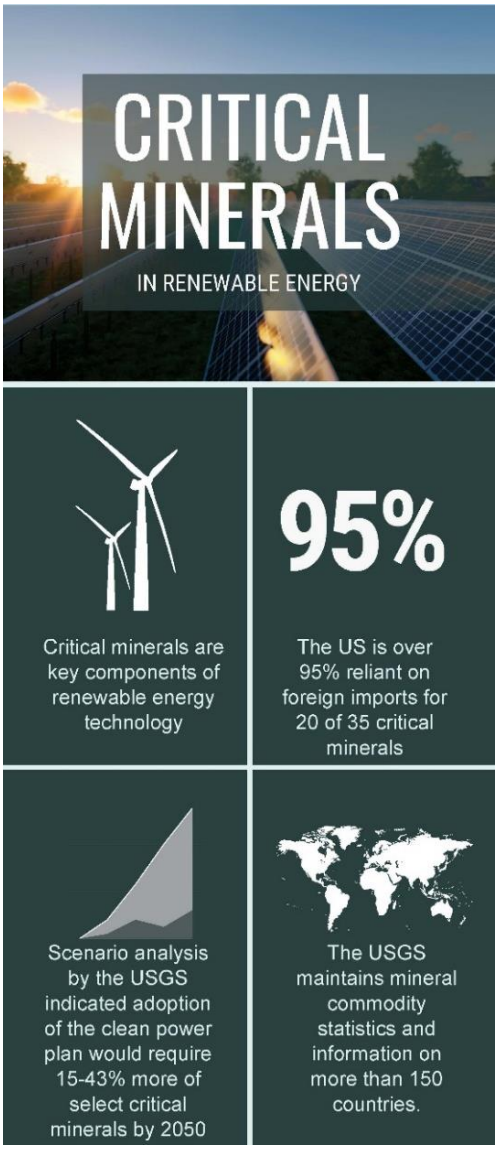
Energy & Mineral Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Mineral Resources Program	**59,869**	**59,869**	**1,368**	**0**	**25,000**	**86,237**
Supply Chain Research for Green Technologies	*1,670*	*1,670*	*0*	*0*	*5,000*	*6,670*
Mine Waste Research and Assessments in Support of Reclamation	*1,274*	*1,274*	*0*	*0*	*15,000*	*16,274*
Critical Minerals (Location, Forecasting)	*1,991*	*1,991*	*0*	*0*	*5,000*	*6,991*
FTE	***286***	***286***	***0***	***0***	***46***	***332***
Energy Resources Program	**30,172**	**30,172**	**564**	**0**	**23,000**	**53,736**
Geologic Carbon Sequestration	*1,477*	*1,477*	*0*	*0*	*4,500*	*5,977*
Geophysical Data Acquisition in Areas with Potential for Geologic Carbon Sequestration	*75*	*75*	*0*	*0*	*3,500*	*3,575*
Inventory of Greenhouse Gases Emissions and Sinks on Federal Lands	*50*	*50*	*0*	*0*	*10,000*	*10,050*
Scenario Analysis Tools for Greenhouse Gas Reduction on Federal Lands	*250*	*250*	*0*	*0*	*5,000*	*5,250*
FTE	***118***	***118***	***0***	***0***	***21***	***139***
Energy and Mineral Resources Total	**90,041**	**90,041**	**1,932**	**0**	**48,000**	**139,973**
FTE	***404***	***404***	***0***	***0***	***67***	***471***

Mission Area Overview

The Energy and Mineral Resources Mission Area is the Nation's primary source of impartial scientific information on domestic and global geologic resources and their supply chains. The Nation relies on a variety of energy and mineral resources to power homes and businesses and to manufacture products and technologies from phones to vehicles. The mission area conducts research on the full life cycle of these resources, including the Nation's domestic resources and global trade relationships; carbon storage potential and critical mineral supply chains essential to sustainable energy transitions; environmental and socioeconomic effects of geologic resource occurrence, extraction, use, wastes, and demands on water

supplies; and supply, demand, and trade of mineral commodities. It makes publicly available its scientific data on the origin and distribution of energy and mineral resources, potential locations for carbon sequestration, and natural geologic greenhouse gas emissions on Federal lands. The science provided by the mission area is used to inform strategic economic, technological, national security, and geopolitical decisions, as well as sustainable natural resource management and the development of infrastructure and new technologies.

Energy Resource Assessments: The USGS is the sole provider of unbiased publicly available estimates of geological energy resources for the United States (exclusive of the U.S. Outer Continental Shelf) and provides publicly available estimates related to global oil and gas resources. These geological energy resources include traditional products such as oil, natural gas, coal, gas hydrates, and uranium as well as renewable resources such as geothermal resources and carbon capture, utilization, and storage capabilities. The USGS also studies the environmental impacts of energy resource extraction as well as water and waste implications of energy development. USGS science, therefore, helps inform decision-making related to domestic and foreign energy resources as well as the management of energy resources, in particular on Federal lands. The USGS Energy and Mineral Resources Mission Area coordinates with the Ecosystems Mission Area on the Wind Energy Impact Assessment Methodology to assess population-level impacts of wind energy development on birds and bats, helping to inform decisions on the placement of wind turbines and related environmental considerations.



Minerals Information: The USGS conducts analyses of minerals conservation, sustainability, materials flow, availability, and the economic health of the U.S. minerals industry. It produces about 700 reports annually (see *http://minerals.usgs.gov/minerals*) and answers more than 2,000 inquiries monthly pertaining to mineral resources. Key stakeholders include Federal agencies (such as the Departments of Defense, Commerce, and State, as well as intelligence agencies, the Federal Reserve Board, and the U.S. Trade Representative), State agencies, domestic and international organizations, foreign governments, and the public. As an example, MRP information helps the Environmental Protection Agency quantify material flows in annual solid waste reporting.

Minerals Research and Assessments: The USGS conducts research to better understand the origins, character, size, and distribution of ore deposits as well as their natural environmental effects and the impacts of mineral development. Such research is used to evaluate and rank the potential for reclamation and byproduct critical mineral recovery from the many legacy mine sites across the nation,

and USGS mineral resource assessments enable policy makers and others to make more informed decisions that may affect supplies and availabilities of critical minerals.

Energy and Minerals Research for Decision Support: This research, done in collaboration with other Federal agencies, universities, and nongovernmental organizations, includes the development of tools to make energy and mineral resources information more useful for decisions impacting climate, ecosystems, underserved communities, and the economy. This research also includes studies to conduct multi-resource assessments that combine energy and mineral resources assessments with information about those resources' effects on the quantity and quality of other natural resources such as water. Recent USGS research spanning the Energy and Mineral Resources Programs has highlighted the importance of mineral supplies and wastes in the energy technology transition; and identified opportunities to use geologic formations and mine wastes for carbon dioxide mineralization (i.e., turning carbon dioxide into a solid mineral to prevent escape of gases).

Selected Mission Area Accomplishments

- Published the first national map with potential to host 11 critical mineral commodities and published a refined methodology for identifying minerals most at risk of supply chain disruptions.
- Developed tools to estimate geothermal Reservoir Thermal Energy Storage Resources, which have potential uses in both remote communities and major metropolitan areas.

For additional information about these programs, please visit the USGS website (www.usgs.gov).

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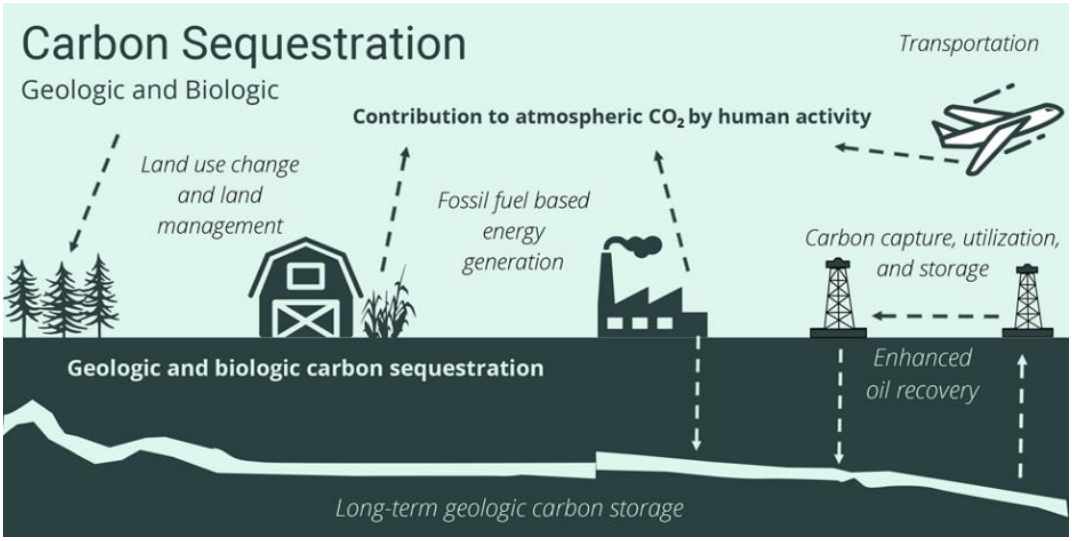
Energy & Mineral Resources
Energy Resources Program

Energy and Mineral Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Energy Resources Program	**30,172**	**30,172**	**564**	**0**	**23,000**	**53,736**
Geologic Carbon Sequestration	*1,477*	*1,477*	*0*	*0*	*4,500*	*5,977*
Geophysical Data Acquisition in Areas with Potential for Geologic Carbon Sequestration	*75*	*75*	*0*	*0*	*3,500*	*3,575*
Inventory of Greenhouse Gases Emissions and Sinks on Federal Lands	*50*	*50*	*0*	*0*	*10,000*	*10,050*
Scenario Analysis Tools for Greenhouse Gas Reduction on Federal Lands	*250*	*250*	*0*	*0*	*5,000*	*5,250*
FTE	***118***	***118***	***0***	***0***	***21***	***139***

2022 Program Changes

The 2022 budget request for the Energy Resources Program is $53,736,000 and 139 FTE, a program change of $23,000 and 21 FTE from 2021 Enacted.

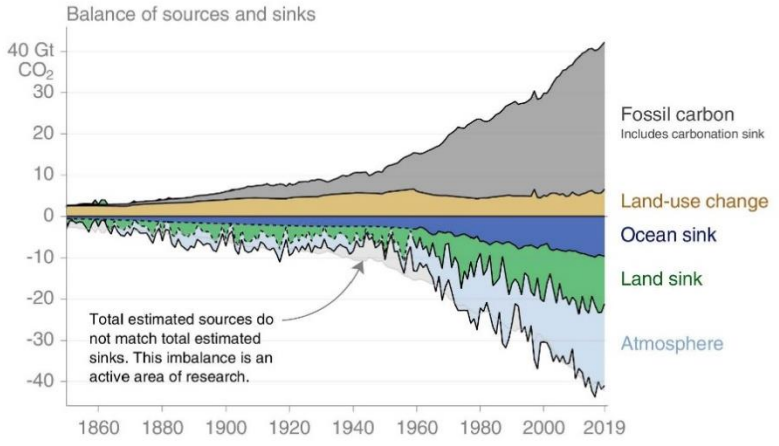
Geologic Carbon Sequestration (+$4,500,000/+4 FTE) – The USGS and Federal, State, and international partners have demonstrated the potential to scale up existing research on geologic carbon sequestration, which allows for the capture and storage of carbon in geologic formations, and has the potential, in some



cases, for use in recovery of oil and gas resources while balancing the net greenhouse gases created by consumption of those resources. Additional science is needed to target implementation to areas of high potential and low risk. The USGS would launch the following: refined regional assessments of select priority geologic basins for carbon dioxide (CO_2) storage potential; evaluation of regional opportunities for oil and gas operations to adopt carbon capture and storage which could both decarbonize ongoing energy production and provide energy communities an alternate stream of services and income; and research on alternate forms of geologic storage, including a methodology to assess both carbon and hydrogen storage potential in a future hydrogen energy economy, and opportunities for CO_2 mineralization (i.e., turning carbon dioxide into a solid mineral to prevent escape of gases) in mine wastes.

Geophysical Data Acquisition in Areas with Potential for Geologic Carbon Sequestration– (+3,500,000 / +3 FTE) – The potential for CO_2 injection to induce seismicity could forestall regional implementation of greenhouse gas management, without additional science to mitigate such risks. The USGS would identify areas that should be prioritized for geophysical data collection, thus providing high-resolution data that will be analyzed jointly by the USGS Earthquake Hazards Program to determine the potential for induced seismicity (See complementary program increase in the Earthquake Hazards program for performing the analysis). Data acquisition priorities would be based on USGS Energy Resources Program's assessments of regional carbon storage potential. Data acquisition in 2022 would focus on the Illinois Basin, where collaboration with the Illinois State Geological Survey and the U.S. Department of Energy has identified needs for a basin-wide magnetic and radiometric survey to better delineate the deep subsurface in areas with high CO_2 storage potential. These data would also support characterization of critical minerals, groundwater, and geothermal resources, maximizing the ability to gather data once and use it for multiple resource management purposes.

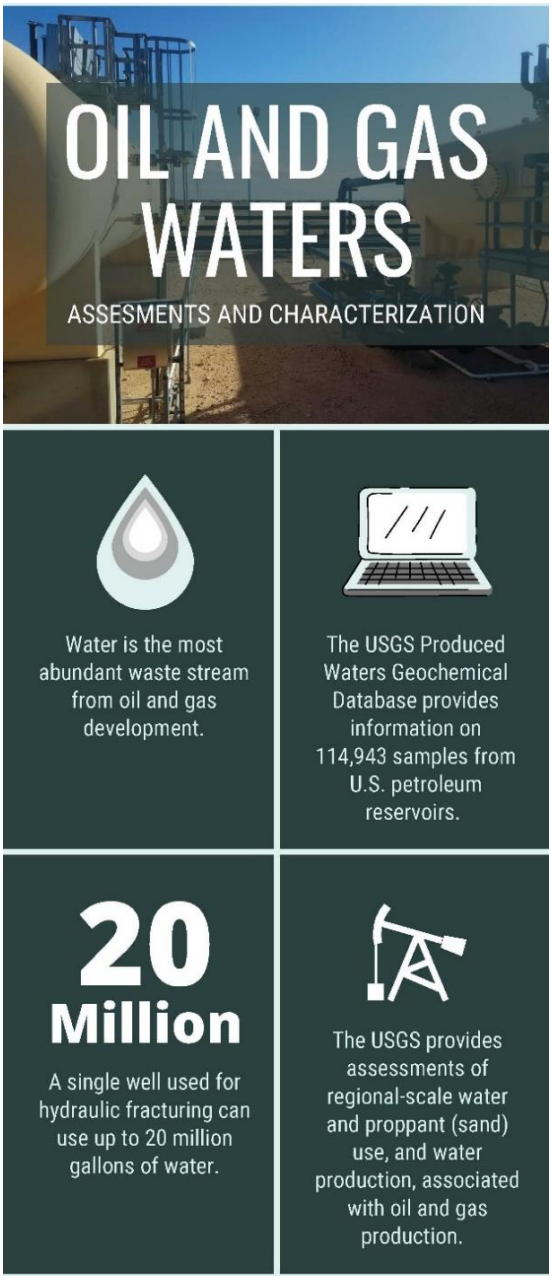
Inventory of Greenhouse Gases Emissions and Sinks on Federal Lands (+$10,000,000 /+8 FTE) – The USGS would collaborate with other Interior bureaus and Federal agencies on a system to measure, monitor, report, and verify carbon sequestration and greenhouse gas reductions in the lands and energy sectors, ranging from extractive activity to wetland and vegetation management on Federal lands. In 2022, the USGS would update the 2018 inventory of greenhouse gas emissions from Federal lands, develop approaches to provide biennial updates to the inventory, incorporate negative emissions (e.g., monitoring the effects of reforestation projects and geologic carbon storage on Federal land), and convene a working group across Interior bureaus to include greenhouse gas emissions from inactive and abandoned or orphaned wells on Federal land. By 2024, this effort would provide Federal land managers an initial tool to plan for and measure the impact of potential greenhouse gas management



Global Carbon Project - Data: USGS/GCP/CDIAC/NOAA-ESRL/UNFCCC
The figure illustrates the global carbon budget in gigatons, Gt, of carbon dioxide (CO2) that are averaged over the historical period from 1850–2019. Note that fossil CO2 sources are primary from fossil fuel combustion emissions that have increased dramatically since about 1950. Also note that CO2 accumulation (sinks) in the atmosphere and the oceans also start to increase at about the same time. Increased CO2 in the atmosphere leads to global warming and increased CO2 in the oceans leads to ocean acidification and damage to corals and other wildlife. (Friedlingstein et al 2020; Global Carbon Budget 2020)

practices. This funding would also support USGS research quantifying uncertainties in greenhouse gas emissions, in areas ranging from wildfire to coal mine methane seeps, and coordination with other nations' related efforts.

Scenario Analysis Tools for Greenhouse Gas Reduction on Federal Lands (+$5,000,000 / +6 FTE) – USGS data show that energy development on Federal lands, which are approximately 20 percent of the U.S. land mass, accounts for 25 percent of U.S. greenhouse gas emissions. Shifting Federal land use strategies to lower-emissions energy development will give rise to a number of opportunities and tradeoffs, including the water requirements and land disturbance associated with different forms of energy development. The USGS would better support sustainable uses of Federal lands by providing Federal decision-makers, local communities, and land managers with the tools to analyze tradeoffs among all-of-the-above energy development scenarios. The USGS would also identify potential resource conflicts in specific regions. The USGS has developed several building blocks for these scenario analysis tools, including methods to evaluate feedbacks between oil and gas and water resource development, and the potential to manage CO_2 injection as a transition technology both enhancing oil recovery and reducing greenhouse gas emissions. In 2022, the USGS would build on these methods to develop analysis of a range of energy technologies' effects on land change and water supplies; build on existing relationships with other Interior bureaus and State agencies to better understand the conservation and development scenarios relevant to those partners; and launch development of a new National Solar Generation Database, in collaboration with the U.S. Department of Energy (DOE). The existing USGS/DOE/American Clean Power Association's National Wind Turbine Database and the existing USGS Wind Energy Impact Assessment Methodology would be used to identify potential conflicts between wind energy and wildlife. Integration of energy/water/land change and energy/wildlife/habitat analyses will provide a powerful analytical tool to land managers.



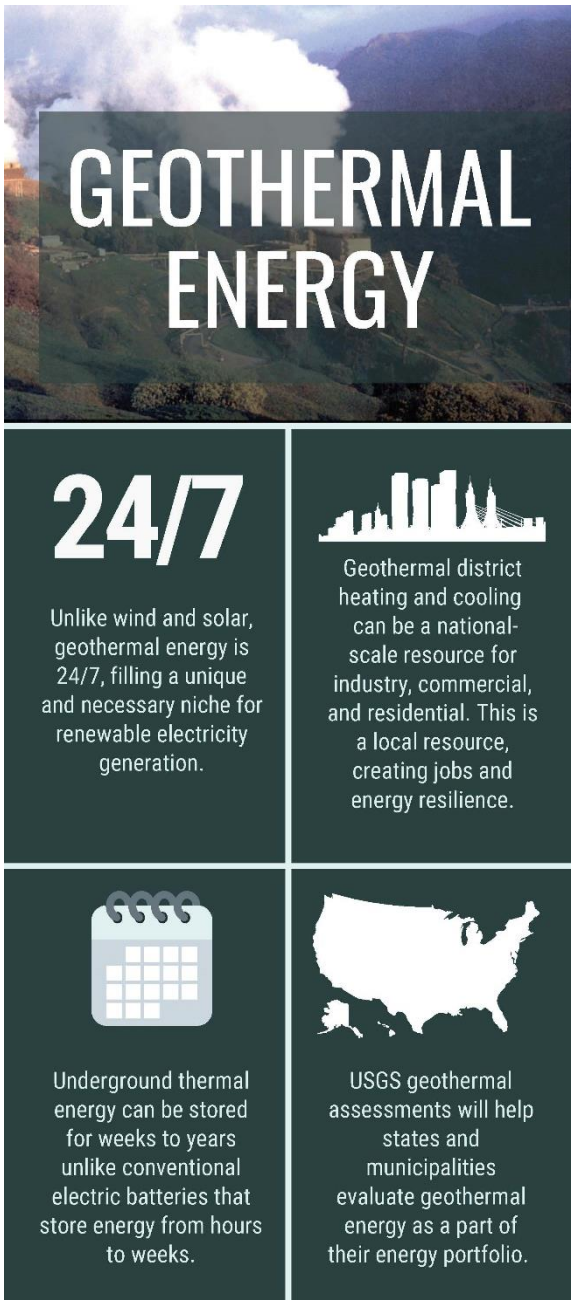
Program Overview

The Energy Resources Program is the sole provider of unbiased, publicly available estimates of undiscovered, technically recoverable energy resources for the United States (exclusive of the U.S. Outer Continental Shelf). The USGS addresses the challenge of increasing demand for energy resources by conducting basic and applied

research on geologic energy resources and on the environmental and economic impacts of their use. The program studies both emerging and renewable (e.g., geothermal, wind, hydrogen) and traditional geologic energy resources (e.g., oil, natural gas), as well as the carbon, water, and waste implications of energy development. USGS science informs decision-making related to domestic and foreign energy resources, as well as the management of energy resources on Federal lands. Such information is critical in efforts to meet increased energy demands while simultaneously mitigating climate change.

Energy Resource Assessments and Methods Development

The USGS's work includes assessment of oil and gas resource potential through in-depth studies of geology and energy resources in various petroleum provinces throughout the United States. Studies of the geologic, geophysical, and geochemical framework of these areas allow for better understanding of the resource potential and environmental impacts of oil and gas development. USGS resource assessments are widely used by a variety of stakeholders including local, State, and Federal governments, land resource managers, and the public.



The USGS also supports studies to understand and quantify the Nation's renewable and alternative energy resources, including geothermal energy resource assessments (pursuant to the Energy Act of 2020) and uranium resource evaluations, to further diversify the U.S. energy portfolio. The potential to harness our Nation's renewable and alternative energy potential is important for informed decision-making that considers the resulting effects on our economy and environment.

As part of its resource assessment portfolio, the USGS is pioneering the development of tools and techniques for multi-resource analysis that combine energy resource assessments with information about the quantity and quality of other natural resources, and feedbacks between development of one resource and availability of other resources. These assessments, which include the relationship between energy and water, will help natural resource managers better understand the connections between the resources they manage and the changes that might occur as a result of natural events and human decisions.

Energy Resources Research

The USGS conducts research on the geologic processes that form energy resources and the geologic setting of these resources to enable and improve assessments of

current national and global coal, oil, gas, and geothermal resources. Accurate and scientifically based assessments of coal, oil, and gas resources of the Nation and world are dependent upon this geologic information. The USGS's work in geologic process and resource characterization also facilitates the evaluation of potential contributions to future energy supplies from traditional hydrocarbon energy resources such as oil, gas, and coal, as well as from emerging resources such as gas hydrates and geothermal energy.

USGS research addresses the complete life cycle of energy resources from geologic setting and source studies prior to resource extraction by industry to reclamation, recycling, and disposal once extraction activities are complete. Benefits from this research apply to a variety of stakeholders, including resource industries, who use the information to identify best practices to limit adverse environmental impacts and for other purposes; citizens who want unbiased scientific information about the risks and benefits of resource development; and land use managers and regulators to enhance stewardship of public lands for multiple uses and for national energy and economic security.

The USGS supports research to anticipate or consider the near-term and long-term benefits and cumulative effects of resource development. Spatial analyses and other data delivery and analysis tools (for example, interactive maps), combined with economic analyses of energy resources, facilitate data dissemination and synthesis within and among other USGS activities and external collaborators and stakeholders. Products include the Geologic Carbon Sequestration interactive map, U.S. Wind Turbine Database, and National and Global Oil and Gas Assessment Website. Outcomes from USGS-supported research efforts generate large volumes of science-driven research and information in compliance with Federal data management (OpenData) policies, requiring specialized data management expertise and services to assist with documentation, data sharing, Web applications, and delivery systems.

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Energy & Mineral Resources
Minerals Resources Program

Energy and Mineral Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Mineral Resources Program	**59,869**	**59,869**	**1,368**	**0**	**25,000**	**86,237**
Supply Chain Research for Green Technologies	*1,670*	*1,670*	*0*	*0*	*5,000*	*6,670*
Mine Waste Research and Assessments in Support of Reclamation	*1,274*	*1,274*	*0*	*0*	*15,000*	*16,274*
Critical Minerals (Location, Forecasting)	*1,991*	*1,991*	*0*	*0*	*5,000*	*6,991*

2022 Program Changes

The 2022 budget request for the Mineral Resources Program is $86,237,000 and 332 FTE, a program change of $25,000 and 46 FTE from 2021 Enacted.

Supply Chain Research for Green Technologies (+$5,000,000 / +6 FTE) – The Nation's transition to low-carbon energy generation and storage will greatly increase society's need for minerals. Without careful study of these dependencies, renewable energy transition to technologies like solar cells, wind turbines and electric vehicles may be jeopardized by weak supply chains for key minerals, accompanied by production and waste management challenges. In 2022, the USGS would build on recently published analyses of the mineral dependencies of current and emerging energy generation and storage technologies to increase the provision of data and technical assistance to other Federal agencies, including the interagency Federal Consortium on Advanced Batteries under Executive Order 14017, *America's Supply Chains* (2021). In addition, the USGS would build on 2020 research identifying mineral dependencies across multiple economic sectors to identify cumulative risks to energy technology supply chains and potential for cross-sector competition for mineral commodities. The USGS would also begin development of updated scenarios for future energy generation and storage technologies' uptake and adoption and will develop supply risk analyses for those scenarios upon completion. These scenarios can be used by private-sector manufacturers and policy makers to identify key data and measures useful to identify opportunities to reduce the climate and environmental impacts of U.S. imports and supply chains. The scenarios can also be used to help forecast future demand, supply chain vulnerabilities, and market disruption and potential impacts on the broader economy as well as identify opportunities for economic investment.

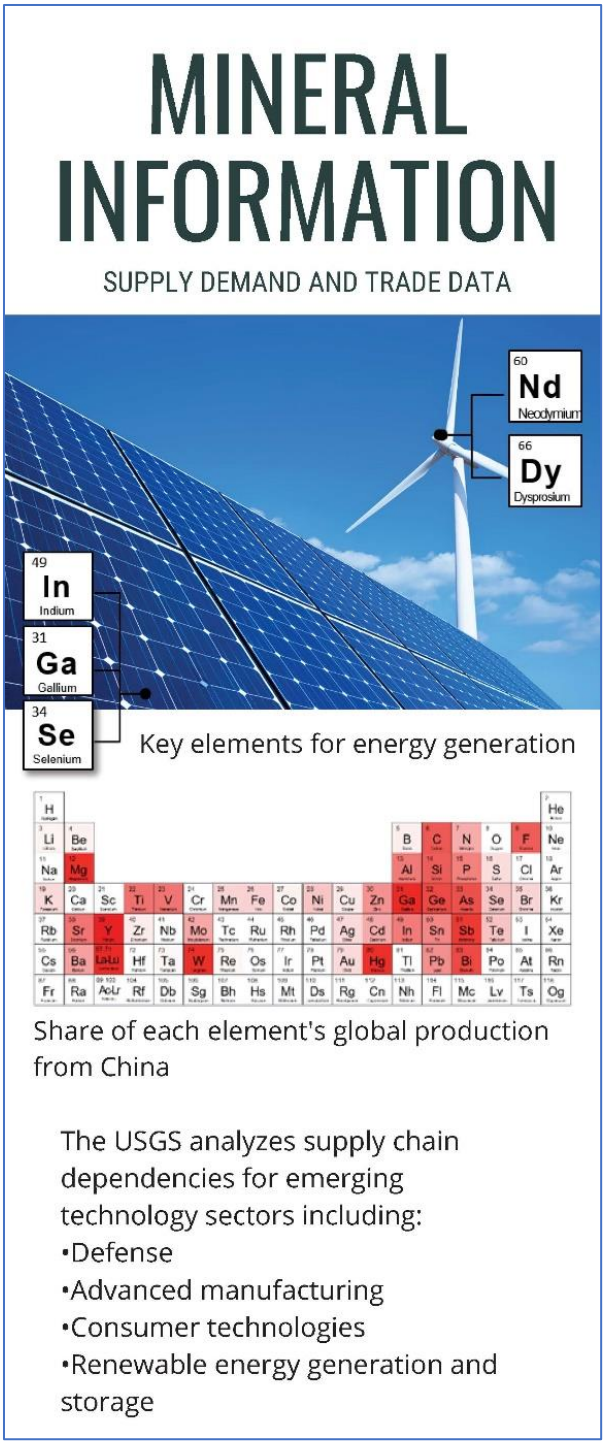
Mine Waste Research and Assessments in Support of Reclamation (+$15,000,000 / +25 FTE) – Federal agencies have a long history of working with States, Tribes, and non-governmental organizations on mine waste issues, but these efforts center on individual projects rather than scaling up to larger successes. There has been no unified national strategy to accelerate and coordinate these efforts or to include the evaluation of mine waste as a resource for critical minerals. The USGS would collaborate with other Interior bureaus

and Federal and State agencies to support development of such a strategy. The USGS and partners would initiate development of a national mine waste inventory, leveraging the joint USGS/Bureau of Land Management USMIN database of historical mining locations to prioritize both field data collection and remote sensing (such as airborne hyperspectral surveys). To understand the priorities and needs of agencies responsible for managing mine wastes, the USGS would leverage the interagency Federal Mining Dialogue and an existing partnership with State agencies that must weigh the benefits and risks of reprocessing, reclaiming, and restoring mine waste sites in light of environmental and community concerns. In collaboration with DOI's Office of Environmental Policy and Compliance and other USGS programs, the USGS would launch a pilot project evaluating the potential to reprocess minerals from mine wastes on National Park Service lands in the southwestern United States. The USGS would also leverage a 2021 mine waste research workshop to develop a science strategy that will complement the Department of Energy's focus on technological aspects of waste recycling and reprocessing (Energy Act of 2020).

The old Kennecott copper mill and shop in Alaska's Wrangell – St. Elias National Park. Kennecott was once a thriving mine and mill during the early 1900s and is now a National Historic Landmark. The mines are 5 miles up the mountain. (Photo Credit: Frederick Wilson, USGS)

Critical Minerals (Location & Forecasting) (+$5,000,000 / +15 FTE) – Strategies to strengthen supply include trade, increased domestic production, or advanced recycling and waste reprocessing. Strengthening the supply chains for critical minerals may require employing these strategies at multiple stages of each mineral's life cycle. The USGS currently provides mineral supply chain analyses to several Federal agencies, including the Defense Logistics Agency's stockpile managers. The USGS would leverage its experience providing interagency technical assistance to launch development of an automated analytical capability for supply risk and economic impact forecasting. In accordance with the Energy Act (2020),

upon completion, this capability would provide both forecasts of supply chain vulnerabilities to disruption, and near-real-time identification of economic impacts during supply chain disruption events ranging from trade wars to pandemics; and would include projections of critical minerals production, consumption, and recycling. The USGS would use an initial set of scenarios to forecast multiple economic sectors' supply chain vulnerabilities and advise on strategies under Executive Order 14017, *America's Supply Chains* (2021). Within the USGS, these supply chain forecasts would be used to further prioritize domestic data acquisition through the MRP-led Earth Mapping Resources Initiative (Earth MRI). This increase will also support the interpretation of the data to inform domestic and global mineral resource assessments of undiscovered critical mineral resources. These data and assessments provide an essential strategic understanding of long-term critical mineral resources both domestically and for trade partners, which will in turn strengthen longer-term forecasts of supply chain health.

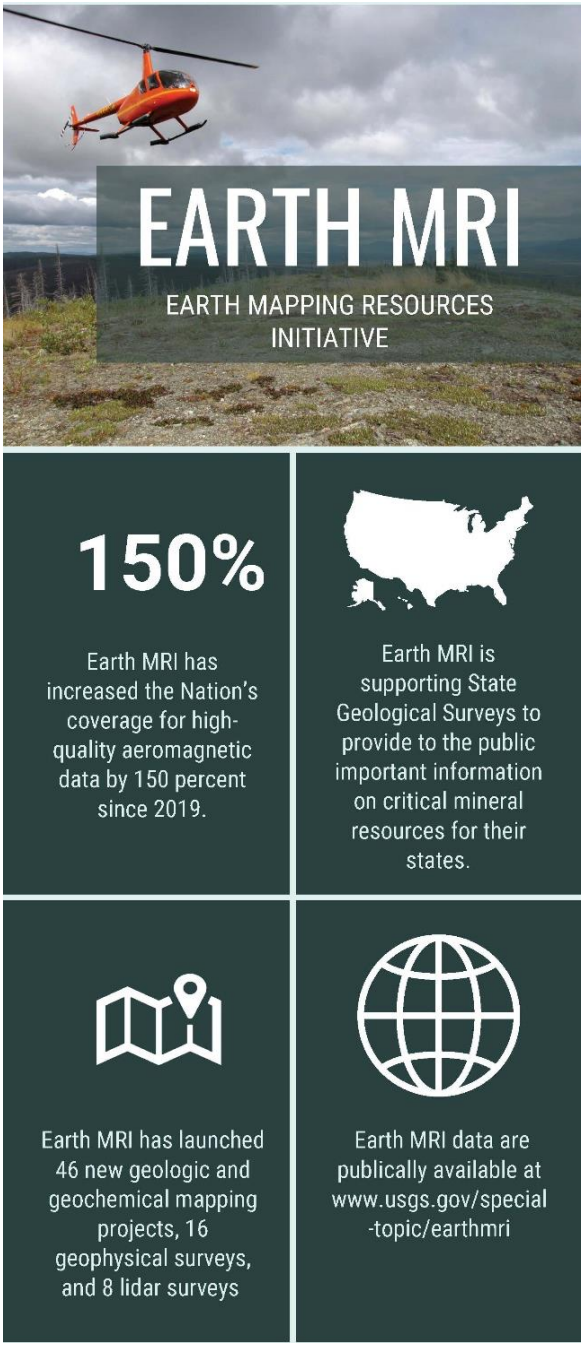


Program Overview

The Mineral Resources Program is the primary Federal source of scientific information and research on onshore nonfuel mineral potential, production, consumption, and interaction with the environment. The USGS supports data collection and research on a wide variety of nonfuel mineral resources that are critical to the economic stability and national security of the United States. Research by the USGS helps to define and forecast foreign dependencies on mineral commodities and to provide the scientific data for the Nation's minerals industry, especially critical minerals needed for renewable energy and other emerging technologies. USGS research on how minerals and mine wastes interact with the environment is also essential to inform the management of our public lands and resources, and for protecting and improving public health and safety.

By statute, the USGS's National Minerals Information Center (NMIC) collects, analyzes, and disseminates data on the production and consumption of about 100 mineral commodities for 180 countries. The data provide decision makers information to ensure adequate and dependable supplies of minerals and mineral

materials to meet its defense and economic needs at acceptable costs. The NMIC provides hundreds of reports annually, such as the Minerals Commodity Summaries, the Minerals Yearbook, the Mineral Industry Surveys, Metal Industry Indicators, and the Nonmetallic Mineral Products Industry Indexes; and under the Energy Act (2020) will launch a new series of Critical Mineral Outlooks. The public and private sectors use this information to understand the use of mineral materials in the economy and to forecast supply and demand. Other Federal agencies, including defense, intelligence, trade, and diplomatic agencies, use NMIC data to formulate plans to address shortages and interruptions in mineral supplies in the global economy. The Defense Logistics Agency uses the data to identify supply chain vulnerabilities of mineral commodities.



Critical Mineral Resources

The USGS's work has a strong focus on critical minerals research, mapping, and data to better inform the public, industry, land managers, and policy makers about domestic critical mineral resources. Today, many critical minerals are metals that are central to emerging high-tech and renewable energy sectors, including rare earth elements used in wind turbines and electronics such as smart phones and computers. The Department of the Interior published a list of 35 critical minerals in the Federal Register (83 FR23295) in May 2018, based largely on MRP data and methodologies. The USGS developed and continues to refine a "criticality tool" which can be used to identify emerging supply risks and evaluate the impact of commodity supply restrictions.

The Nation's subsurface is under-mapped relative to other developed nations. In 2019, the USGS launched the Earth Mapping Resources Initiative (Earth MRI) to modernize the Nation's mapping of geologic resources, with an initial focus on mapping needed to better understand supplies of DOI's 2018 list of critical minerals essential to the Nation's economy. In 2022, Earth MRI will acquire new geologic mapping, airborne geophysical surveys, and high-resolution topographic mapping in a number of States. Earth MRI coordinates efforts across various USGS programs and with the Association of American State Geologists. Earth MRI data are essential for delineating areas with critical mineral potential as well as for decisions on infrastructure, transportation, and land-use planning; hazard assessments for landslides, volcanoes, and floods; water resources management; geothermal resources and geologic carbon storage; and emergency response.

Mineral Resources Research

The USGS supports a wide variety of research on mineral resources, including research on mine wastes' environmental impact and the potential for reprocessing mineral resources from wastes, and the development of analytical tools and databases to support mineral research and assessments. The USGS supports geologic framework research on how and where mineral deposits form and develops methods to detect potential mineral resources. This research has produced innovations in mineral resource science, including recognition of new areas that are prospective for the discovery of critical mineral deposits. The USGS conducts research studies to understand the geologic history and characteristics of an area, define what processes formed the mineral deposits, and identify keys to predicting undiscovered deposits. USGS research and associated databases are used Federal and State agencies, academia, and the private sector.

USGS scientists conduct research into the interactions of mineral resources with the environment, both natural and because of resource extraction, to understand emerging challenges and opportunities for future mining, as well as new uses of previously mined materials. The USGS has unique expertise in the flow of resources through the global economy as both commodity and waste and works to improve the Nation's understanding of the potential for deriving value from above-ground resources such as waste streams from manufacturing and mining.

The USGS has launched several efforts to modernize research databases and digitize legacy mining and minerals information. These include USMIN, a national-scale geospatial database that is the authoritative data source on the most significant mines, mineral deposits, and mineral districts of the United States, including digitized mine features from historical paper topographic maps.

Mineral Resource Assessments and Methods Development

USGS mineral assessments and inventories evaluate the potential for undiscovered domestic and global deposits of minerals ranging from major metals (e.g., copper) to rare earth elements. These assessments are informed by a diverse array of data types and sources, including space-based and airborne Earth observation instruments, aeromagnetic and radiometric surveys conducted as part of Earth MRI, hyperspectral remote sensing data, and innovative new geochemical tools and methods. The Energy Act of 2020 directs the USGS to carry out comprehensive national assessments of identified and undiscovered resources of critical minerals. Such assessments enable land managers to make more informed decisions for land-use planning and management and aid policy makers in understanding global resource issues.

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Natural Hazards

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Natural Hazards

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Earthquake Hazards Program	**84,903**	**85,403**	**1,234**	**0**	**6,000**	**92,637**
Subduction Zone Science	*3,500*	*2,700*	*0*	*0*	*2,000*	*4,700*
Induced Seismicity	*1,100*	*1,100*	*0*	*0*	*2,000*	*3,100*
Modernization/Hardening of Infrastructure in Support of Earthquake Analysis	*2,000*	*2,000*	*0*	*0*	*2,000*	*4,000*
FTE	***253***	***253***	***0***	***0***	***14***	***267***
Volcano Hazards Program	**30,266**	**30,266**	**766**	**0**	**2,500**	**33,532**
Next Generation Volcanic Hazard Assessments	*520*	*520*	*0*	*0*	*1,000*	*1,520*
National Volcano Early Warning System: National Volcano Center Improvements	*300*	*300*	*0*	*0*	*1,500*	*1,800*
FTE	***157***	***157***	***0***	***0***	***9***	***166***
Landslide Hazards Program	**4,038**	**8,038**	**141**	**0**	**3,000**	**11,179**
Actionable Landslide Hazard Data and Science	*0*	*0*	*0*	*0*	*3,000*	*3,000*
FTE	***21***	***29***	***0***	***0***	***6***	**35**
Global Seismographic Network Program	**7,153**	**7,153**	**59**	**0**	***0***	**7,212**
FTE	***12***	***12***	***0***	***0***	***0***	***12***
Geomagnetism Program	**4,000**	**4,114**	**59**	**0**	**1,500**	**5,673**
Expansion of Magnetometer Observatories	*2,274*	*2,388*	*0*	*0*	*1,500*	*3,888*
FTE	***12***	***12***	***0***	***0***	***2***	***14***
Coastal/Marine Hazards and Resources Program	**40,510**	**40,510**	**1,005**	**0**	**16,000**	**57,515**
Coastal Hazards	*10,674*	*10,674*	*0*	*0*	*10,000*	*20,674*
Coastal Blue Carbon	*1,000*	*1,000*	*0*	*0*	*4,000*	*5,000*
Risk Reduction and Community Resilience	*800*	*800*	*0*	*0*	*2,000*	*2,800*
FTE	***206***	***206***	***0***	***0***	***28***	***234***
Natural Hazards Total	**170,870**	**175,484**	**3,264**	**0**	**29,000**	**207,748**
FTE	***661***	***669***	***0***	***0***	***59***	***728***

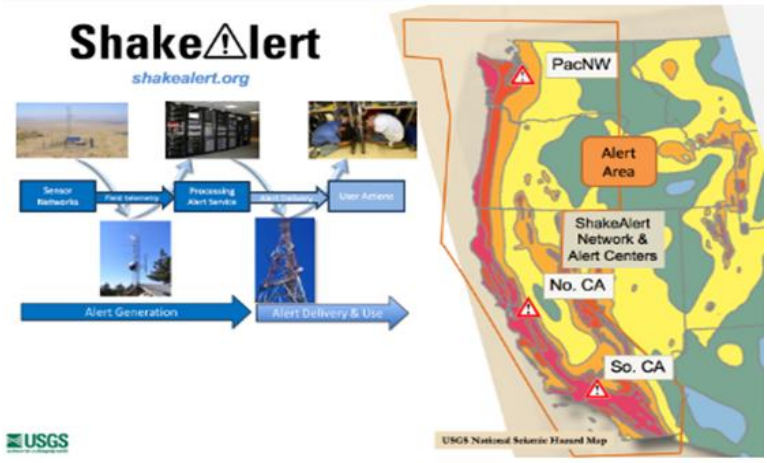
Mission Area Overview

The Natural Hazards Mission Area provides scientific information to emergency responders, policy makers, and the public to reduce losses from a wide array of natural hazards, including earthquakes, hurricanes, landslides, tsunamis, volcanic eruptions, and geomagnetic storms, as well longer-term climate change-driven impacts such as sea level rise, coastal erosion, and intense wildfires. The USGS delivers actionable assessments of these hazards and helps to develop effective strategies for achieving more-resilient communities. The USGS is the Federal agency responsible for monitoring and notification of earthquakes, volcanic activity, landslides, and coastal erosion in the United States. For many other hazards, the USGS directly supports the warning responsibility of the National Oceanic and Atmospheric Administration (NOAA), and other Federal or State agencies.

To achieve its primary mission, and to fulfill its responsibilities for loss and risk reduction, the USGS Natural Hazards Mission Area develops, delivers, and applies several components of hazard science: observations and targeted research, both of which underpin assessments, forecasts, warnings, and crisis and disaster response. The research, data, products, and detailed information that the USGS provides enables Federal, State, Tribal, local, and private-sector end-users to better understand, anticipate and reduce their risks associated with natural, technological, and environmental hazards, and enables science-based decisions that effectively enhance resilience and reduce impacts from those threats.

Natural Hazards Mission Area Accomplishments

- Statewide ShakeAlert earthquake early warning public alerting rollout took place in Oregon in March 2021, and in Washington in May 2021. The first statewide rollout took place in California in October 2019. These alerts are distributed to mobile devices.
- The National Seismic Hazard Model for the conterminous 48 States is being updated on a schedule aligned with periodic updates to building codes. The model and associated maps, last updated in 2018, will next be updated in 2023, and will include updated models for Alaska and Hawaii.
- The USGS continues development of the lahar-detection system on Mt. Rainier. This has led to improved monitoring capability on this very-high-threat volcano. Additional new stations are scheduled for installation at Mt. Rainier in FY 2021.



A map of the West Coast of the United States showing the boundaries of the *ShakeAlert* alert areas in the Pacific Northwest, and in northern and southern California. Source: USGS.

- Following authorization of the National Volcano Early Warning System (NVEWS) in 2019, the USGS Volcano Hazards Program provided an implementation "blueprint" for NVEWS via the NVEWS 5-Year Management Plan, which was provided to Congress in March 2020.
- The Geomagnetism Program is working toward completion of a magnetotelluric (MT) survey across the southern third of the lower 48 States, carrying out requirements established by the National Space Weather Strategy and Action Plan and Executive Order 13865 for Coordinating National Resilience to Electromagnetic Pulses. The target completion date is currently 2024.
- Due to funding increases provided by Congress since 2016 to upgrade sensors, the Global Seismographic Network is realizing significant improvements in data quality. These improvements have allowed better characterization of seismic signals across a very large range of frequencies, including great subduction zone earthquakes (e.g., Japan, Alaska), moderate crustal earthquakes (e.g., California), and smaller natural and manmade events.
- By the end of 2020, the Landslide Hazards Program (LHP) had delivered rapid estimates of debris-flow potential and size for 78 major wildfires covering more than 6.5 million acres in 11 Western States to Interior, the U.S. Forest Service, the National Weather Service, State Burned Area Emergency Response teams, and local emergency management.
- Coastal/Marine Hazards and Resources Program (CMHRP) developed a methodology using Landsat 8 satellite imagery of the coastal wetlands of in the United States that enables DOI and State managers to get broad assessments of the most vulnerable marshes without requiring intensive site-specific studies. The methodology was based on data that showed the ratio of unvegetated to vegetated area (UVVR) within a coastal marsh is a reliable indicator of marsh vulnerability.
- As the Federal provider of research expertise on marine geology and geologic processes, the CMHRP completed analyses required by the Extended Continental Shelf (ECS) Task Force to determine the limits of the U.S. ECS under international law.
- The CMHRP provided technical leadership for a collaborative program, with the National Science Foundation and NOAA, to map geologic hazard indicators on and below the seafloor off the Pacific Northwest coast.

For additional information about these programs, please visit the USGS website (www.usgs.gov).

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Natural Hazards
Earthquake Hazards Program

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Earthquake Hazards Program	**84,903**	**85,403**	**1,234**	**0**	**6,000**	**92,637**
Subduction Zone Science	*3,500*	*2,700*	*0*	*0*	*2,000*	*4,700*
Induced Seismicity	*1,100*	*1,100*	*0*	*0*	*2,000*	*3,100*
Modernization/Hardening of Infrastructure in Support of Earthquake Analysis	*2,000*	*2,000*	*0*	*0*	*2,000*	*4,000*
FTE	***253***	***253***	***0***	***0***	***14***	***267***

2022 Program Changes

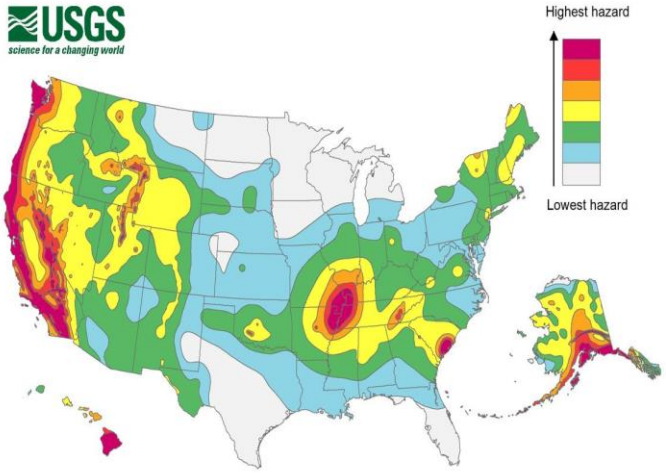
The 2022 budget request for the Earthquake Hazards Program is $92,637,000 and 267 FTE, a program change of $6,000,000 and 14 FTE from the 2021 Enacted budget.

Subduction Zone Science (+$2,000,000 / +4 FTE) – The USGS would conduct enhanced hazard forecasts and risk assessments in subduction zones, including continued research and development of earthquake early warning in the Pacific Northwest. The most powerful earthquakes occur in subduction zones, where two plates collide, and one is thrust over another. Subduction zones (e.g., Cascadia, Alaska, and the Caribbean) generate the largest earthquakes and are prone to cascading hazards, such as Tsunamis. Yet for all of the risk, they remain poorly understood because much of their extent lies offshore. This funding would improve understanding of subduction zone processes which would improve the speed and accuracy of offshore earthquake characterization and expand targeted scientific information to support community resilience and emergency response, thereby reducing risk to communities. Work undertaken with the increased funds would include new seafloor geodetic monitoring to detect the build-up of stresses that lead to future earthquakes; seafloor and lake paleoseismology to locate dangerous faults and determine how often large earthquakes recur; and improved urban seismic hazard mapping to support building design codes, prioritized retrofitting, and risk-conscious urban planning. In partnership with west coast universities and State agencies, efforts would also involve studies of new and innovative approaches to improving the speed and accuracy of earthquake characterization in earthquake early warning via the ShakeAlert system.

Induced Seismicity (+$2,000,000 / +6 FTE) – The Induced Seismicity Project would be expanded to assess increased seismic hazard (earthquakes) associated with clean energy, including geothermal energy and carbon sequestration. Work undertaken as part of this effort includes significant expansion of current induced seismicity projects, which are mostly focused on the impacts of oil and gas production. New research would focus on the effects of geothermal production and injection (including Enhanced Geothermal Systems) and carbon sequestration on induced earthquakes and Earth surface changes, and

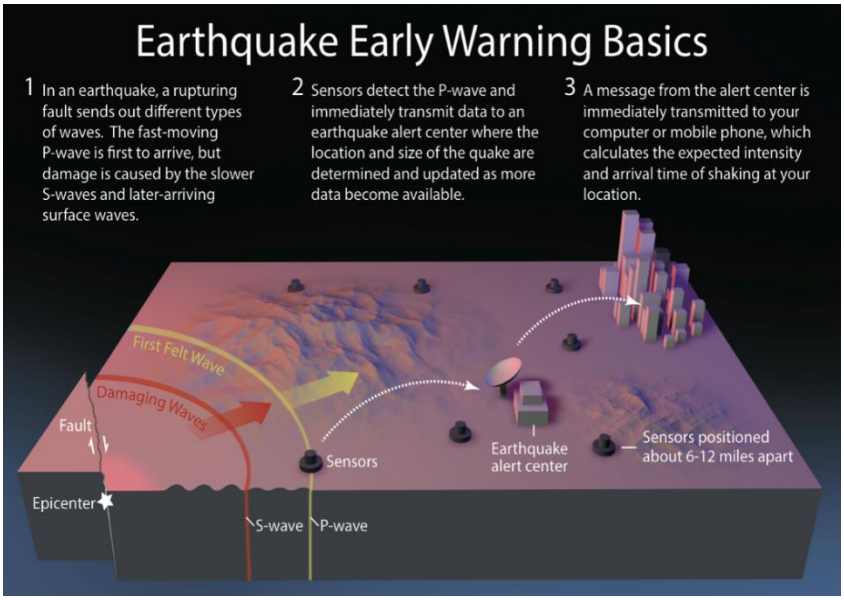
involves partnerships with the Department of Energy, State geological surveys, and universities. Funding would also support development of continuously refined hazard maps associated with induced seismicity, which will evolve with time as new clean energy facilities are developed, operated, and monitored over the long term. This project would complement a request of $3,500,000 included in the Energy Resources Program for **"**Geophysical Data Acquisition in Areas with Potential for Geologic Carbon Sequestration".

Modernization/Hardening of IT Infrastructure in Support of Earthquake Analysis (+$2,000,000/ +4 FTE) – The USGS would modernize and harden IT infrastructure to ensure robust delivery of enhanced multi-hazards products such as ShakeMap and PAGER to decision makers, emergency managers, and the general public for risk mitigation, disaster planning, and situational awareness following major disasters. The USGS provides critical and rapid information to decision makers through some of the most heavily trafficked Web pages in the Federal Government. This funding would ensure national interests are supported by a robust, modern, cloud-based infrastructure.



National Seismic Hazard Map of the United States with colored gradients shown in areas that represent earthquake risk from highest to lowest. Source: USGS.

Work undertaken would focus on cloud-based infrastructure supporting data delivery and use of artificial intelligence and machine learning for earthquake detection. Currently, highly complex computational systems which manage data flow, processing, and product delivery, are being reconfigured around a cloud-based operational environment. This requested funding will accelerate these system reconfiguration efforts. Additionally, this requested funding will allow work to begin on streamlining national seismic monitoring systems to keep pace with modern research and innovation, including further incorporation of artificial intelligence and machine learning capabilities into earthquake detection, characterization, and alerting capacities.



Graphic displaying the basics of earthquake early warning by showing how seismic waves travel to sensors, seismic sensors send data to an alert center, and the alert is then transmitted to the population through cell phones and computers. Source: USGS.

Program Overview

Nearly half of the U.S. population is at risk from earthquakes and annualized earthquake losses to the United States infrastructure are estimated at $6.1 billion per year. The USGS provides the scientific information, situational awareness, and knowledge necessary to reduce deaths, injuries, and economic losses from earthquakes and earthquake-induced tsunamis, landslides, and soil liquefaction.

The USGS Earthquake Hazards Program (EHP) is the applied Earth science component of the four-Agency National Earthquake Hazards Reduction Program (NEHRP, reauthorized by the National Earthquake Hazards Reduction Program Reauthorization Act of 2018, P.L. 115-307). Through NEHRP, the USGS partners with the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the National Institute of Standards and Technology (NIST) to reduce earthquake losses in the United States. To effect loss reduction, the EHP supports a highly coordinated set of monitoring, hazards assessment, applied research, and risk translation and communication activities in at-risk regions nationwide. Through the National Earthquake Information Center (NEIC), the USGS is the only U.S. agency that continuously reports on current domestic and worldwide earthquake activity. Through the Advanced National Seismic System (ANSS), the USGS and its State and university partners monitor and report on earthquakes nationwide. Through the USGS National Seismic Hazard Model, the EHP provides the basis for seismic provisions in the Nation's building codes, which affect one trillion dollars' worth of new construction annually in the United States. The USGS also issues timely aftershock forecasts following potentially damaging earthquakes within the United States and its Territories and provides aftershock forecasts following significant global earthquakes when called upon by other Federal agencies or international partners.

The USGS will continue, in cooperation with States and other partners, to finalize build out, operate, and maintain the *ShakeAlert* system based on the *ShakeAlert* Earthquake Early Warning Technical Implementation Plan for the west coast, which was revised in 2018.

The EHP provides universities, State geological surveys, and private institutions with earthquake hazards applied research grants and cooperative agreements. In recent years, more than 40 entities have been the recipients of approximately $20 million of funding that supports earthquake research in high-risk areas nationwide, contributes to the maintenance and operation of the ANSS, and supports the *ShakeAlert* west coast earthquake early warning system.

***ShakeAlert* – Earthquake Early Warning**

The EHP, along with Federal and State partners and other organizations, has developed an earthquake early warning (EEW) system called *ShakeAlert* to serve the public in the highest risk areas of the United States: namely, California, Oregon, and Washington. The purpose of the system is to reduce the impact of earthquakes and save lives and property by providing alerts that are transmitted to the public via mass notification technologies and to institutional users and commercial service providers to trigger automated protective actions. Statewide roll out of *ShakeAlert* public alerting took place in California in October 2019, in Oregon in March 2021, and in Washington in May 2021, with alerts being distributed through the FEMA Wireless Emergency Alert system and multiple mobile apps. Sustained EHP efforts to support *ShakeAlert* development have been provided for in appropriations, including $25.7 million in FY 2021. With continued funding, the effort will focus on continued *ShakeAlert* system build out, operations, and maintenance based on the *ShakeAlert* Earthquake Early Warning Technical Implementation Plan for the west coast, which was revised in 2018.

Natural Hazards
Volcano Hazards Program

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Volcano Hazards Program	**30,266**	**30,266**	**766**	**0**	**2,500**	**33,532**
Next Generation Volcanic Hazard Assessments	*520*	*520*	*0*	*0*	*1,000*	*1,520*
National Volcano Early Warning System: National Volcano Center Improvements	*300*	*300*	*0*	*0*	*1,500*	*1,800*
FTE	***157***	***157***	***0***	***0***	***9***	***166***

2022 Program Changes

The 2022 budget request for the Volcano Hazards Program (VHP) is $33,532,000 and 166 FTE, a program change of $2,500,000 and 9 FTE from the 2021 Enacted budget.

Next Generation Volcanic Hazard Assessments (+$1,000,000 / +6 FTE) – The USGS would accelerate work already begun and would to improve the characterization of two active volcanic systems that are current or potential geothermal resources and that pose potential threats to surrounding communities: Clear Lake Volcanic Field and Sonoma Volcanic Field in California; and Makushin Volcano, Alaska. Both of these volcanoes lie under heavily travelled air traffic routes; therefore, the Federal Aviation Administration and the National Weather Service Volcanic Ash Advisory Centers, and the Department of Defense (particularly the U.S. Air Force 557th Weather Wing) would also benefit from these assessments would benefit.

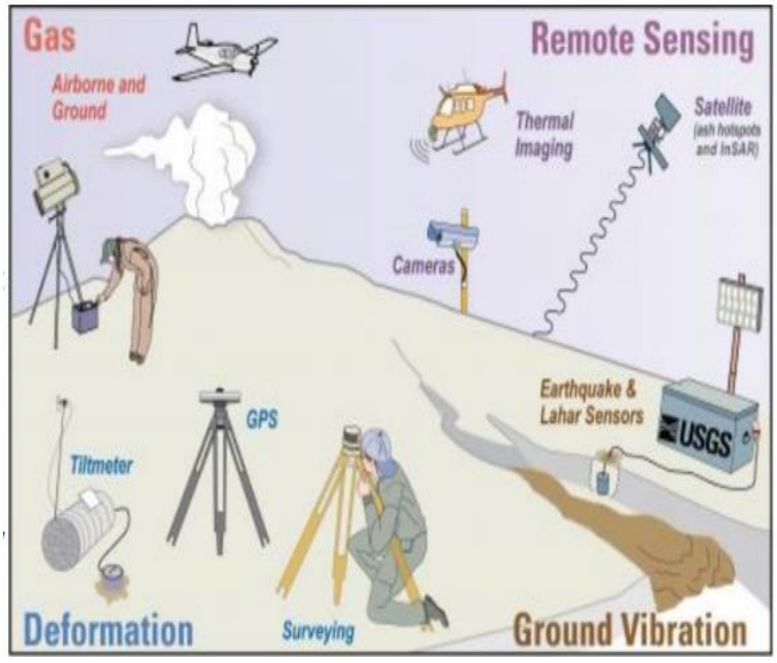
Makushin has been targeted for geothermal exploration since 1981, and the location is currently being planned for clean energy development. The volcano is also near Dutch Harbor, Alaska, one of the world's busiest fishing ports. Clear Lake Volcanic Field is home to the Geysers Geothermal Field that generates 22 percent of California's renewable power. The project would generate data to aid in constructing accurate eruption histories and characterization of the internal structures beneath the volcanic centers. This work is important to address volcanic hazards for optimal siting of critical energy infrastructure or protecting other existing critical infrastructure. Hazard assessments are delivered to end users as a portfolio of products that delineate hazard zones as well as ash fall. These assessments identify the vulnerability of nearby populations and critical infrastructure to volcano hazards. The next generation volcanic hazard assessments delivered at the end of five years would ensure that all volcanic hazards and their respective impact zones are clearly delineated; critical geothermal infrastructure is adequately protected with a monitoring network; and potential geothermal development is sited out of high hazard zones.

National Volcano Early Warning System: National Volcano Data Center Improvements +($1,500,000 / +3 FTE) – A National Volcano Data Center (NVDC) is a key component of the National Volcano Early Warning System (NVEWS). The investment in the NVDC would build a modern and scalable cloud-based processing, analysis, and storage capability. These capabilities would create a fully functioning NVDC with a capacity to accommodate anticipated growth of volcano monitoring data over the next 5-10 years. The USGS would establish the NVDC component called for in Public Law 116-9 that authorized the establishment of the NVEWS. The NVDC is critical to merging the U.S. volcano observatories into an integrated, interoperable system. The majority of the work would be done at the Volcano Science Center in Anchorage, AK, but would also involve the four other volcano observatories. USGS volcano observatories will need an easily accessible and cloud-hosted capability to analyze, store, and disseminate real time and near real time data from multiple types of ground sensors in addition to satellite based remote sensing imagery.

Beneficiaries of an improved NVDC include land managing agencies in Interior including the National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service as well as other Federal agencies, State geological surveys, State and local emergency response agencies, and Civil Defense Offices.

Program Overview

Volcanic eruptions are among the most destructive phenomena of nature and can have significant social and economic impacts. However, volcanic eruptions are usually predictable well in advance of their occurrence if adequate in-ground instrumentation is in place that can provide the time needed to avoid loss of life and reduce other effects. The USGS VHP monitors and studies active and potentially active volcanoes, assesses their hazards, and conducts research on how volcanoes work so that the USGS can issue timely warnings of potential volcanic hazards to emergency management professionals and the public. In addition to collecting and interpreting scientific information, the program works to effectively communicate its scientific findings and volcanic activity alerts to authorities and the public. These warnings and forecasts enable the public to take appropriate actions to mitigate the risk to life and property. The VHP has evaluated all the Nation's volcanoes to determine the monitoring levels needed commensurate with the threat they pose. This national threat level assessment was first completed in 2005 and was updated in 2018, based



Different volcano monitoring types and methods employed by the USGS. Source: USGS.

on new data. The USGS and affiliated partners used this threat assessment to design a national-scale plan—the National Volcano Early Warning System (NVEWS) Implementation Plan—to improve monitoring networks so that unrest can be detected at the earliest stages using in-ground monitoring instrumentation deployed on the Nation's most threatening volcanoes. The NVEWS Implementation Plan also includes a prioritization of scientific investigations and other planned work. A congressional report on the NVEWS 5-Year implementation plan has been delivered to Congress in March 2020.

The VHP is built upon a structure of five volcano observatories that organize the Nation's volcanoes into distinct areas of responsibility:

- Hawaiian Volcano Observatory – Hawaii
- Cascades Volcano Observatory – Idaho, Oregon, and Washington
- Alaska Volcano Observatory – Alaska and the Commonwealth of the Northern Mariana Islands
- California Volcano Observatory – California and Nevada
- Yellowstone Volcano Observatory – Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming

Lahar Detection on Mount Rainier

If a large lahar, a mixture of water and rock fragments that flows down the slopes of a volcano, were to occur on Mount Rainier, models indicate it would take the lahar approximately 20-30 minutes to reach the nearest community, Ashford; approximately 10 minutes to reach Mount Rainier National Park's Nisqually Entrance; and approximately 50-60 minutes to reach the nearest large community of Orting on the Puyallup River side of Mount Rainier. A lahar detection system to serve the public in areas in proximity to Mount Rainier is currently in development by the USGS, which will enable detection of a large lahar within minutes. First, the system will detect a landslide, which will signal monitoring instruments that will trigger alerts within seconds. The current goal is to provide emergency managers with confirmation of a lahar impacting their communities within 3-5 minutes of detection. State and county emergency managers would then activate alarm systems for the communities at risk. USGS is placing sensors at strategic locations along the Puyallup, Nisqually, and Carbon River and lahar detection instruments will likely be installed in the Cowlitz and White River drainages in FY 2022 (permits pending). The target date for completing the system is October 2022, if weather and site permitting timelines allow. Sustained VHP efforts to support the lahar detection efforts on Mount Rainier have been provided for in annual congressional appropriations, with $4.1 million provided for the effort in FY 2021.

Each observatory is responsible for volcano monitoring, community preparedness (including development and regular practice of volcano hazard emergency response plans), managing volcanic crises, and coordinating research in their areas of responsibility.

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Natural Hazards
Landslide Hazards Program

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Landslide Hazards Program	**4,038**	**8,038**	**141**	**0**	**3,000**	**11,179**
Actionable Landslide Hazard Data and Science	*0*	*0*	*0*	*0*	*3,000*	*3,000*
FTE	***21***	***29***	***0***	***0***	***6***	**35**

2022 Program Changes

The 2022 budget request for the Landslide Hazards Program is $11,179,000 and 35 FTE, a program change of $3,000,000 and 6 FTE from the 2021 Enacted budget.

Actionable Landslide Hazard Data and Science (+$3,000,000 / +6 FTE) – Increasing wildfire severity and extent (megafires), along with growing population and changing land-use and land cover, increase the risk from post-fire debris flows and flooding. Shifting precipitation patterns also drive consequent changes in landslide frequency and distribution. The USGS would develop and deliver actionable landslide hazard and risk modeling for vulnerable populations and high-risk settings with an emphasis on areas recently burned by wildfire. The request would build on advances in landslide hazard assessment and data collection in recent appropriations, including supplemental appropriations. Data collection and research efforts would be targeted toward reducing uncertainty in hazard and risk forecasts over timescales ranging from weeks to decades. The USGS would also begin meeting requirements set out in Public Law 116-323 (National Landslide Preparedness Act) to develop and maintain Federal capacity to deploy scientists and assets to assist emergency response to landslide events.

A sustained increase in capacity to deliver enhanced landslide hazard and risk assessments, and to provide situational awareness and technical assistance to emergency response would support Interior, the U.S. Forest Service, the Federal Emergency Management Agency, State geological surveys, and State and emergency management. Work would be conducted in partnership with technical expertise from State, academic, and private sectors and data and products would benefit land and emergency managers at all levels as well as the general public across the western United States and other States and Territories with landslide risk.

Program Overview

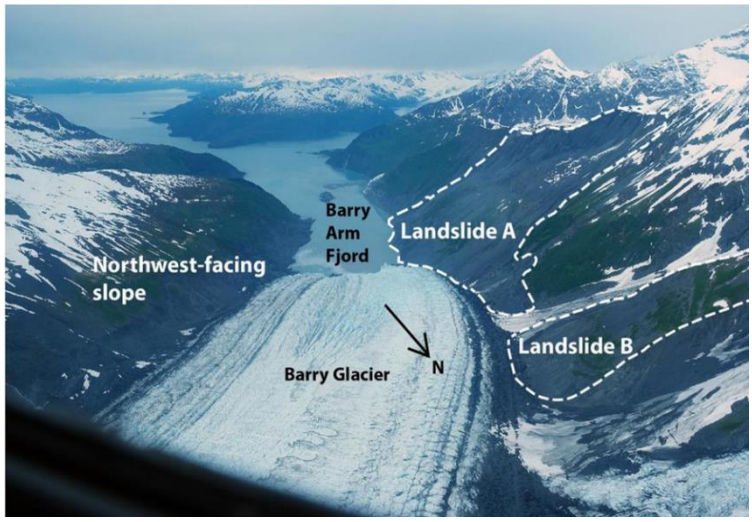
Landslides occur in all 50 States and many Territories, and where landslides impact human activities, lives may be lost and property and infrastructure damaged. Widespread landslides can accompany big storms or

earthquakes, impacting broad areas and hindering rescue and recovery efforts. In 2017, Hurricane Maria generated more than 70,000 landslides across Puerto Rico, impacting transportation and other lifelines, hampering response, recovery, and rebuilding.

Landslide-Generated Tsunami Potential in Prince William Sound, Alaska

Large, rapidly moving landslides can generate a destructive local tsunami if they occur on steep slopes above fjords or other water bodies. Unstable slopes at the terminus of the retreating Barry Glacier in Prince William Sound have been identified and the concern raised they could fail rapidly and generate a local tsunami that could impact marine and recreational interests and local communities. The USGS is working with the U.S. Forest Service, the NOAA Tsunami Warning Center, and the Alaska Division of Geological and Geophysical Surveys to understand the current movement state of the Barry Arm slides and movement patterns. The behavior of large bedrock landslides, even those extensively monitored, is extremely difficult to predict. Data collection and scientific analyses are needed to assess landslide and tsunami potential. Efforts are focused on using satellite and aerial imagery to obtain movement history and to inform a monitoring and hazard assessment strategy. The three-year effort will evaluate the catastrophic failure potential of a Barry Arm Landslide and a broader assessment of landslides in Prince William Sound, providing a public service, particularly to the local community of Whittier and the tribal, marine, and recreation interests in the region. Funding to support this effort has been provided for in annual congressional appropriations, with $4.0 million provided in FY 2021.

The USGS Landslide Hazards Program (LHP) is the only Federal program dedicated to landslide hazard science and conducts targeted studies to understand landslide initiation and mobility processes. This understanding is used to (1) develop methods and models for landslide hazard assessment, (2) develop and deploy systems to monitor threatening landslides, and (3) to develop methods and tools for landslide early warning and situational awareness. Program activities are targeted toward the types of landslides that result in human and economic losses in the United States, such as those with long travel distances, those initiated by heavy rainfall, and those exacerbated by the effects of wildfire. The USGS assists Federal, State, and local agencies through landslide site evaluations and provides strategies for reducing ongoing and future impacts from landslides. The LHP deploys near-real-time monitoring systems at active landslide sites to gather continuous movement, rainfall, and hydrologic data needed to understand the mechanisms of landslide occurrence and mobility and forecast future behavior. Such data and understanding form the scientific underpinnings for early warning of conditions that may trigger landslides.



The USGS is working with Federal and State partners to assess the risk of a catastrophic landslide and tsunami at the terminus of a retreating glacier in Prince William Sound, Alaska. This photo shows the Barry Arm Fjord of Prince William Sound, the area of potential landslides outlined, and the retreating Barry glacier in the middle foreground. Photo taken by Gabe Wolken, June 2020 Source: Public domain

The LHP began cooperative work with the National Weather Service in 2005, to deliver alerts for debris flows from recently burned areas in southern California. This limited-scale project has provided essential guidance to emergency and land managers for many burned areas in the region, including the 2017 Thomas Fire in California, Eagle Creek Fire in Oregon in 2018, and the major fires on the California central coast and in the Pacific Northwest in 2020. The Landslide Program and National Weather Service will continue to build on recent scientific advances to expand the project to other parts of California and the Western United States to meet the intent in the National Landslide Preparedness Act. The LHP is also leading efforts with Federal and State partners, to collect data and conduct analyses to assess the hazard from landslides with the potential to generate tsunami in Prince William Sound, AK. The LHP is surveilling landslide movement of the unstable slopes at the terminus of the Barry Glacier using satellite radar and other methods to inform the National Tsunami Warning Center and land and emergency managers of potential hazards.

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Natural Hazards
Global Seismographic Network Program

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Global Seismographic Network Program	**7,153**	**7,153**	**59**	**0**	***0***	**7,212**
FTE	***12***	***12***	***0***	***0***	***0***	***12***

2022 Program Changes

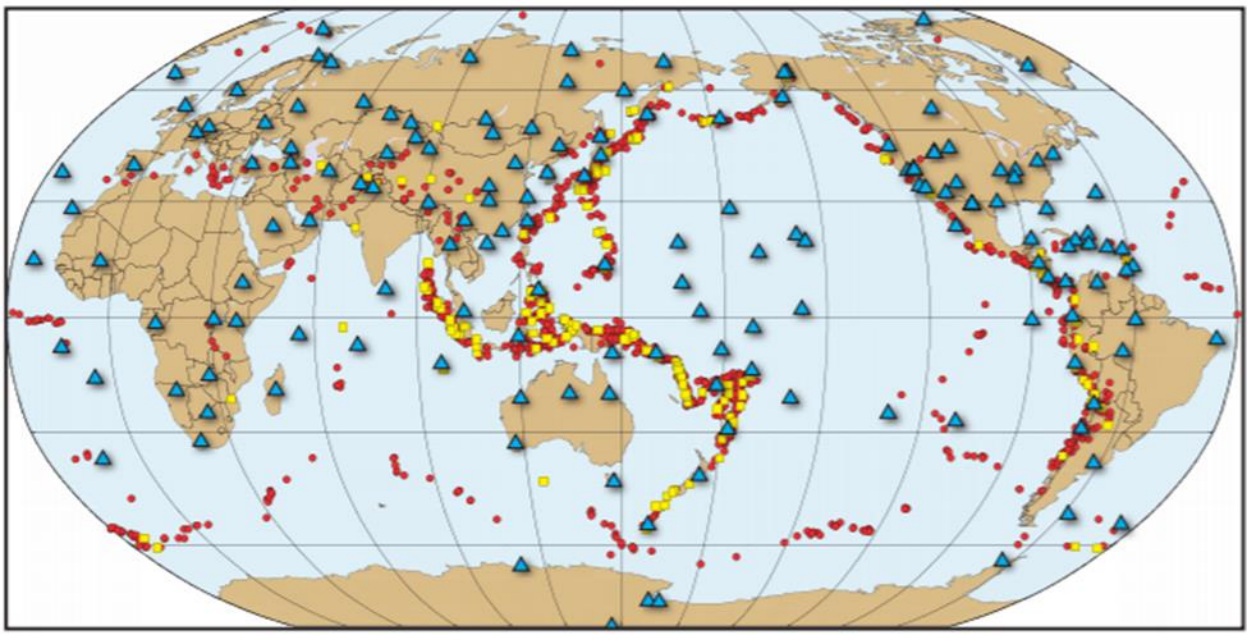
The 2022 budget request for the Global Seismographic Network (GSN) is $7,212,000 and 12 FTE, level with the FY 2021 Enacted budget.

Program Overview

The Global Seismographic Network (GSN) consists of more than 150 globally distributed stations, 100 of which are operated by the USGS. The GSN is a partnership between the USGS and the National Science Foundation (NSF) and is implemented in partnership with the Incorporated Research Institutions for Seismology (IRIS) university consortium and many other entities. It provides the high-quality seismic data needed for global earthquake alerts and situational awareness products, tsunami warnings, national security (through nuclear test treaty monitoring and research), seismic hazard assessments and earthquake loss reduction, as well as research on earthquake sources and the structure and dynamics of the Earth.

Because of its real-time data delivery, the GSN is a critical element of USGS hazard alerting activities, as well as supporting activities of other Federal agencies, including the National Oceanic and Atmospheric Administration tsunami warning; NSF basic research; and the Department of Energy and the Department of Defense nuclear test treaty monitoring and research. GSN stations transmit real-time data continuously to the USGS National Earthquake Information Center in Golden, CO, where they are used to rapidly determine the locations, depths, magnitudes, and other parameters of earthquakes worldwide, in conjunction with data from other networks. GSN data allows for the rapid determination of the location and orientation of the fault that caused the earthquake and provides an estimate of the length of the fault that ruptured during the earthquake, which are both essential for modeling earthquake effects. An additional important aspect of GSN activities is evaluating, developing, and advancing new technologies for seismic instrumentation, sensor installation, and seismic data acquisition and management.

GSN operation is accomplished in cooperation with international partners who, in most cases, provide facilities to shelter the instruments and personnel to oversee the security and operation of each station. USGS responsibilities include station maintenance and upgrades, overseeing telecommunications, troubleshooting problems and providing major repairs, conducting routine service visits, training station



GSN stations (triangles) are shown against a backdrop of large earthquakes from 2000 to 2010 (red circles – magnitude 6-6.9, yellow squares – magnitude 7 and larger earthquakes). Source: USGS

operators, providing limited financial aid in support of station operations at sites lacking a host organization, and ensuring data quality and completeness.

In order to continue to receive high-quality seismic data needed, the USGS and the Incorporated Research Institutions for Seismology have recently installed new high-quality Very Broad Band (VBB) seismic sensors and have been improving the physical infrastructure of select GSN sites.

Natural Hazards
Geomagnetism Program

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Geomagnetism Program	**4,000**	**4,114**	**59**	**0**	**1,500**	**5,673**
Expansion of Magnetometer Observatories	*2,274*	*2,388*	*0*	*0*	*1,500*	*3,888*
FTE	***12***	***12***	***0***	***0***	***2***	***14***

2022 Program Changes

The 2022 budget request for the Geomagnetism Program is $5,673,000 and 14 FTE, a program change of $1,500,000 and 2 FTE from the 2021 Enacted budget.

Expansion of Magnetometer Observatories (+$1,500,000 / +2 FTE) - The USGS would enhance monitoring and evaluation of space-weather hazards via a significant expansion of operational ground-based magnetometer stations. In coordination with the NOAA Space Weather Prediction Center, this expansion would enable delivery of accurate geoelectric hazard maps by reducing uncertainties that are primarily associated with the limited number of current observatories. This expansion is necessary for national electric grid resilience and is responsive to the interagency Space Weather Action Plan, which calls for an enhanced geomagnetic monitoring network that will deliver data to operational centers in real time. The Space Weather Action Plan is being executed by the Space Weather Operations, Research, and Mitigation Interagency Working Group, involving Interior, Department of Energy (DOE), Department of Commerce, Department of Defense (DOD), Department of Homeland Security, Department of Justice, Department of State, and Department of Transportation. Funding will begin the addition of the first of three planned new permanent observatory sites, adding to the six existing sites within the CONUS and will facilitate beginning the addition of roughly a dozen new low-cost variometer stations. As the three new observatories are completed, they will be targeted to cover regions of high hazard and fill in the geographic footprint of the current observatory network.

Program Overview

The Geomagnetism Program provides data and information on short-term and long-term variations in the strength and direction of the Earth's magnetic field, including the intensity of magnetic storms, through operation of a network of geomagnetic observatories and supporting research, and analyzes related geomagnetic hazards that threaten the economy and national security. Magnetic storms are caused by the dynamic interaction of the Earth's magnetic field with the Sun. While magnetic storms often produce beautiful aurora lights that can be seen at high latitude, they can also wreak havoc on the infrastructure and

activities of our modern, technologically based society. Large storms can induce voltage surges in electric-power grids, causing blackouts and the loss of radio communication, reduce GPS accuracy, damage satellite electronics, and affect satellite operations, enhance radiation levels for astronauts and high-altitude pilots, and interfere with directional drilling for oil and gas.

The Geomagnetism Program is part of the U.S. National Space Weather Program (NSWP), an interagency collaboration that includes programs in NASA, DOD, NOAA, the National Science Foundation (NSF), and DOE. The Geomagnetism Program provides data to the NSWP agencies, oil drilling services companies, geophysical surveying companies, and several international agencies, including INTERMAGNET, an organization with a worldwide membership drawn from institutes operating geomagnetic observatories who coordinate geomagnetic monitoring around the world. Data, products, and services from the USGS are also used by the electric-power industry to evaluate geomagnetic storm risk.

Domestically, the USGS continues to operate 14 geomagnetic observatories (six within CONUS), delivering data and working cooperatively with the NOAA Space Weather Prediction Center (SWPC), the U.S. Air Force 557th Weather Wing, and numerous other customers and Federal agencies. For example, USGS observatory data are used by NOAA's SWPC, and by the U.S. Air Force, for issuing geomagnetic warnings and forecasts. USGS geomagnetism research is conducted in collaboration with the Colorado School of Mines, the USGS Crustal Geophysics and Geochemistry Science Center, the NOAA SWPC, and the NASA Community Coordinated Modeling Center.

The USGS also works with private entities that are affected by space weather and geomagnetic activity, including electric-power grid companies and the oil and gas drilling industries. In the oil and gas industry, for example, drill operators need to know the exact direction that their drill bits are going to maximize oil production and avoid collisions with other wells. One way to accomplish this is to install a magnetometer—a sort of modern-day "compass"—in a drill-string instrument package that follows the drill bit. Simultaneous measurements of the magnetic field in the drill hole are combined with those monitored by the USGS to produce a highly accurate estimate of the drill bit position and direction.

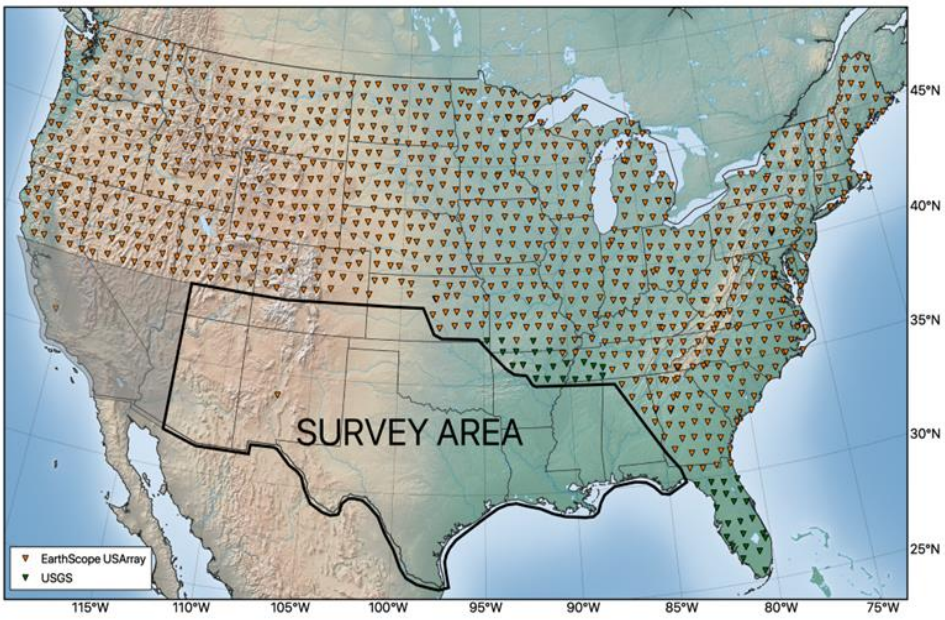
The USGS works with NOAA SWPC to produce hazard maps of the induced electric field in the crust due to geomagnetic storms. This work is part of a National Science and Technology Council's interagency working group for coordinating Space Weather Operations Research and Mitigation (SWORM). These results, targeted for real time production in the near future, will help power-grid companies improve the resilience of their systems to magnetic storms, as required by the Federal Energy Regulatory Commission. Power grid operators will use these results to design mitigation strategies for geomagnetic storms, and the

Magnetotelluric (MT) survey

The USGS Geomagnetism Program is completing a magnetotelluric (MT) survey across the southern third of the lower 48 States, carrying out requirements established by the National Space Weather Strategy and Action Plan and Executive Order 13865 for Coordinating National Resilience to Electromagnetic Pulses. The survey will provide a public service by conducting electromagnetic pulse vulnerability assessments, which will be used to protect critical national infrastructure from geomagnetic events. The survey is being executed through a cooperative agreement with Oregon State University, which began in April 2020, and is now in its second year, with an estimated completion date of 2024. Sustained efforts on the MT survey have been provided for in annual congressional appropriations, with $1.7 million provided for the effort in FY 2021.

space weather alerting agencies will use the resulting electric field model to issue improved forecasts and nowcasts for space weather alerts.

The Geomagnetism Program will continue the magnetotelluric (MT) survey of the United States to improve U.S. electrical grid resilience, improve forecast models for geomagnetic storms, and aid in mineral resource assessments. Collection of MT data on a national scale is a basis for modeling the Earth's electric field, used to assess the impact of electrical storms. This survey is responsive to priorities established in the National Space Weather Strategy, as well as related international initiatives for pursuing induction hazard research. This broad collaboration includes scientists from NASA, NOAA, the Institute for Defense Analyses, the Federal Energy Regulatory Commission, the Federal Emergency Management Agency, and the NSF.



Map of the United States showing the area of the country undergoing a magnetotelluric (MT) survey by the USGS Geomagnetism Program. Source: USGS.

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Natural Hazards
Coastal/Marine Hazards and Resources Program

Natural Hazards $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Coastal/Marine Hazards and Resources Program	**40,510**	**40,510**	**1,005**	**0**	**16,000**	**57,515**
Coastal Hazards	*10,674*	*10,674*	*0*	*0*	*10,000*	*20,674*
Coastal Blue Carbon	*1,000*	*1,000*	*0*	*0*	*4,000*	*5,000*
Risk Reduction and Community Resilience	*800*	*800*	*0*	*0*	*2,000*	*2,800*
FTE	***206***	***206***	***0***	***0***	***28***	***234***

2022 Program Changes

The 2022 budget request for the Coastal/Marine Hazards and Resources Program is $57,515,000 and 234 FTE, a program change of $16,000,000 and 28 FTE.

Coastal Hazards (+$10,000,000 / +15 FTE) – The USGS would accelerate implementation of a national coastal change hazards strategy to develop and deliver understanding, modeling and forecasting of the coastal response to climate change, natural processes, and management actions across diverse landscapes and communities. Models of the response of natural landscapes, resources, and infrastructure to coastal inundation and erosion form future storms and sea-level rise would enable coastal land and resource managers to evaluate the sustained benefits of alternative adaptation and restoration strategies in increasing resilience and reducing risk. This would enable co-development of science and applications to meet site- and decision-specific requirements of resource managers (i.e., U.S. Fish and Wildlife Service and National Park Service), installation operators (i.e., Department of Defense) and designers and developers of nature-based solutions (i.e., U.S. Army Corps of Engineers, States) to reduce risk, enhance resilience and pursue adaptation strategies in a variety of coastal settings. The USGS would also support development and application of observational (land cover/elevation characterization and change) and modeling capacities required to deliver actionable forecasts at regional and national scales. Furthermore, the USGS would increase the technical and operational capacities required to sustain rapid translation of new knowledge and methods to application by diverse users. The USGS would implement a strategy for multidisciplinary risk science and applications related to coastal change, including capacities to effectively engage stakeholders in coastal change hazards product design and evaluation. As a result of these investments, coastal resource and emergency managers would have the ability to anticipate the consequences of climate change, future storms, and coastal policies and projects on public safety, infrastructure performance, and community and ecosystem health and resilience.

Coastal Blue Carbon (+$4,000,000 / +8 FTE) – Coastal marshes and wetland sediments are a natural sink for atmospheric carbon, with the rates of carbon capture dependent on the extent, health, and expansion of the marsh complex. The USGS would increase national and local scale evaluations of carbon sequestration potential in coastal salt marsh, mangrove, and associated environments. This includes field observations, development of new models leading to improved assessments and forecasts, and geospatial products to support decisions and policy within land management agencies. The USGS would quantify the consequences of management decisions in terms of enhanced carbon sequestration and reduced wetland methane emissions and integrate emissions benefits into tools to forecast the trajectories of natural, managed, and restored wetlands. This will allow marsh restoration and management decisions to include evaluation of carbon capture and emission reduction values in the prioritization and planning of coastal ecosystem protection and restoration projects. With an initial focus on the almost 1.2 million acres of wetlands and impoundments in FWS refuges, and the approximately 3.2 million acres of wetlands managed by the NPS; the USGS and partners would develop and deliver tools that enable stakeholders to quantify and compare long-term benefits of alternative management strategies in terms of varied restoration, conservation, and risk reduction objectives, including reductions in greenhouse gas emissions.

Risk Reduction and Community Resilience - (+$2,000,000 / +5 FTE) – The USGS risk reduction and community resilience strategic initiative would be significantly expanded to include new capabilities for improving the delivery of hazards information to reduce multi-hazard risk to multiple stakeholders, including underserved communities. In the past, this initiative has supported both Natural Hazards Mission Area (NHMA) programs and those outside the NHMA to carry out the USGS hazards mission. The USGS would strengthen capacity for: conducting collaborative and participatory research; designing research informed by local and traditional knowledge; increasing expertise in addressing the disproportionate impacts of hazards on Native Americans and other underserved communities; and advancing our ability to deliver hazards information in understandable, meaningful, and actionable formats. Specifically, requested funding would strengthen critical personnel capacities in **s**ocial science, equity, risk communication, and monitoring and evaluation. The new personnel would support USGS scientists in strategically identifying stakeholders, building partner coalitions, facilitating stakeholder meetings, and collaborating with underserved communities. In addition, at the requested level, a Hazards, Risk, and Social Equity Internship Program would be established for undergraduate and graduate students. This program will focus on developing USGS hazard research and applications to meet the needs of underserved communities. An example of this are decision making applications created to improve Departmental planning for hazard threats to assets, resources, and people. In addition, this program would create a career pipeline for Science, Technology, Engineering, Arts, and Mathematics (STEAM) students working on hazards risk reduction and improving community resilience. By leveraging existing USGS partnerships with universities and academic research centers, and forging new partnerships with minority-serving institutions, an annual cohort of students would be recruited and mentored on projects focused on applying USGS science to reduce hazard risks at the community scale. This effort is estimated to cost $500,000 annually once established.

Program Overview

The CMHRP characterizes the hazard and resource potential of the Nation's offshore and coastal landscapes. CMHRP information and tools help public trust managers anticipate and reduce risks from natural hazards and coastal change, and to responsibly manage marine and coastal resources. As the only Federal science program focused on the geology and processes of coastal and marine landscapes, the CMHRP investigates a wide range of issues, in locations ranging from shallow waters of estuaries to the deep sea.

Screenshot from the USGS Coastal Change Hazards Portal displaying a map of the East Coast of the United States showing colored strips along the coast at the locations forecast to have potential coastal change impacts. Source: USGS

The CMHRP responds to immediate local and regional priorities across these environments, while addressing the Nation's needs for coastal and marine science-based products on a national scale. The unique capabilities and expertise of the CMHRP are applied in support of the mission objectives of Interior and other Federal, State, and local agencies; non-governmental organizations; and, ultimately, the public.

The CMHRP serves Federal, State, and local users with assessments of hazard sources (earthquakes, tsunami, submarine landslides) and their potential impacts on offshore operations, coastal communities, and infrastructure. The CMHRP characterizes marine methane systems and associated seabed processes to enhance understanding of their role in the global carbon system and marine ecological productivity and biodiversity; the risk they represent to offshore operations and infrastructure, including that associated with renewable energy; and their domestic and international potential as an energy resource.

The CMHRP contributes analyses and expertise to delineate the U.S. Extended Continental Shelf consistent with international law, an effort led by the U.S. Department of State that expands U.S. sovereignty over resources on and beneath the seafloor. The CMHRP provides unique Federal expertise on deep-sea mineral resources, including rare-earth and other critical minerals, in support of the broad natural resource mission of the USGS.

The CMHRP provides real-time forecasts of erosion and inundation due to coastal storms, including hurricanes. CMHRP long-term forecasts allow coastal communities and resource managers to anticipate the likelihood of future coastal change due to storms, erosion, and sea level rise. The CMHRP is the recognized Federal provider of tools to anticipate and respond to physical change along our Nation's coasts and the consequences of coastal change on communities, infrastructure, and resources.

Sustaining Salt Marshes for Blue Carbon Management and Coastal Protection

Tidal salt marshes provide a valuable natural means of carbon reduction and coastal protection. Absorbing 8.1 million tons of carbon dioxide in the United States each year, salt marshes provide a major component of the Nation's carbon sequestration capacity. These resources protect coastal communities by storing 1.5 million gallons of flood water in a single acre, with vegetation buffering waves to reduce flooding, erosion, and subsequent damage to property and infrastructure during storms. Expansive restoration of degraded estuarine wetlands could provide substantial carbon capture and methane emissions avoidance and strengthen coastal protection over the coming decades. Recognizing that as much as 40 percent of potential U.S. tidal wetland area is in degraded condition impairing, the CMHRP completed a national assessment of marsh vegetation and resilience, with analysis of greenhouse gas emission reductions via coastal marsh management practices. This service provides metrics for land and resource managers within the DOI, State agencies, and non-governmental organizations to track changes and trends in the extent and health of these coastal wetlands, to understand their stability and vulnerability. This product and its future applications will provide a scientific basis for managing and sustaining the 3.8 million hectares of tidal estuarine (saline) and fresh wetlands in the coterminous U.S, nearly a third of which are managed by Federal agencies.

Water Resources

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Water Resources

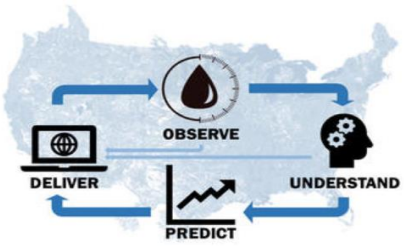
Water Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Water Availability and Use Science Program	**47,487**	**57,987**	**1,514**	**0**	**10,000**	**69,501**
Integrated Water Prediction	*0*	*9,500*	*0*	*0*	*4,000*	*13,500*
Integrated Water Availability Assessments	*5,621*	*3,725*	*0*	*0*	*6,000*	*9,725*
FTE	***331***	***401***	***0***	***0***	***67***	***468***
Groundwater and Streamflow Information Program	**84,173**	**100,673**	**1,978**	**0**	**10,000**	**112,651**
Next-Generation Water Observing System	*8,500*	*24,500*	*0*	*0*	*6,400*	*30,900*
Federal Priority Streamgages	*24,715*	*24,715*	*0*	*0*	*3,600*	*28,315*
FTE	***461***	***524***	***0***	***0***	***34***	***558***
National Water Quality Program	**92,460**	**93,460**	**1,782**	**0**	***0***	**95,242**
FTE	***466***	***472***	***0***	***0***	***0***	***472***
Water Resources Research Act Program	**10,000**	**11,000**	**0**	**0**	***0***	**11,000**
FTE	***1***	***1***	***0***	***0***	***0***	***1***
Water Resources Total	**234,120**	**263,120**	**5,274**	**0**	**20,000**	**288,394**
FTE	***1,259***	***1,398***	***0***	***0***	***101***	***1,499***

Mission Area Overview

Beginning in 1888, with the National Streamgaging Program on the Rio Grande River under the direction of John Wesley Powell, the USGS has evolved to become one of the largest providers of in situ water data in the world. The Water Resources Mission Area (WMA) works with partners to monitor, assess, conduct targeted research, and deliver information on a wide range of water resources and conditions including streamflow, groundwater, water quality, and water use and availability. These activities support an overarching science strategy to observe, understand, predict, and deliver water science to the Nation.

As the Nation looks to a more extreme climatic future, the USGS is integrating its water science activities to better address the greatest water resource challenges. Timely information and predictions on water availability can inform national and regional efforts for climate adaptation and resilience. In addition to continuing work nationwide, the USGS plans to intensively monitor and study select Integrated Water Science (IWS) basins. These IWS basins will become focus areas for bringing a complete science capability

together through multiple water science efforts including the Next Generation Water Observing System (NGWOS), Integrated Water Availability Assessments (IWAAs), and Integrated Water Prediction (IWP). Three basins have already been selected – the Delaware River Basin, the Upper Colorado River Basin, and the Illinois River Basin – and a fourth basin will be selected at the beginning of FY 2022.



The above science processes (observe, understand, predict, and deliver) are necessary for acquiring reliable and actionable information about water availability. If one is overlooked, the others are limited. For example, if observing systems are not advanced, understanding is limited as is the ability to build better models for prediction. This is why science integration is critical and why it is a priority at the USGS. Source: USGS.

IWS basins are medium-sized watersheds (10,000-20,000 square miles) that represent a wide range of environmental, hydrologic, and landscape settings and human stressors of water resources to improve understanding of water availability across the Nation. In each basin, the USGS will be developing the assessment and predictive methodologies and tools that can be expanded from the basin to the larger surrounding region and ultimately the Nation. The USGS will deploy multiple water science efforts like the NGWOS, IWAAs, and IWP to better understand and predict water challenges. For example, in the Delaware River Basin, the USGS is studying issues such as the impact of the drought of record under current water supply and demand restrictions. In the Upper Colorado River Basin, the priority issues being studied include cold-region processes of snow, ice, and frozen soils. In the Illinois River Basin, the relation between an overabundance of nutrients (primarily nitrogen and phosphorus) and associated harmful algal blooms (HABs) will be a focus of integrated water science efforts. Through integrated activities funded through three of the four WMA budget programs, the USGS will continue to serve society by providing tools that managers and policy makers can use to manage water resources so they meet both human and environmental needs.

The FY 2022 budget makes targeted investments in these integrated activities. The Water Resources Mission Area will focus on the following science priorities:

- ***Delivering IWAAs.*** These multi-extent, stakeholder-driven assessments support the delivery of the National Water Census (NWC), a near-real time census and prediction of water availability integrating water quantity, quality, and use; indicators of socioeconomic demand; and, impacts of climate-related stressors to forecast water availability for human and ecological needs. At the national level, the USGS will work to integrate predictions of water quantity and quality, along with models of water use; indicators of socioeconomic demand; and, impacts of climate-related stressors, such as drought and wildfire, to forecast water availability for human and ecological needs at daily, weekly, monthly, seasonal, and decadal time steps. Regionally, the USGS will continue IWAA activities in the Delaware and Upper Colorado River Basins, with a focus on an improved understanding of impacts related to drought and wildfire and begin a water-quality focused assessment in the Illinois River Basin, in collaboration and coordination with the NGWOS and Integrated Water Prediction programs.
- ***Advancing USGS water observing systems.*** The USGS will complete NGWOS implementation in the Upper Colorado River and Illinois River basins and will begin planning for implementing

NGWOS in a fourth basin (to be selected at the beginning of FY 2022). In addition, the USGS will continue to operate its National Streamgaging Network in cooperation with over 1,400 partners. As part of the Streamgaging Network, the USGS will support approximately 3,470 locations in the Federal Priority Streamgage Network, which provide long-term, real-time data at locations that serve strategic responsibility of various Federal agencies.

- ***Building integrated water prediction (IWP) capabilities.*** The USGS is developing a new water prediction framework that, using advanced science and technology, will integrate state-of-the-art climate, weather, water observations, and models to assess and simulate the underlying factors that limit water availability for both human and ecological uses. Using traditional observational networks, as well as targeted NGWOS data collection efforts, the USGS will evaluate and co-design data collection strategies to support model improvement and advance multi-scale modeling capabilities to conduct water availability assessments at daily, weekly, monthly, seasonal, and decadal time steps. Work will be accomplished through collaborations with Federal and local partners in addition to academia.
- ***Modernizing USGS water data infrastructure***: The National Water Information System (NWIS) is the USGS enterprise system supporting the storage, processing, and delivery of real-time and historic water data. To ensure NWIS can manage the data and new data types produced through all WMA activities into the future, integrate water data from multiple agencies and sectors, and continue to deliver data and model results to the public, funding from across the WMA programs is used to support activities to modernize NWIS IT infrastructure and data systems. In 2022, efforts will be focused on rebuilding water use databases into a single streamlined data system, building a new storage and delivery system for discrete groundwater and water-quality data, and enhancing user-centered data delivery.

Cooperative Matching Funds

Much of WMA work with partners is supported by a unique subset of funds referred to as Cooperative Matching Funds (CMF). Required by law to be matched at least 50:50 by State, local, or Tribal partners, CMF is matched by over 1,600 of these partners to monitor and assess water resources in every U.S. State, protectorate, and territory. CMF are found in three of the four budget programs: Water Availability and Use Science; Groundwater and Streamflow Information; and National Water Quality. The FY 2022 budget requests $64,529,000 for CMF across these three programs, continuing funding at the FY 2021 level.

Selected Mission Area Accomplishments

- The USGS is working to provide daily, integrated, water budget estimates for all small watersheds across the United States as part of the National Water Census. In FY 2020, an additional two water budget components were published for the continental United States (actual evapotranspiration and snowpack). These components add to the suite of available daily water budget estimates on soil moisture, groundwater recharge, precipitation, and streamflow. As each piece of the water budget is completed, a more accurate picture emerges of where and when water is available in more than 100,000 small watersheds in the United States. By making this information available nationally, the

USGS gives local and regional water managers nationally consistent information on water availability in their local area that can inform current decisions.

- The USGS advanced NGWOS in the first IWS basin – Delaware River – by adding over 200 water monitoring sites for conditions, such as streamflow, water temperature, salinity, evapotranspiration/soil moisture, and nutrients, as well as conducting synoptic surveys of salinity migration in the Delaware River and underlying aquifers. In addition, the USGS initiated NGWOS activities in the second IWS basin (Upper Colorado) by engaging with stakeholders to identify major science objectives and establishing a new snow hydrology test-bed site near Winter Park, CO. This site will improve estimates of snowpack and snowmelt dynamics, which are critical observations to support advanced predictive models of streamflow and reservoir operations in the Colorado River basin and other snowmelt dominated watersheds.
- The USGS advanced the Nation's understanding of where water-quality is changing and the potential causes for degradation or improvement. These efforts provided information on water quality trends, loads, multiple emerging constituents of concern, and the overall status of water quality in multiple regional settings. In addition, the USGS explored potential drivers of water-quality trends such as land use activities and hydrologic and climatic factors. Information was used to update web-based maps of decadal groundwater trends and water-quality trends in U.S. streams.

For additional information about these programs, please visit the USGS website (www.usgs.gov).

Water Resources
Water Availability and Use Science Program

Water Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Water Availability and Use Science Program	**47,487**	**57,987**	**1,514**	**0**	**10,000**	**69,501**
Integrated Water Prediction	*0*	*9,500*	*0*	*0*	*4,000*	*13,500*
Integrated Water Availability Assessments	*5,621*	*3,725*	*0*	*0*	*6,000*	*9,725*
TE	***331***	***401***	***0***	***0***	***67***	***468***

2022 Program Changes

The 2022 budget request for the Water Availability and Use Science Program (WAUSP) is $69,501,000 and 468 FTE, a program change of $10,000,000 and 67 FTE from the 2021 Enacted budget.

Integrated Water Availability Assessments (IWAAs) (+$6,000,000 / +40 FTE) – The USGS would expand USGS capacity to conduct IWAA activities across the USGS Integrated Water Science (IWS) basins. Regional IWAAs are planned, coordinated, and conducted with Next Generation Water Observing System (NGWOS) and Integrated Water Prediction activities in each basin and will provide enhanced assessments of the selected region's water availability that incorporate predictions and forecasts of water availability components, and the factors influencing both. Each Regional IWAA would gather and provide a common set of products to allow consistent information transfer to stakeholders and integration into National IWAA activities and products. Regional IWAAs would also have the flexibility to go beyond core requirements and prepare study designs that address regionally important science gaps that improve national assessment capacity and meet stakeholder information needs. Assessment periods for Regional IWAAs may vary, but would generally consist of three phases totaling about 10 years of activity:

- Phase 1 – Discovery and Evaluation (1-2 years)
- Phase 2 – Availability Assessment (5-years)
- Phase 3 – Operational Linkages (3-4 years)

With additional funds, the USGS would advance phase 2 IWAAs activities in the Delaware River Basin and initiate phase 2 activities in the Upper Colorado River Basin. In addition, the USGS would begin phase 1 implementation in the Illinois River Basin and engage with stakeholders in the fourth IWS basin once it is selected.

Integrated Water Prediction (IWP) (+$4,000,000 / +27 FTE) – Through the IWP, the USGS will transform hydrologic modeling software to a scale that has never been feasible before. These efforts will support water resource managers who are increasingly faced with new challenges that require tighter

integration of hydrologic models with other components of the earth system (e.g., weather, climate, ecosystems, and species). In addition, these activities will modernize the water prediction capabilities needed to fully realize the deliverables envisioned through IWAAs. In FY 2022, the USGS would design and develop an integrated hydrologic modeling software framework that will support an ecosystem of model codes that represent both natural and human system processes. The USGS would test and evaluate this framework at national, regional, and local scales in coordination with other integrated water science activities such as IWAAs. WAUSP efforts would focus on incorporating climate change and variability, land-use land-cover change, and socio-economic drivers into USGS water budget prediction. The USGS would also enhance prediction capabilities related to the water availability impacts from climate-driven extreme events such as drought, wildfire, and hurricanes for incorporation into IWAAs and the National Water Census.

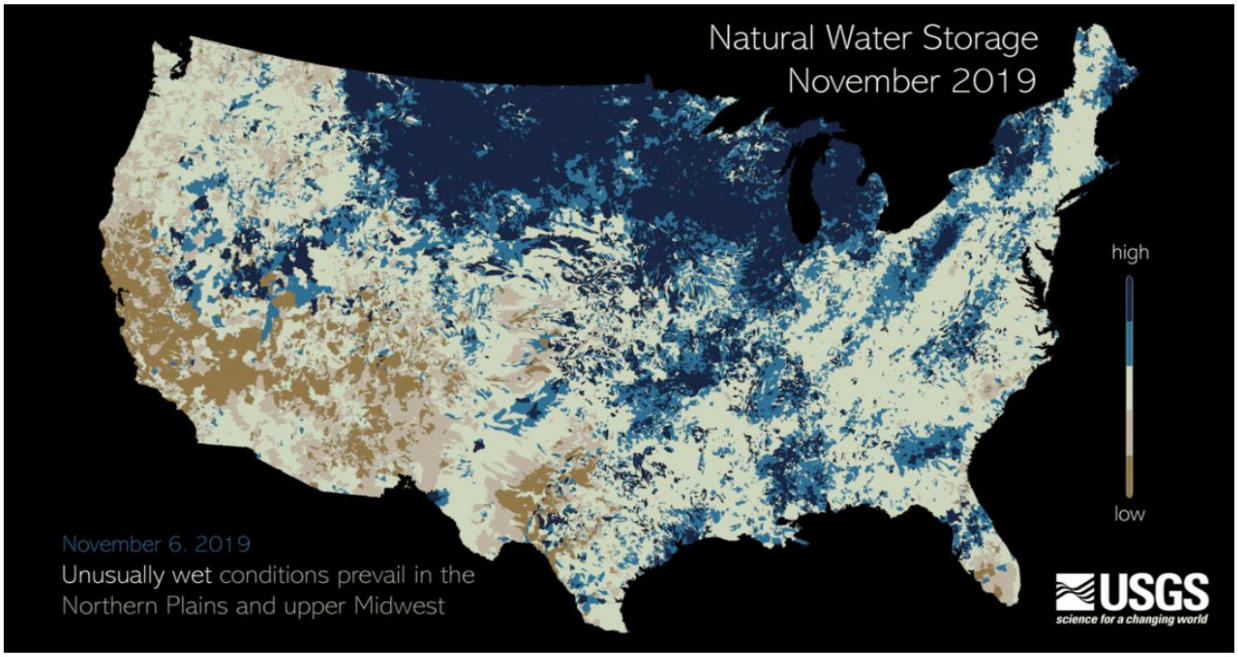
Program Overview

The Water Availability and Use Science Program (WAUSP) fulfills the goals established by Congress in the SECURE Water Act (Public Law 111-11, Section 9508) by investing in research and assessments that improve the Nation's understanding of water availability. Specifically, the WAUSP supports the National Water Census, a USGS activity designed to systematically provide information that will allow resource managers to assess the quantity, quality, and use of the Nation's water. The WAUSP focuses on conducting national and regional water availability assessments; developing methods to estimate water budgets; and evaluating trends in water availability. In addition, the WAUSP supports efforts to develop techniques to evaluate water availability, advance the models and infrastructure that support assessments, and deliver tools that resource managers can use to support resource planning.

The National Water Census (NWC)

The goal of the USGS NWC is to provide nationally consistent, well-documented information on water quantity, quality, and use that will allow resource managers to assess the Nation's water availability. The USGS supports this goal by investing in efforts to assess and provide information on the inputs, the outputs, and changes in the water budget. Furthermore, the USGS is examining the dynamic interactions and complex roles that major factors (i.e., water quality, drought, ecological flows, and water use) can have in water availability. Estimates of water budget components, as well as an understanding of how various factors can impact water availability, provide a means for the USGS to assess water availability.

Integrated Water Availability Assessments (IWAAs): Critical to the development and delivery of the NWC are multi-extent stakeholder-driven assessments, referred to as IWAAs, that will provide a near real-time census and seasonal prediction of water availability for both human and ecological uses. At a national scale, the USGS is working to deliver a web-based map that conveys daily snapshots of various water conditions and trends across the United States. The WAUSP supports this effort by developing and refining models to simulate water budget components and factors that influence water availability. The USGS is providing daily estimates for six of nine targeted water budget components: precipitation, streamflow, soil moisture, groundwater recharge, evapotranspiration, and snowpack. These water budget components will provide a foundation of data for the NWC.



The initial USGS National IWAAs concept map showing estimates of natural water storage (water present on the landscape such as standing water, snowpack, soil water, and shallow groundwater) for approximately 110,000 regions across the conterminous United States on November 6, 2019. While the demonstration map is not yet ready for decision making, it can be used as a method to understand current water storage conditions. Concept map coloring indicates either wetter (blue shading) or drier (brown shading) conditions on a given day in comparison to historical storage on that same day. Source: USGS.

IWAA activities are also at work in each of the USGS IWS basins. The USGS is developing Regional IWAAs in partnership with stakeholders to ensure they are timely and informative at the local and regional level but can also be assimilated into national-scale products. In FY 2022, Regional IWAAs will be ongoing in the Delaware River, Upper Colorado River, and Illinois River basins. In the Delaware River Basin, with the increased funding in 2022, the USGS would continue phase 2 of the Regional IWAA with a focus on understanding the impacts of drought on water availability and issues related to water temperature, salinity, and coastal hydrology (including coastal inundation). The USGS would also begin full implementation of phase 2 in the Upper Colorado River Basin with a focus on improving water resource planning with advancements to overall understanding and prediction of the processes that influence the magnitude and timing of snowmelt. In the Illinois River Basin, the USGS would begin phase 1 of the Regional IWAAs. These activities will support the design and implementation of projects aimed at better understanding how the timing, magnitude, and variation in water budget components influence water quality conditions, with a particular focus on nutrients and HABs. Finally, following the selection of the fourth Integrated Water Science basin at the beginning of FY 2022, the USGS would engage with Federal, State, local, tribal, and other regional stakeholders to identify IWAA priorities in the selected basin. While the IWS selection process would consider the major high-level science questions in play in the basin, stakeholder engagement would allow the USGS to further refine efforts to ensure activities meet local and regional needs. Moving forward, in collaboration with NGWOS and IWP efforts, Regional IWAAs will be conducted in other regions of the United States. For more information on IWAA activities, see the Program Changes section.

Water Use, Ecological Flows, and Drought: In order to fully deliver the NWC, the USGS must develop the capacity to assess and understand not only the traditional hydrologic components of the water budget but also human and ecological supply and demand. Through incorporation of research and technical evolution, the USGS is focused on model development that will improve water use reporting from 5-year annual reports (how the USGS currently reports on water use) to daily estimates modeled on a national scale with verified uncertainty. The USGS will also identify, evaluate, and predict potential ecological responses to alterations in water availability and forecast the onset, severity, and duration of hydrologic drought.

In 2022, the USGS will be working to develop water use withdrawal models for thermoelectric, irrigation, and public supply uses accounting for 90 percent of water use nationally; piloting ecological flow assessments and model development in the Upper Colorado and Illinois River Basins; and, using data-driven methods to prototype early warning of drought conditions including potential impacts to different components of water availability, including agricultural areas and ecological flows most vulnerable to drought.

Better Tools for the Public
Improving Water Use Reporting with Models

As the Nation's steward for reporting water use, the USGS has been directed by Congress to improve water use information nationally (SECURE Water Act of 2009). Traditionally, comprehensive national water use reporting has been done every 5 years by county; however, the USGS is developing an enhanced ability to observe, understand, predict, and deliver water data. The USGS has been working to provide multi-resolution daily estimates for eight categories of water use through: (1) development of data driven machine learning and physics-based modeling approaches that also provide uncertainty to the water-use estimates; (2) regular data transfers of site and system specific water withdrawals and ancillary data at a fine temporal scale; and, (3) increased use of data services enabling more frequent dissemination of water use data and resulting estimates. By the end of FY 2022, the first national water-use estimates from models, for thermoelectric, irrigation, and public supply uses, will be provided for calendar year 2020 and will provide water resource managers access to water use estimates at a spatial and temporal scale never possible before.

Model Development, Infrastructure, and Information Delivery

Integrated Water Prediction (IWP): The USGS is participating in an ambitious Federal partnership with agencies like the National Oceanic and Atmospheric Administration, Bureau of Reclamation, and the U.S. Army Corps of Engineers, to develop a new national, interagency capacity for water prediction. Working as part of this Federal community, the USGS is fostering a formalized, transparent, and adaptive governance process to integrate the modeling and computational strengths of multiple organizations.

Through identification of the science and technological needs that will serve the Nation's long-term hydrologic prediction capacity at the national, regional, watershed, and local scale, the USGS will establish the modeling framework, software architecture, and standards needed to support the robust, efficient, and sustainable development of integrated water prediction capabilities. The USGS is working through the IWP program to develop nationally consistent approaches for predicting and forecasting hydrologic conditions, changes, and outcomes for water availability. These approaches are being designed to consider water quantity, quality, and use together in an integrated water availability model framework. Advancements

from these activities will provide the tools used by IWAAs. For more information on planned IWP activities in FY 2022, see the Program Changes section.

High-Impact Hydrologic Research

Research and development are critical foundations to the effective management of the Nation's water challenges, providing a foundation for understanding how the hydrologic process works and impacts water availability. To this end, the WAUSP supports research to better understand how factors like socioeconomics and extreme events can impact water budgets, and at a broader level, water availability. Through these efforts, the USGS strives to provide water resource managers with high-impact data, tools, and information that support management decisions.

Social and Economic Drivers: The USGS is working to better understand the impacts of and interactions between socioeconomics and water availability. A comprehensive understanding of the social and economic factors that drive water demand and alter water supply is needed to assess water availability in a predictive framework. Assessments and model development will identify the economic sectors, ecosystem goods and services, and other social, cultural, and economic factors that affect, or are affected by, water availability. In 2022, the USGS will initiate activities focused on understanding the socioeconomic influence on water demand, use, and movement regionally as well as the national drivers that impact socioeconomic decision-making. These efforts will improve the ability of the NWC to forecast availability under a variety of conditions.

Water Budget Research: This research is focused on improving water availability prediction through efforts to better quantify the hydrologic cycle. Activities at a range of spatial and temporal scales aim to improve the USGS ability to evaluate all components of the water budget, including groundwater-surface water interactions, recharge, evapotranspiration, snowpack, soil moisture, and streamflow and how changes to these components impact water availability. In 2022, the USGS will work to better understand model uncertainty for each component of the hydrologic cycle and develop strategies to reduce that uncertainty with NGWOS and IWP. This includes specific activities in understanding models that assess and predict snowpack as a driver of water availability in the Upper Colorado River Basin.

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Water Resources
Groundwater and Streamflow Information Program

Water Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Groundwater and Streamflow Information Program	**84,173**	**100,673**	**1,978**	**0**	**10,000**	**112,651**
Next-Generation Water Observing System	*8,500*	*24,500*	*0*	*0*	*6,400*	*30,900*
Federal Priority Streamgages	*24,715*	*24,715*	*0*	*0*	*3,600*	*28,315*
FTE	***461***	***524***	***0***	***0***	***34***	***558***

2022 Program Changes

The 2022 request for Groundwater and Streamflow Information Program is $112,651,000 and 558 FTE, a program change of $10,000,000 and 34 FTE from the 2021 Enacted budget.

Federal Priority Streamgages (FPS) (+$3,600,000 / +11 FTE) – As designed, the FPS Network includes more than 4,700 sites identified as valuable for streamflow and related data collection to address long-term Federal needs, such as drought and flood forecasting, interstate and international water compacts and decrees, and tracking sentinel trends. In FY 2021, the USGS estimates it will have to discontinue up to 29 streamgages due to rising operational costs of the network. In FY 2022, an additional 58 streamgages will be at risk for discontinuation if we are not able to get partners to assist in covering more costs within the FPS. The requested increase would ensure the continued operation of approximately 3,470 streamgages in the FPS Network. Furthermore, the USGS would implement enhancements that increase the resiliency of the FPS network (e.g., flood-hardening sites) and ensure sites meet requirements for successful data collection and transmission (e.g., cyclical equipment upgrades for monitoring, telecommunication, and data transmission).

Next Generation Water Observing System (NGWOS) (+$6,400,000 / +23 FTE) – At this funding level, USGS would operate and maintain the fully-deployed NGWOS in the Delaware River Basin and complete full implementation of the NGWOS in the Upper Colorado River Basin and Illinois River Basin, and begin implementation in a fourth basin. The USGS would complete approximately one-quarter of NGWOS implementation in a fourth Integrated Water Science (IWS) basin to be selected at the beginning of FY 2022 *(for more information on IWS basins, see the Mission Area Overview section.)* The USGS would also support hydrologic instrumentation research and development aimed at pushing the state of monitoring technology forward in each IWS basin, which would ultimately improve USGS national observing networks at large. As innovative data collection techniques and technologies are tested in each IWS basin, those that prove effective and beneficial could be rolled out to the national USGS observing networks.

Beyond these efforts, at the requested level, the USGS anticipates completing NWIS Modernization efforts by the end of FY 2024.

Program Overview

The Groundwater and Streamflow Information Program (GWSIP) focuses on the collection, management, and dissemination of high-quality and reliable water information in real-time and over the long-term, both of which are critical for managing the Nation's water resources and anticipating and responding to water hazards that can result in loss of life and property. Serving as one of the largest water data holders in the world, the USGS partners with more than 1,600 Federal, regional, State, Tribal, and local agencies to maintain and manage its water monitoring networks. Furthermore, the GWSIP is increasingly targeting integrated monitoring for parameters of water-quality and quantity at a single location providing continuous real-time water data used for decisions such as emergency response, flood forecasting, reservoir management, water-use restrictions, drinking water deliveries, permit compliance, water-quality studies, and recreational safety. The long-term data supplied by the program are a critical component to sustaining the viability of industries such as agriculture, fishing, and outdoor recreation and are used for decisions related to water-supply planning, aquifer storage and recovery, infrastructure design, floodplain and ecosystem management, energy development, and resolution of water disputes.

National Water Census (NWC)

The goal of the USGS NWC is to provide nationally consistent, well-documented information on water availability that will allow resource managers to assess the quantity, quality, and use of the Nation's water resources. The GWSIP is supporting this goal by collecting, analyzing, and assessing hydrologic data in transboundary rivers along the U.S-Canada border. Initiated in 2019, the USGS is currently supporting activities in Alaska, Washington, Idaho, and Montana that are aimed at documenting baseline conditions and assessing any potential impacts from mining activities in British Columbia. Work is being coordinated with various Federal, State, local, and tribal agencies to ensure that USGS efforts will serve their data needs.

Observing Systems

Water monitoring networks are the foundation of understanding the Nation's hydrologic systems; they provide information that is critical for defining, using, and managing water resources. The USGS operates a suite of real-time surface water and groundwater networks that provide data on water levels, streamflow, and a variety of water-quality parameters. The GWSIP primarily supports the networks that provide data on water quantity (water levels and streamflow), while also investing in next-generation water observing systems designed to integrate monitoring for water quantity, quality, and use.

National Streamgaging Network: The GWSIP supports the collection and (or) delivery of both streamflow and water-level information for more than 8,400 sites and water-level information alone for more than 2,880 additional sites. The data are served online—most in near real-time—and form the basis for decisions related to protection of life and property from hazards, such as floods; cost-effective management of freshwater that is safe and available for drinking, irrigation, energy, industry, recreation, and ecosystem health; and national, State, tribal, and local economic well-being.

Improving Program Performance
Advancing USGS Monitoring Capabilities in Remote Areas through Satellite Remote Sensing

The USGS began the production of historic and operational real-time discharge data at four "virtual" stream monitoring stations in Alaska, on the Nanana, Yukon, and Susitna Rivers utilizing satellite remote sensing to measure river widths, slopes and altitudes at these locations and, using hydraulic equations, convert these to discharge measurements. These virtual streamgaging stations are demonstration and test sites for use of satellites to measure rivers in remote areas that are too difficult or expensive to measure with traditional methods. With these test sites, USGS is developing accurate and reliable methods that can expand coverage of the national stream monitoring network. This work will improve safety by keeping technicians out of dangerous waters and will lead to less expensive stream monitoring methods that can be used to expand the coverage of monitoring across the Nation.

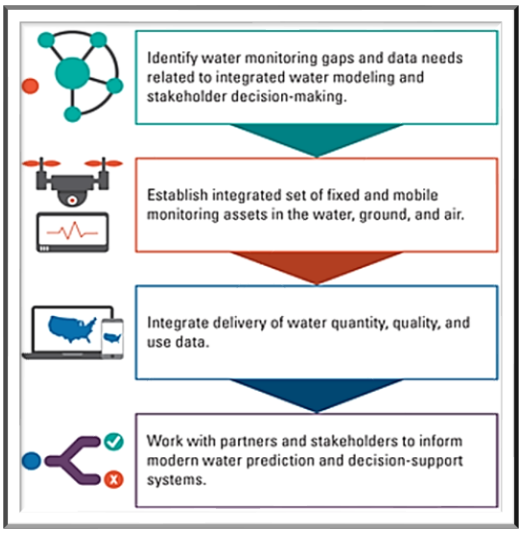
Federal Priority Streamgage (FPS) Network: The FPS Network (previously known as the National Streamflow Information Program) is a subset of the National Streamgaging Network and was conceived in 1999 to be a core, federally funded network. The original network design identified 4,300 sites that were strategically positioned across the country to address long-term Federal information needs, such as forecasting (primarily supporting National Weather Service flood forecasts and to trigger operational drought or emergency declarations), interstate and international water compacts and decrees, and tracking sentinel trends. Now, that design has expanded to more than 4,700 target locations; however, only about 3,441 FPS will be active by the end of FY 2021. These sites are supported through a combination of USGS and partner funding—approximately one-quarter are fully funded by the USGS. For information on how the GWSIP will support the FPS Network in FY 2022, see the Program Changes section.

Improving Program Performance
Augmenting USGS Monitoring Capabilities during Flood Events

The USGS has developed a suite of tools that can be used to temporarily augment the monitoring capacity of the Streamgaging Network during flood response and fill data gaps. For example, Rapid Deployment Gages (RDGs) are temporary sensors that provide real-time water-level and meteorological data to communities lacking permanent streamgages, or where temporary stream or estuary information is needed. Storm-tide sensors are monitoring devices that observe and document storm-surge, waves and tides as coastal storms make landfall. Instruments like these can be deployed prior to a storm event and then retrieved shortly after. These Data are useful for informing forecasts on potential coastal erosion and flooding hazards, and they help public officials to assess storm damage, enhance flood forecasting models, and improve long-term planning for future coastal storms.

National Groundwater Monitoring Network (NGWMN): The NGWMN was designed in 2009 in response to the SECURE Water Act (P.L. 111-11). Authorized as a collaborative groundwater network among intergovernmental agency data providers, the NGWMN provides access to water-level and (or) water-quality data from over 10,500 groundwater wells that are supported by over 30 Federal, State, local, and Tribal agencies. As part of the NGWMN, the USGS supports 693 Climate Response Network (CRN) sites, representing 256 of 366 Climate Divisions in the United States as outlined in P.L. 111-11. These sites are supported by a combination of USGS and partner funding. The primary purpose of these data is to portray the response of groundwater systems to short- and long-term climate variations Nationwide. The CRN serves as a critical measure of groundwater conditions during drought and provides long-term groundwater level data. In FY 2022, the USGS will continue to support the CRN.

Next Generation Water Observing System (NGWOS): In efforts to modernize observing networks, the USGS has developed a strategy for implementing a NGWOS. The USGS has begun establishing advanced, intensive monitoring networks in medium-sized watersheds across the United States, referred to as Integrated Water Science (IWS) basins. Selected watersheds are being instrumented to monitor water quantity, quality, and use with a mixture of monitoring equipment in the water, ground, and air. When fully implemented, the NGWOS will provide high temporal and spatial resolution data on streamflow, evapotranspiration, snowpack, soil moisture, water quality, groundwater/surface-water connections, stream velocity distribution, sediment transport, and water use. These data are intended to be coupled with advanced models, such as the National Water Model, and other modern modeling tools to lower prediction uncertainty as well as provide flood and drought forecasts; drive emergency- and water-management decision support systems; and address a variety of other water-resource questions in a given region. Further, the NGWOS will provide a foundational dataset as the USGS develops Integrated Water Availability Assessments.



Infographic of the NGWOS implementation process. The NGWOS is integrating fixed and mobile monitoring assets in the water, ground, and air, including innovative webcams and new ground- and space-based sensors. Partner and stakeholder needs are informing NGWOS design so that data helps them anticipate water shortages more accurately and react to water hazards more quickly. Source: USGS.

Thus far, the USGS has selected three IWS basins (the Delaware River (DRB), Upper Colorado River (UCOL), and Illinois River (ILRB) Basins) and NGWOS implementation is ongoing in all three. When fully implemented, NGWOS instrumentation in the DRB will focus on enhanced monitoring of streamflow, temperature and salinity to help address key water-resource issues such as: *interbasin transfers to New York City in the upper basin; maintaining ecological flows and stream temperatures adequate to support blue ribbon trout fisheries in the upper and middle part of the basin; and saltwater intrusion for cities like Philadelphia in the lower basin*. NGWOS implementation in the UCOL will focus on monitoring of snow to streamflow, groundwater to streams, and real-time water-quality, helping to answer specific hydrologic questions important to stakeholders such as: *What are the near-term and long-term risks of floods and droughts, and what scenarios change these risks? How long will drought recovery take? How much water is stored in seasonal snowpacks, and how will changes affect water supplies? How much does groundwater contribute to streamflow, or vice-versa? What is the quality of water and how will it change during wet/dry periods?* In the ILRB, full implementation will focus on real-time monitoring of nutrient and sediment delivery, factors leading to the formation of harmful algal blooms (HABs), and urban flood hydrology, helping to answer specific hydrologic questions important to stakeholders such as: *What are the near-term and long-term risks of floods and droughts, and what scenarios change these risks? What factors affect water availability in basins that possess a complex mixture of urban and agricultural land use? How do nutrient loads influence HABs? What are the best ways to monitor for water supply contaminants such as per- and poly-fluoroalkyl substances (PFAS)? What are the best practices to inform Federal, State, and local agencies about sediment loads in watersheds to facilitate planning of dredging operations that maintain navigable waters?*

At the beginning of FY 2022, the USGS will select a fourth IWS basin. For information on how the GWSIP will support the NGWOS in FY 2022, see the Program Changes section.

Data Systems

National Water Information System (NWIS) Modernization: As the USGS moves its monitoring networks forward through initiatives like NGWOS, it is modernizing the enterprise system that supports water data transmission, storage, processing, and delivery: NWIS. These efforts will ensure that NWIS can efficiently manage new data and data types, integrate water data from multiple agencies and sectors, and continue to deliver data to the public, but in new and more user-friendly formats. In FY 2022, the USGS will continue to modernize data infrastructure and data delivery components of NWIS. Data delivery efforts will directly benefit data users by enhancing the National Water Dashboard, adding new public search and data download functionality, and enhancing delivery of camera imagery, geospatial information, and discrete groundwater data. In addition, the GWSIP is investing in activities to ensure that state-of-the-art tools are used to develop information and data visualizations that meet the decision-making needs of stakeholders.

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Water Resources
National Water Quality Program

Water Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
National Water Quality Program	**92,460**	**93,460**	**1,782**	**0**	***0***	**95,242**
FTE	***466***	***472***	***0***	***0***	***0***	***472***

2022 Program Changes

The 2022 budget request for National Water Quality Program is $95,242,000 and 472 FTE. There are no program changes requested for FY 2022.

Program Overview

To effectively manage the Nation's water resources, decision makers depend on understanding what resources are available for various purposes, and whether the quality of those resources is fit for purpose. The National Water Quality Program (NWQP) supports the data collection, assessments, modeling, and research needed to assess the quality of freshwater resources. Activities are focused on understanding the role that water quality plays in water availability. The long-term data, assessments, and models supported by the program are a critical component to sustaining the viability of industries such as agriculture, fishing, and outdoor recreation, and are used for decisions related to water-supply planning, aquifer storage and recovery, infrastructure design, floodplain and ecosystem management, energy development, and resolution of water disputes. The multi-scale prediction of water quality and availability of freshwater resources are met through integrated capabilities across multiple programs. These programs include IWP to provide the computational framework for advanced models of quality and quantity, IWAAs to assess water availability within the context of competing demands, and research into water quality processes to identify and fill gaps models for more accurate predictions.

National Water Census (NWC)

The goal of the USGS NWC is to provide nationally consistent, well-documented information on water availability that will allow resource managers to assess the quantity, quality, and use of the Nation's water resources. The NWQP supports this goal by investing in efforts to evaluate the water-quality aspects of water availability. Given the cost of treating water for various uses (e.g., public supply, irrigation, energy development), water-quality is critical in the availability of water for human and ecological purposes.

Integrated Water Availability Assessments (IWAAs): IWAAs will provide a near real-time census and seasonal prediction of water availability for both human and ecological uses at regional and national extents.

As part of this effort, the NWQP is working to analyze trends and develop advanced techniques to account for water quality. At a national scale, efforts are focused on developing water availability indicators related to water quality that will convey periodic snapshots of current conditions and national trends. Water-quality indicators will show water availability based on suitable uses and untreated quality (e.g., water may be available but must be treated before using in an industrial setting yet could be used untreated for mining.

Water availability has four components: (1) the need for certain volume of water to meet the intended purpose, (2) the timing of which water is delivered, (3) the adequate quality of the water for intended purpose, and (4) the need for water to meet human and environmental/ecological uses.

In addition, the USGS supports efforts to evaluate water-quality trends on a national scale. At regional scales, the NWQP is working to integrate water-quality assessment and evaluation capabilities into Regional IWAAs. These Regional IWAAs are being developed in partnership with stakeholders to ensure they are informative at local and regional levels but can also be assimilated into national-scale products as part of the National IWAA. In FY 2022, regional IWAAs will be ongoing in the Delaware River (DRB), Upper Colorado River (UCOL), and Illinois River (IRB) basins. The NWQP will be supporting those basins with efforts to assess water-quality factors such as salinity and temperature in the DRB, groundwater salinity and selenium in the UCOL, and developing a framework for assessing the impacts of nutrients on water availability in the IRB.

Ecological Flows: The USGS is working to develop the data, tools, and information water resource managers need to protect and restore stream health as it is affected by alteration of flows for human water use, climate change, and anthropogenic changes to water quality. The results will be used to identify, evaluate, and predict potential ecological responses to alteration of water availability. In 2022, the NWQP will continue to incorporate ecological flows into the NWC through efforts to develop methods for assessing freshwater biological diversity—a key indicator of watershed health and ecological wellbeing. Leveraging the multi-disciplinary nature of the USGS, this work is being conducted in collaboration with the USGS Ecosystems Mission Area. The USGS will also apply new technologies in genomic analyses, bioinformatics, and machine learning to improve the accuracy and interpretability of indicators of ecological well-being.

Water Prediction and Information Delivery/Data Systems

Integrated Water Prediction (IWP): As part of an ambitious Federal partnership, agencies such as the National Oceanic and Atmospheric Administration, Bureau of Reclamation, U.S. Army Corps of Engineers, and the USGS are developing a new national, interagency capacity for water prediction. As part of this effort, the USGS is working to advance its water modeling capabilities through an IWP program that is focused on developing nationally consistent approaches for predicting hydrologic conditions, changes, and outcomes for water availability. These approaches are being designed to consider water quantity, quality, and use together in an integrated water availability model. While these activities are supported by both the NWQP and the Water Availability and Use Science Program, NWQP funding supports activities that focus on incorporating water-quality processes into water prediction for a holistic view of water availability.

In 2022, the USGS is working to design and develop an integrated hydrologic modeling software framework that will support an ecosystem of model codes that represent both natural and human system processes. NWQP efforts will focus on multi-scale testing and evaluation of this framework, specifically on improving the process representation and prediction of key water quality drivers such as surface water temperature, constituent transport, biogeochemical reactions, physical transport processes. These activities will be coordinated with other integrated water science activities such as IWAAs.

Better Tools for the Public
Advancing Water Quality Models

The USGS supports research in assessing variables and developing models to evaluate water quality across the United States. In 2020, the USGS delivered multiple, regionally based, numerical, statistical, and machine learning models that predict depth to water, estimate groundwater age and recharge, pH and oxygen levels, stream discharge, and total nitrogen, phosphorus, salinity, and suspended sediment for over 90 percent of the U.S. population. These models provide water resource managers critical estimates of water-quality conditions in sources of drinking water and irrigation supplies and assist in the management of water resources and in prioritizing monitoring programs.

High Impact Hydrologic Research

The USGS is investing in the research needed to better understand the water-quality factors that impact water availability. This work provides the foundation for providing models and tools for resource managers that can consider the quantity, quality, and use aspects of water availability as an interdependent system.

Water Quality Processes: These activities support the methods development and research that the USGS needs to quantify impacts of constituent fate and transport on changes in water-quality and how those changes impact water availability for both human and ecological uses. In 2022, the USGS is continuing efforts to understand the processes that influence both existing and emerging water-quality challenges such as harmful algal blooms (HABs) and per- and poly-fluorinated compounds (PFAS). Specifically, methods development activities will focus on the ability to detect and quantify contaminants of interest and to understand linkages between biogeochemistry and fate and transport. This is a critical foundation for understanding the potential impacts that contaminants like HABs and PFAS can have on water availability. Additional research will focus on improving prediction capabilities for the constituents identified as priority issues by stakeholders in IWS basins including sediment, salinity, selenium, carbon, and nutrient dynamics.

Social and Economic Drivers: These activities focus on a better understanding of the impacts of and interactions between socioeconomics and water availability. A comprehensive understanding of the social and economic factors that drive water demand and alter water supply is needed to assess water availability in a predictive framework. Assessment and model development will identify the economic sectors, ecosystem goods and services, and other social, cultural, and economic factors that affect, or are affected by, water availability. When considering these factors, water quality is an integral driver in socioeconomic decisions related to water availability given its role in the suitability of water resources for use. For example, under drought conditions, water resources managers must weigh water demand with the intended uses (e.g., irrigation vs. public supply vs. mining) and the costs associated for the required treatment to meet those purposes when planning for water needs. In 2022, the USGS will initiate studies aimed at understanding

interactions such as these and ultimately how these interactions influence water demand, use, and movement regionally. These efforts will improve the ability of the National Water Census to forecast availability under a variety of conditions.

Water Availability Impacts of Extreme Events: The NWQP is working to understand how extreme events impact water availability through short-term changes in the quality of water resources accessible for use. The initial focus of research activities will be in the water availability impacts of wildfire and hurricanes. In 2022, the USGS is developing the capacity to predict wildfire impacts on water availability using a strategic, nationally consistent, approach to quantify critical drivers of water-quality impairment. Improvements in measurement, assessment, and modeling techniques will allow USGS to produce near-real time predictions of wildfire impact for post-fire debris flows and water-availability impairment. These activities support the goals and strategies of the USGS Wildland Fire Strategic Plan released in February 2021. Additional efforts include developing a strategy for predicting short- and long-term water availability impacts of hurricanes.

Observing Systems

The USGS operates a suite of surface water and groundwater networks that provide real-time data on water levels, streamflow, and a variety of water-quality parameters such as dissolved oxygen, pH, specific conductance and temperature, as well as discrete water-quality data on contaminants. The NWQP primarily supports the networks that provide data on water quality, while also investing in next-generation water observing systems designed to enhance and integrate monitoring for water quantity, quality, and use. This integration is increasingly important as the WMA works to improve the prediction skill of complex hydrologic and water-quality models and ultimately improve understanding of water-availability and stakeholder decision making.

National Water Quality Network (NWQN) for Streams and Rivers: The NWQN is the only nationally designed, long-term monitoring network for tracking the quality of rivers and streams with consistent, comparable data collection and analytical methods at all sites. NWQN data is primarily collected through discrete sampling at sites; however, a growing number of sites have sensors that provide continuous, real-time water-quality conditions. Through NGWOS, new sensors and instruments will be developed and implemented to measure more types of contaminants on a continuous basis and be delivered to users in real-time. In FY 2022, the USGS will continue monitoring at 110 sites in the NWQN covering important environmental settings (e.g., small agricultural and urban watersheds, large inland and coastal rivers, and minimally disturbed reference watersheds).

National Groundwater Quality Monitoring Networks (NGWQMN): The USGS monitors groundwater quality conditions through an enterprise of approximately 80 long-term networks across the United States. These groundwater-quality monitoring networks track water quality conditions in principal aquifers across the United States. Concentrations of constituents, such as arsenic, nitrate, metals, pesticides, and volatile organic compounds, are compared to benchmarks established for the protection of human health. Users can access an online tool to see how concentrations of these constituents in groundwater are changing during decadal periods across the Nation. Currently, data is collected on a discrete basis where hydrologists must visit a groundwater site in person to take water samples. Moving forward, emerging NGWOS sensor technologies may allow the USGS to advance continuous, real-time groundwater-quality monitoring and

provide more safeguards for human health. In FY 2022, the USGS will continue sampling through these networks.

National Atmospheric Deposition Program (NADP): The USGS monitors wet atmospheric deposition (chemical constituents deposited via snow, sleet, rain) in the United States through the interagency NADP. The USGS supports sites in the National Trends, Mercury Deposition, and Mercury Litterfall networks, which provide long-term, high-quality data to support decisions related to sources of water-quality impairment, and watershed studies. In FY 2022, the USGS will continue to support monitoring through the NADP.

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Water Resources
Water Resources Research Act Program

Water Resources $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Water Resources Research Act Program	**10,000**	**11,000**	**0**	**0**	***0***	**11,000**
FTE	***1***	***1***	***0***	***0***	***0***	***1***

2022 Program Changes

The 2022 budget request for Water Resources Research Act Program is $11,000,000 and 1 FTE. There are no program changes requested in FY 2022.

Program Overview

The Water Resources Research Act, authorized by section 104 of the Water Resources Research Act (WRRA) of 1984, is a Federal–State partnership that plans, facilitates, and coordinates water resources research, education, and information transfer through a matching grant program. The WRRA authorized the establishment of State Water Resources Research Institutes (National Institutes for Water Resources; NIWR) at land grant universities across the Nation. There are currently 54 Institutes: one in each State, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam. The Institute in Guam serves the Federated States of Micronesia and the Commonwealth of the Northern Mariana Islands.

Annual Base Grants

Under the provisions of section 104 of the Water Resources Research Act of 1984, annual base grants (104b) are awarded to the Institutes or Centers that have been established in each of the 50 States, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam. Annual base grants are required to have a 2:1 match by the Institute and are used to fund projects that are selected at the Institute level through a competitive selection process that is run by each Institute within their respective States. The annual base grants help each Institute or Center to plan and conduct applied and peer reviewed research on water resource issues that address State needs. Institutes also use their base grants to help train new scientists, disseminate research results to water managers and the public, and to cooperate with other colleges and universities in their respective states and with other institutes and other organizations in their regions to promote regional coordination. Through research projects, the WRRA program directly supports about 250 undergraduate and graduate students each year. In addition, USGS grants help to support information transfer activities including an annual conference at every institute to facilitate the transfer of research progress and findings to the hydrologic research community as well as the public at large. In FY 2022, the USGS will continue to support base grants to all 54 Institutes.

National Competitive Grants

The WRRA program, in cooperation with the Institutes, supports an annual call for proposals to focus on water problems and issues that are of a regional or interstate importance or relate to a specific priority identified by the Department of the Interior and the Institutes. Through these grants, the WRRA program seeks to promote research collaboration between the USGS and university scientists on significant national and regional water resources issues; promote the dissemination and results of this research; and to assist in training scientists in water resources. Any investigator at an accredited institution of higher learning in the United States is eligible to apply for a grant through an Institute or Center established under the provisions of the Water Resources Research Act of 1984. However, these grants must be matched with non-Federal dollars on a 1:1 basis. Successful research topics have included research on improving and enhancing the nation's water supply, developing innovative approaches to water treatment, evaluation of the dynamics of extreme hydrological events and associated costs; development of methods for better estimation of the physical and economic supply of water; developing approaches for integrated management of ground and surface waters; and the evaluation and assessment of conservation practices.

A subset of these competitive grants is offered for specific priority research areas. One of those is aquatic invasive species (AIS), and five grants were selected to improve our understanding of the impacts of aquatic invasive species on lakes and rivers in the Upper Mississippi River basin, including changes to water quantity, quality and the connected ecosystem dynamics. In addition, in FY 2021, the USGS was provided additional funds to support grants for per- and poly-fluoroalkyl substances (PFAS) issues. Grants will be selected based on how well they will improve understanding of the fate, persistence, and transport of PFAS as well as how PFAS may impact water quality and/or ecosystem dynamics in water resources.

Coordination Grants

These grants allow other Federal agencies, including bureaus within the Department of the Interior, to use and take advantage of the expertise and capabilities that are available through the network of Institutes. The USGS may accept funds from other Federal departments and agencies for purposes of establishing a grant with an Institute to conduct hydrologic research with Federal programs concerned with water resources problems and issues. Historically, these grants have been used by several agencies, including the Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers. The USGS fully supports and encourages other Federal programs concerned with water resources problems and issues to develop grants with the Water Resources Institutes in cooperation with the USGS.

Student Internships

The NIWR-USGS student internship program provides undergraduate and graduate students with career enhancing field, laboratory, and research experience through participation in USGS activities as interns. The program is a collaborative effort between the WRRA program and NIWR. On a need basis, the USGS, through our Science Centers, will fund interns hired by the Institute. These interns focus on various hydrologic topics including research to separate atmospheric sources of mercury sources from legacy mercury contained in sediments and peat, development of new numerical techniques for improving the predictability of temperature models, and improvements to data mining techniques for searching USGS hydrologic databases.

Interns are employees of participating universities and colleges and may be a student from any college or university in the Institute's State. Information about the availability of the Internship program in a State may be obtained by contacting the USGS representative or Institute Director in the State.

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Core Science Systems

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Core Science Systems

Core Science Systems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
National Geospatial Program	**79,454**	**79,454**	**1,144**	**0**	**5,000**	**85,598**
Geospatial, 3DEP, and Geologic Research and Collection on Tribal Lands	*0*	*0*	*0*	*0*	*5,000*	*5,000*
FTE	***247***	***247***	***0***	***0***	***1***	***248***
National Cooperative Geologic Mapping Program	**34,397**	**40,397**	**534**	**-350**	**0**	**40,581**
National Cooperative Geologic Mapping Program Projects and 3D Geologic Mapping	*34,397*	*40,397*	*0*	*-350*	*0*	*40,047*
FTE	***109***	***115***	***0***	***0***	***0***	***115***
Science Synthesis, Analysis and Research Program	**25,972**	**25,972**	**381**	**350**	**72,100**	**98,803**
National Geological and Geophysical Data Preservation Program (NGGDPP)	*1,332*	*1,332*	*0*	*350*	*0*	*1,682*
Tools Supporting Conservation Planning, Monitoring and Projection	*900*	*900*	*0*	*0*	*9,600*	*10,500*
Assessment of Biodiversity	*0*	*0*	*0*	*0*	*2,500*	*2,500*
Collaborative Climate Adaptation and Resilience Research	*0*	*0*	*0*	*0*	*60,000*	*60,000*
FTE	***82***	***82***	***0***	***0***	***4***	***86***
National Land Imaging Program	**106,865**	**106,865**	**627**	**0**	**9,400**	**116,892**
Science Research and Investigations	**14,557**	**14,557**	**75**	**0**	**0**	**14,632**
Satellite Operations	**84,337**	**84,337**	**451**	**0**	**0**	**84,788**
Land Cover Monitoring and Assessments	**7,971**	**7,971**	**101**	**0**	**9,400**	**17,472**
Tools Supporting Conservation Planning, Monitoring and Projection	*3,858*	*3,858*	*0*	*0*	*5,400*	*9,258*
Biologic Carbon Sequestration	*0*	*0*	*0*	*0*	*4,000*	*4,000*
FTE	***135***	***135***	***0***	***0***	***30***	***165***
Core Science Systems Total	**246,688**	**252,688**	**2,686**	**0**	**86,500**	**341,874**
FTE	***573***	***579***	***0***	***0***	***35***	***614***

Mission Area Overview

The USGS is the Federal agency responsible for mapping the geologic, geographic, and land features of the United States. The USGS conducts detailed surveys and distributes the resulting high-quality and highly accurate topographic, geologic, hydrographic, and biogeographic maps and remotely sensed data to the public. Mapping accuracy enabled by cutting-edge technologies allows precise planning for recreational use on public lands; collaborative conservation with Interior partners; conservation and climate change; critical minerals assessments; renewable energy development; transportation and pipeline infrastructure projects; urban planning and development; land change and flood prediction at regional, local, and neighborhood scales; emergency response; and hazards mitigation.

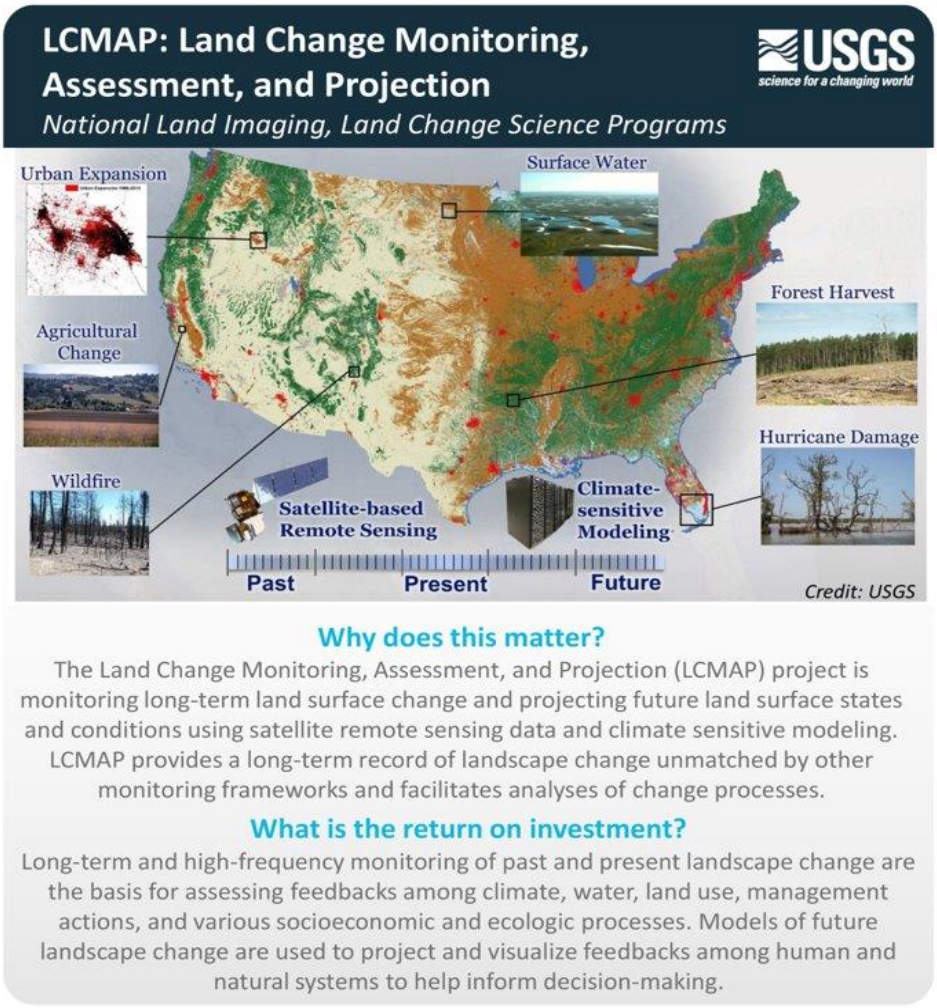
The USGS Core Science Systems Mission Area is the Federal steward of this high-quality geospatial data and provides access to the public through The National Map, the Federal GeoPlatform, the National Land Cover Database, the National Geologic Map Database, the USGS Earth Explorer, and the National Biogeographic Map. The USGS also operates Landsat satellites and data systems necessary to understand, monitor, and detect changes that affect the Nation's natural and agricultural resources, economy, public safety and national security, and historical heritage.

Selected Mission Area Accomplishments

- Increased USGS 3D Elevation Program (3DEP) high-resolution data coverage to 77.6 percent of the Nation. The 3DEP program will provide the first-ever national baseline of consistent high-resolution topographic elevation data that will enable critical applications including flood risk mapping, infrastructure development, climate science, and mapping of potential critical mineral deposits.
- Completed the National Hydrography Dataset Plus High Resolution (NHDPlus HR) for 84.7 percent of the Nation. When complete, the NHDPlus HR will provide the geospatial underpinning for the National Hydrography Infrastructure and contributes to data discovery and sharing tools as well as a broad range of applications including flood modeling and prediction, chemical spill response, and public safety.
- Constructed new 2D and 3D geologic maps that address issues identified by the States, including earthquake, flood, karst, volcanic, and landslide hazards; water, mineral resources; soil conditions; coastal resiliency; and urban and infrastructure development.
- Increased the Survey’s high-performance computing capacity by adding two new supercomputers and large data storage. Completed over 1.3 million computing jobs, increasing the scale, scope, and timeliness of scientific research and integrated modeling efforts.
- Released the first collection of land change and spectral change products through the Land Change Monitoring, Assessment, and Projection initiative. This marks the beginning of a new era in satellite-based land change science to improve decision-making for land resource management, agriculture, and wildfire planning and response.

- Continued to collaborate with NASA to develop Landsat 9 ground systems in preparation for a fiscal year 2021 launch and formulate the follow-on Landsat Next mission. Landsat's free and open data policy allows users to access imagery for many purposes including monitoring consumptive water use in the Western United States; monitoring health and changes in rangelands, forests, and agricultural lands; estimating heat temperatures in urban areas; and monitoring wildfires in various terrains.

For additional information about these programs, please visit the USGS website (www.usgs.gov).



USGS Land Change Monitoring, Assessment, and Projection project.

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Core Science Systems
National Geospatial Program

Core Science Systems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
National Geospatial Program	**79,454**	**79,454**	**1,144**	**0**	**5,000**	**85,598**
Geospatial, 3DEP, and Geologic Research and Collection on Tribal Lands	*0*	*0*	*0*	*0*	*5,000*	*5,000*
FTE	***247***	***247***	***0***	***0***	***1***	***248***

2022 Program Changes

The 2022 budget request for the USGS National Geospatial Program is $85,598,000 and 248 FTE, a program change of +$5,000,000 and +1 FTE from 2021.

Geospatial, 3DEP, and Geologic Research and Collection on Tribal Lands (+$5,000,000/+1 FTE) – The USGS would significantly improve the amount of, and access to, geospatial data and mapping information for underserved tribal communities with availability of data through The National Map or other existing data portals. In coordination with the priorities of Tribes, the USGS would expand elevation and hydrography data collection and generation over tribal lands, and geologic mapping information through detailed surveys of the landforms, rivers, and geologic framework of areas recognized to be vital to the economic, social, or scientific welfare of Tribes. Foundational elevation, hydrography, and geologic datasets, including acquisition of 3D Elevation Program (3DEP) high-resolution lidar data and curation of data and maps, will support a broad range of critical conservation and land management needs of underserved tribal communities including wetlands inventories, land use planning, natural resources management, and survey, inventory, and interpretation of tribal cultural resources.

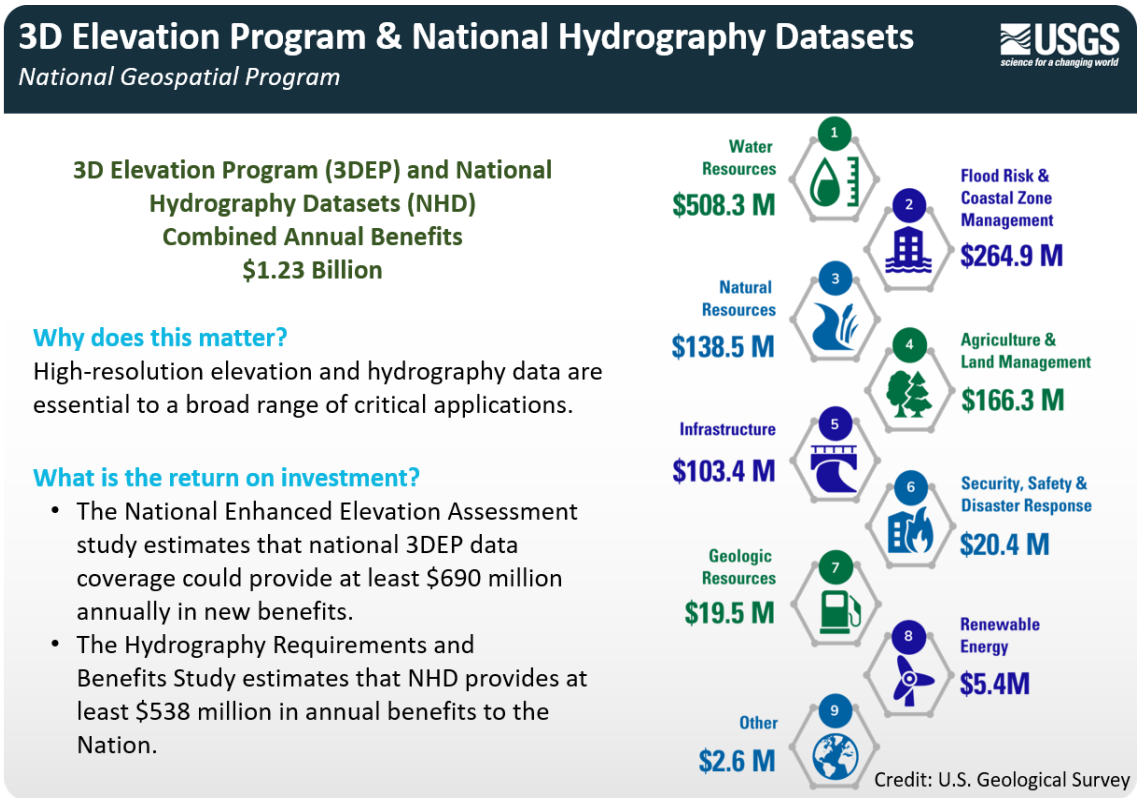
Program Overview

The National Geospatial Program (NGP) organizes, updates, and publishes the geospatial baseline of the Nation's topographic information, to advance science, enlighten citizens, and support decision-making through The National Map—a compilation of the foundational data layers for the entire Nation, maintained in the public domain. The USGS supports Interior's responsibilities for national geospatial coordination and carries out the USGS's government-wide leadership responsibilities for elevation, hydrography and watershed boundaries, and geographic names. As one of the cornerstones of the USGS, The National Map has many uses ranging from recreation to scientific analysis to emergency response. The National Map is easily accessible for display online, as products and services, and as downloadable data allowing the public to enhance their recreational experiences, make life-saving decisions, and support scientific missions. The

American people rely on the USGS's publicly available data and mapping to remain informed and to stay healthy and safe.

The goal of the USGS 3D Elevation Program (3DEP) is to provide the first-ever national baseline of consistent high-resolution topographic elevation data, including both the bare Earth surface and 3D point clouds that map the Nation's natural and constructed features. USGS 3DEP data directly support Departmental and Administration priorities including climate resilience, conservation, Tribal programs, clean energy deployment, infrastructure, and identification of undiscovered critical minerals. USGS 3DEP supports racial and economic equity by underpinning broadband development for underserved communities. Investments in 3DEP support the economy by creating jobs in the private mapping sector that acquire the data through contracts with the program, as well as providing high-quality elevation data to inform decisions.

The NGP hydrography program produces and delivers the Nation's most comprehensive and up-to-date portfolio of surface waters datasets, including the National Hydrography Dataset, the Watershed Boundary Dataset, and the National Hydrography Dataset Plus High Resolution. NGP is building on these baseline programs to develop the 3D National Topography Model that integrates USGS elevation and hydrography datasets to model the Nation's topography in 3D. In the future, the 3D National Topography Model will include the next generation of 3DEP data and a modernized 3D Hydrography Program, with improvements including an updated hydrography data model, hydrography derived from elevation, integration with inland bathymetry, inclusion of engineered hydrology, and interoperability with groundwater and wetlands data. These datasets will provide data to bolster adaptation and increase resilience to the impacts of climate change.



Annual Benefits of the USGS 3D Elevation Program and National Hydrography Datasets

The USGS 3DEP and NGP hydrography program support the goals of Executive Order 13985 (Advancing Racial Equity and Support for Underserved Communities Through the Federal Government); Executive Order 13990 (Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis); Executive Order 14008 (Tackling the Climate Crisis at Home and Abroad); and Executive Order 14017 (America's Supply Chains).

The Federal Geographic Data Committee (FGDC) is an interagency coordinating committee, which acts as the lead entity in the Executive Branch for the development, implementation, and review of policies, practices, and standards related to geospatial data. The FGDC is responsible for implementing the Geospatial Data Act (GDA) of 2018 and cross-government geospatial initiatives, including the Geospatial Platform (GeoPlatform), the National Spatial Data Infrastructure (NSDI), and Federal geospatial data portfolio management practices. The FGDC coordinates with other interagency bodies including the Chief Data Officers Council and is responsible for actions in the Federal Data Strategy. The FGDC Office of the Secretariat provides executive, administrative, and technical support to the Committee, and to the National Geospatial Advisory Committee of geospatial sector representatives, as directed by the GDA. The FGDC leads the development of the NSDI Strategic Plan, in accordance with OMB Circular A-16 (the Coordination of Geographic Information and Related Spatial Data Activities).

The FGDC leadership in cross-government geospatial initiatives directly supports the goals of Executive Order 14008 (Tackling the Climate Crisis at Home and Abroad).

Use of Cost and Performance Information in the USGS 3DEP Program

The USGS 3D Elevation Program (3DEP) continues to collect high-resolution light detection and ranging (lidar) elevation data to achieve the first-ever baseline of nationwide lidar coverage by 2026. The 3DEP's unique collaboration efforts are critical for coordinating with Federal, State, local, and Tribal governments, and private industry users to obtain matching funds (approximately five partner dollars for each USGS dollar invested). When Federal and non-Federal partners work together to map once and use the data many times, they can achieve efficiencies and lower costs. This strategy effectively leverages Federal dollars to support the Administration’s priorities for improving access to geospatial data for underserved tribal communities and enabling applications including flood risk mapping; infrastructure development; climate science; and mapping of potential critical mineral deposits.

Core Science Systems
National Cooperative Geologic Mapping Program

Core Science Systems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
National Cooperative Geologic Mapping Program	**34,397**	**40,397**	**534**	**-350**	**0**	**40,581**
National Cooperative Geologic Mapping Program Projects and 3D Geologic Mapping	*34,397*	*40,397*	*0*	*-350*	*0*	*40,047*
FTE	***109***	***115***	***0***	***0***	***0***	***115***

2022 Program Changes

The 2022 budget request for the USGS National Cooperative Geologic Mapping Program is $40,581,000 and 115 FTE, a program change of $0 and -0 FTE from 2021, and an internal transfer of -$350,000 to the National Geological and Geophysical Data Preservation Program.

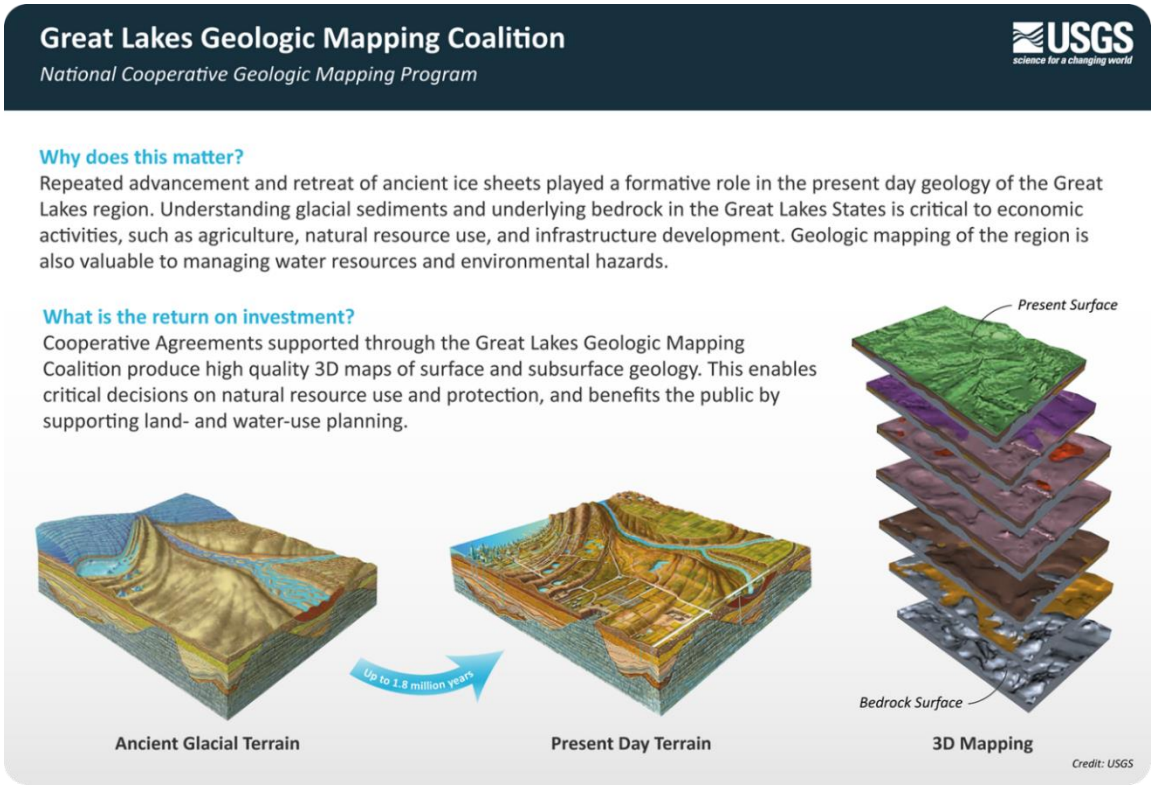
Internal Transfer for the National Geological and Geophysical Data Preservation Program (-$350,000/+0 FTE) – The USGS proposes to transfer funds to the National Geological and Geophysical Data Preservation Program to support operational efficiencies and promote geoscience discovery for Administration priorities including climate and environmental research. The funds will support USGS scientific collections management to facilitate and promote the discovery and reuse of high-value physical samples and associated materials for new scientific discovery, model validation, data recovery and development of new technologies. The USGS maintains a diversity of collections that are highly relevant for climatological, biodiversity, hazards, geotechnical, and natural resources research and can continue to provide new insights as analytical technologies and scientific priorities change. This proposal would not affect distribution of National Geological Cooperative Mapping Program funds to the States and follows the intent of the National Geologic Mapping Act of 1992.

Program Overview

The National Cooperative Geologic Mapping Program (NCGMP) conducts geologic investigations and produces geologic maps and three-dimensional geologic framework models in collaboration with State geological surveys and university partners.

The national geologic framework model is a three-dimensional visualization of surface and subsurface rock, soil, and sediment layers. This model is used to inform the responsible use of land, water, energy, and mineral resources and address the Nation’s rapidly changing natural resource needs. Federal and State

decision-makers use the digital geologic maps and three-dimensional geologic framework models and visualizations to help mitigate natural hazards; conduct energy and mineral resource assessments at county and regional scales; and assess hydrogeology and groundwater availability—all of which sustain and improve the quality of life and economic vitality of the Nation.



Infographic on the Great Lakes Mapping Coalition

The Federal mapping component, or FEDMAP, supports research on the Earth's surface and subsurface geologic framework to solve critical societal and scientific problems.

The State mapping component, or STATEMAP, funds the geologic mapping studies conducted by approximately 44 State Geological Surveys through a competitive cooperative agreement program that matches every federally-provided dollar with a State-provided dollar.

The educational mapping component, or EDMAP, funds competitive grants to universities and colleges for undergraduate and graduate students to conduct geologic mapping across the Nation in support of the Administration's priority for educating and training a 21st century workforce.

The National Geologic Map Database (NGMDB) serves as the authoritative, comprehensive, and publicly available repository for the geologic maps and data produced by the NCGMP mapping components. The USGS manages the NGMDB in partnership with State geological surveys.

The NCGMP's substantial engagement with State governments supporting new discoveries and mapping the location of strategic materials for the supply chain directly supports the goals of Executive Order 14008 (*Tackling the Climate Crisis at Home and Abroad*) and Executive Order 14017 (*America's Supply Chains*).

Use of Cost and Performance Information in the National Cooperative Geologic Mapping Program

The USGS leads a unique collaboration between State Geological Surveys and universities to achieve efficiencies in producing three-dimensional geologic mapping and models that help to create private sector jobs, fuel American economic opportunities, and support a 21st century economy. The USGS has over 23 years of successful cooperation among Federal, State, and university partners to deliver digital geologic maps to the public under the National Cooperative Geologic Mapping Act of 1992. State geological surveys and university participants receive funding through a competitive proposal process that requires 1:1 matching funds, ensuring the value of each proposal addresses issues identified by the States including earthquake, flood, karst, volcanic, and landslide hazards; water, mineral resources; soil conditions; coastal resiliency; and urban and infrastructure development.

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Core Science Systems

Science Synthesis, Analysis and Research Program

Core Science Systems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Science Synthesis, Analysis and Research Program	**25,972**	**25,972**	**381**	**350**	**72,100**	**98,803**
National Geological and Geophysical Data Preservation Program (NGGDPP)	*1,332*	*1,332*	*0*	*350*	*0*	*1,682*
Tools Supporting Conservation Planning, Monitoring and Projection	*900*	*900*	*0*	*0*	*9,600*	*10,500*
Assessment of Biodiversity	*0*	*0*	*0*	*0*	*2,500*	*2,500*
Collaborative Climate Adaptation and Resilience Research (ARPA-C)	*0*	*0*	*0*	*0*	*60,000*	*60,000*
FTE	***82***	***82***	***0***	***0***	***4***	***86***

2022 Program Changes

The 2022 budget request for the Science Synthesis, Analysis and Research Program is $98,803,000 and 86 FTE, a program change of +$72,100,000 and +4 FTE from 2021, and an internal transfer of +$350,000 from the National Cooperative Geologic Mapping Program.

Internal Transfer for the National Geological and Geophysical Data Preservation Program (+$350,000/+0 FTE) – The USGS proposes to transfer funds to the National Geological and Geophysical Data Preservation Program to support operational efficiencies and promote geoscience discovery for Departmental priorities including climate and environmental research. The funds will support USGS scientific collections management to facilitate and promote the discovery and reuse of high-value physical samples and associated materials for new scientific discovery, model validation, data recovery and development of new technologies. The USGS maintains a diversity of collections that are highly relevant for climatological, biodiversity, hazards, geotechnical, and natural resources research and can continue to provide new insights as analytical technologies and scientific priorities change.

Tools Supporting Conservation Planning, Monitoring and Projection (+$9,600,000/+4 FTE) – The Protected Areas Database of the United States (PAD-US) is America's official national inventory of U.S. terrestrial and marine protected areas and this increase will take significant steps to completing that inventory to ensure that important considerations that underscore balanced land and ocean management decisions are informed by accurate maps and geospatial data. These enhancements will not only contribute

to the tracking and reporting of progress on the goals of Conserving and Restoring America the Beautiful, frequently referred to as the 30 by 30 initiative, but it also provides the public, communities, and resource managers information for conservation, land management, recreation planning, and development. Partnering with other Federal agencies, States, and non-governmental organizations will provide updated data contributions and improve the data quality and completeness in PAD-US. The USGS plans to modernize its technology infrastructure to automate integration of partner data and provide national-scale analytics and data delivery. Similar investments for land change monitoring in a complementary request are listed in the National Land Imaging Program section.

Assessment of Biodiversity (+$2,500,000/+0 FTE) – The USGS proposes to deliver a National Biodiversity Assessment Dashboard to conduct an initial assessment that identifies nationwide biodiversity metrics; evaluates the role of protected areas; and projects vulnerabilities under future climate conditions. The National Biodiversity Assessment Dashboard will be integrated with the Protected Areas Database of the United States (PAD-US) to facilitate on-demand biodiversity assessments and analysis on protected area lands. Understanding the current and future value of America's protected areas through a National Biodiversity Assessment Dashboard supports climate adaptation, clean energy, support for tribal lands and aids in providing equal access to managed lands for underserved communities. This will support efforts for the America the Beautiful initiative. For example, biodiversity metrics provide land managers and public health officials with easy access to information on the benefits of locating parks near underserved communities, providing equitable access to nature and encouraging these communities to get outdoors to enjoy local, State and national parks to improve their overall health.

Collaborative Climate Adaptation and Resilience Research (+$60,000,000/+0 FTE) – The USGS proposes to invest in a collaborative research partnership with the new Advanced Research Projects Agency for Climate (ARPA-C) housed at the Department of Energy. This increase invests in high-risk, high-reward, accelerated research to achieve transformational advancement in areas where industry by itself is not likely to invest due to technical and financial uncertainty and focuses on climate adaptation and resilience and achieving a net zero emission economy by 2050. The USGS will develop and deliver actionable science products by investing in mission-spanning infrastructure to apply advancements in technology to pressing societal problems. This will be first demonstrated in five focal areas: planning tools for habitat and biodiversity, models for drought prediction, predictive tools for wildfire and post-wildfire risk management, coastal change and vulnerability forecasts for planning and disaster response and recovery, and models to assess potential and risks for geologic storage of hydrogen as a future energy resource.

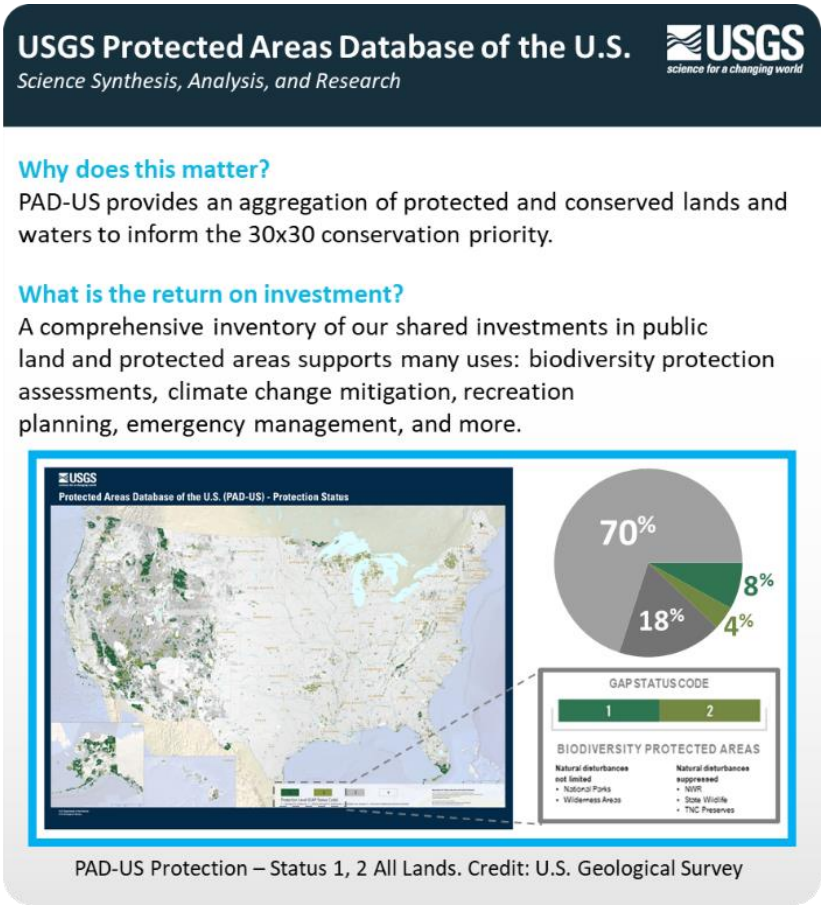
Program Overview

The Science Synthesis, Analysis, and Research Program (SSAR) provides analysis and synthesis of scientific data and information, interdisciplinary research to improve understanding of Earth system changes, and preservation of scientific data and samples and library collections.

This program strives to accelerate research and decision-making through data science, information delivery, advanced computing, biodiversity analytics, multi-hazard risk assessments and preserved geoscientific

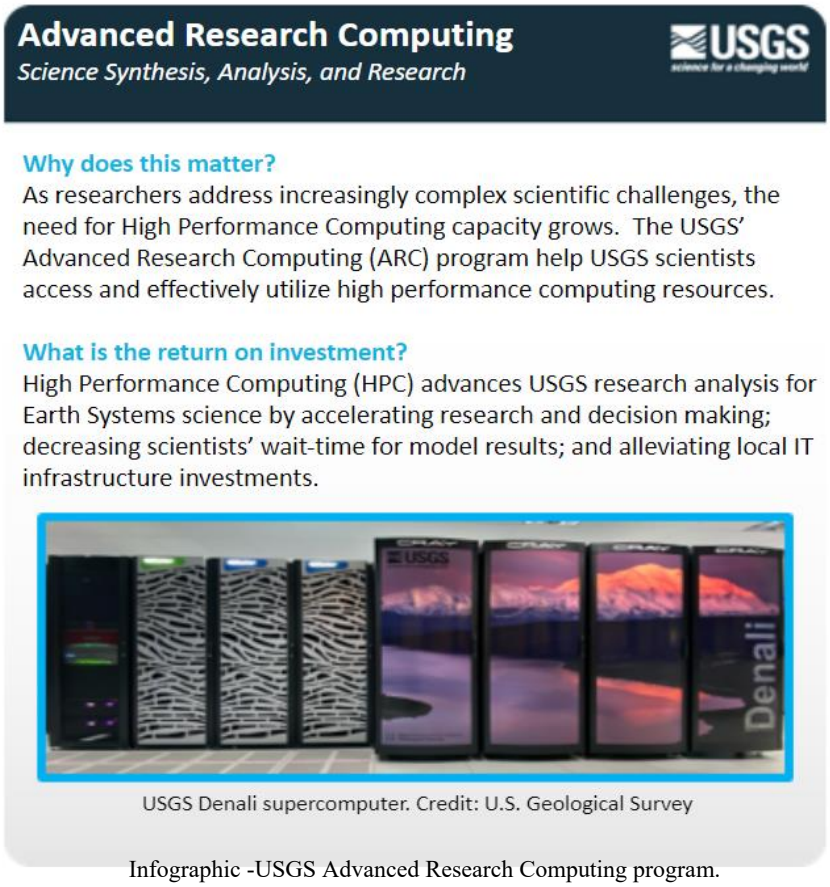
assets. The SSAR ensures that data are strategically managed, integrated, and available to decision makers and others as they focus on issues associated with Earth and life science processes.

The program includes the Science Analytics and Synthesis Program; the National Geological and Geophysical Data Preservation Program; the Geologic Materials Repository (formerly named the Core Research Center); the J.W. Powell Center for Analysis and Synthesis; and the USGS Library, authorized by Congress in 1879. The USGS Library is recognized as one of the world's largest Earth and natural science libraries. Each year, the USGS Library fills more than 2.3 million information requests (journal subscriptions, phone inquiries, online requests) and receives an estimated 10,000 visitors.



USGS Protected Areas Database of the United States

The SSAR program supports the goals of Executive Order 13990 (Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis); Executive Order 14008 (Tackling the Climate Crisis at Home and Abroad); and Executive Order 14017 (America's Supply Chains).



Infographic -USGS Advanced Research Computing program.

Use of Cost and Performance Information

in the USGS Advanced Research Computing Program

As researchers address increasingly complex scientific challenges, the need for High Performance Computing capacity grows. The USGS's Advanced Research Computing program helps USGS scientists to access and effectively utilize high performance computing resources. The USGS uses high performance computing (HPC) to enhance forecasting capacity in support of emergencies. In 2018, the USGS used the Yeti HPC computing cluster to predict Kilauea lava flows for decision making. Yeti can optimize code which runs over 3,300 times faster than a personal computer enabling near-real time hazards forecasting for emergency response. In 2020, the USGS increased the Survey's high-performance computing capacity by adding two new supercomputers and large data storage to complete over 1.3 million jobs, increasing the scale, scope, and timeliness of integrated modeling efforts.

Core Science Systems
National Land Imaging Program

Core Science Systems $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
National Land Imaging Program	**106,865**	**106,865**	**627**	**0**	**9,400**	**116,892**
Science Research and Investigations	**14,557**	**14,557**	**75**	**0**	**0**	**14,632**
Satellite Operations	**84,337**	**84,337**	**451**	**0**	**0**	**84,788**
Land Cover Monitoring and Assessments	**7,971**	**7,971**	**101**	**0**	**9,400**	**17,472**
Tools Supporting Conservation Planning, Monitoring and Projection	*3,858*	*3,858*	*0*	*0*	*5,400*	*9,258*
Biologic Carbon Sequestration	*0*	*0*	*0*	*0*	*4,000*	*4,000*
FTE	***135***	***135***	***0***	***0***	***30***	***165***

2022 Program Changes

The 2022 budget request for the National Land Imaging Program is $116,892,000 and 165 FTE, a program change of +$9,400,000 and +30 FTE from 2021.

Tools Supporting Conservation Planning, Monitoring and Projection (+$5,400,000/+20 FTE) – The USGS proposes to accelerate the delivery of land change monitoring assessment and projection (LCMAP) activities including expansion to Alaska, Hawaii, and the U.S. Territories. This will allow an analysis of rates and trends in land cover and condition from the past to the present; support linking the analyses to protection status and land ownership; and include an assessment of causes of landscape change, including land use, natural disturbance, and climatic factors. The delivery will include modeling of climate scenarios, with national-scale maps of past, present, and potential future landscape conditions and development of conservation scenarios supporting the Administration's America the Beautiful priorities. Similar investments for protected area monitoring in a complementary request are listed in the Science Synthesis, Analysis, and Research Program section.

Biologic Carbon Sequestration (+$4,000,000/+10 FTE) – The USGS proposes to apply multi-sensor analysis and machine learning to enhance, streamline, and deliver improved assessment methodologies and produce regular assessments and monitoring of ecosystem carbon. The USGS would continue to develop land use change and economic scenarios of enhanced carbon management and avoided emissions in the public land management portfolio. The Survey would work with land management agencies to identify

methods that could optimize the protection of carbon resources to serve stakeholders (e.g., forestry, biodiversity). This effort proposes to initiate studies on the feedback between climate change, wildfire, permafrost thaw, hydrologic change, carbon flux, infrastructure, and vulnerability of landscapes in Alaska, an area with rapid climate change. The Core Science Systems Mission Area would work in tandem with the Ecosystems and Energy and Mineral Resources Mission Areas to assist with providing biologic information to help with the completion of the Federal Lands greenhouse gas emissions inventory and sequestration assessment.

Program Overview

The USGS National Land Imaging Program (NLI) delivers remote sensing observation capacity, data, and research to inform land and resource managers and advance understanding of how landscapes and associated natural resources are changing at local, regional, and global scales. Continuous monitoring of the Earth's continents, islands, and coastal regions helps to understand land surface change. The USGS plays a leading role in land surface observations through its Landsat satellite missions that are designed and implemented in collaboration with the National Aeronautics and Space Administration (NASA).

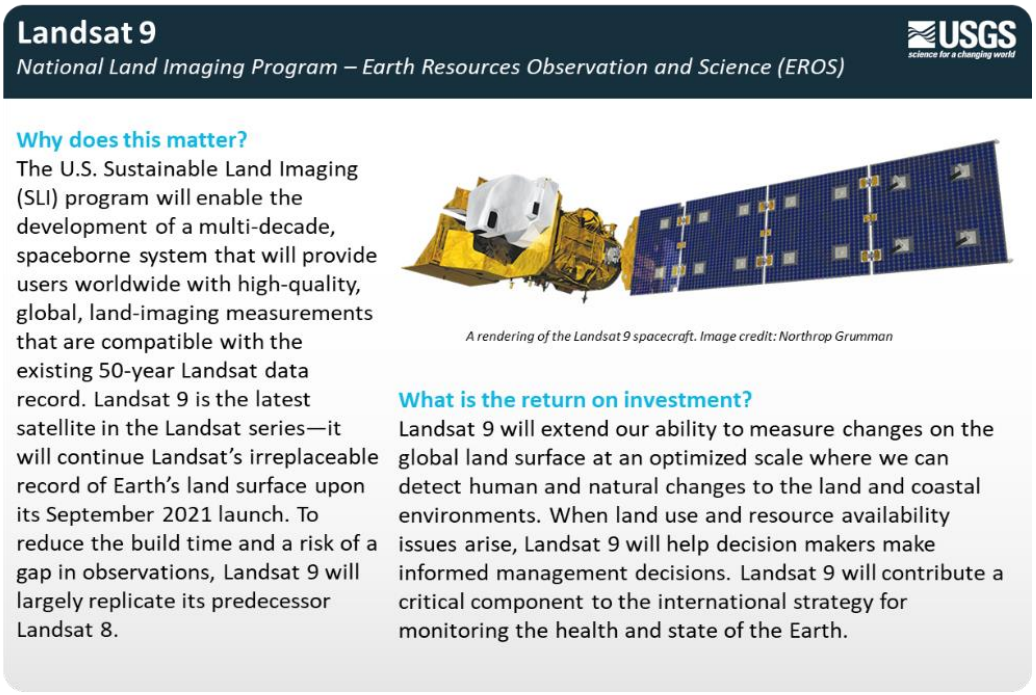
The USGS operates Landsat 7 and Landsat 8 satellites, the only operational civil satellite program with both thermal and short-wave infrared sensors. Landsat 9 is the direct replacement for Landsat 7 and will extend the long-term Landsat observational record to more than five decades of coverage. Together with Landsat 8, it will continue to support a near-weekly Landsat revisit for hundreds of land cover applications, supporting tens of thousands of government, commercial, and academic users across the Nation.

Work continues on the Landsat-Next follow-on mission including the USGS and NASA continuing Landsat-Next mission formulation and related system development. The resulting next-generation land-observing capabilities will continue to support advanced, integrated and predictive science by USGS and its partners. Funding for Satellite Operations includes $32.0 million to support the launch of Landsat 9 and continue developing sustainable land imaging with Landsat Next.

Through the Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota, the USGS collects, processes, archives and provides the Nation with digital land-surface images acquired by satellite and airborne sensors for land and inland water resource management decision makers in all 50 States and 185 countries. The USGS EROS ensures the efficient archiving, processing, and distribution of a wide range of land-imaging data and derived products to users across the Nation, and the advancement of world-class land science research and applications.

The NLI conducts land cover monitoring and assessments, providing land and natural resource managers, policy makers, and stakeholders with data, tools, and scientific information products that support land use and management decisions relevant to the safety of communities, economic prosperity, and condition of natural resources across the Nation. Research products and technical methods produced by the USGS help decision makers apply the knowledge and data gained from on-the-ground and remote sensing observation systems to inform land use planning, natural resource management, and climate adaptation planning decisions.

Other activities within the NLI program include the National Civil Applications Center, which provides the Federal civil agency conduit to National Security Space system data used for applications from volcano monitoring to wildfire response, and Uncrewed Aircraft System (UAS) operations and research.



Infographic on National Land Imaging Program

The NLI program supports the goals of Executive Order 13990 (Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis) and Executive Order 14008 (Tackling the Climate Crisis at Home and Abroad).

Use of Cost and Performance Information in the USGS Landsat Program

Landsat satellites, operating since 1972, provide a continuous global record of the Earth's land surface. Landsat imagery is available at no cost to the public, resulting in the distribution of millions of scenes each subsequent year. Landsat imagery provided domestic and international users an estimated $3.45 billion in benefits in 2017 compared to $2.19 billion in 2011, with U.S. users accounting for $2.06 billion of those benefits (USGS Open-File Report 2019-1112). "The Landsat program continues to be a spectacular value proposition: it unlocks billions in benefits for its users; is a widely recognized "gold" standard reference for commercial Earth observation satellites; and most importantly, provides humanity our longest continuous high-resolution historical record of the Earth's surface since 1972". (Report of the National Geospatial Advisory Committee Landsat Advisory Group, 2020).

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Science Support

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Science Support

Science Support $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Administration and Management Program	**74,881**	**73,787**	**2,468**	**0**	**14,950**	**91,205**
Scientific Integrity, Diversity, and Support	*[1,628]*	*[1,628]*	*0*	*0*	*7,000*	*[8,628]*
DOI Diversity, Inclusion, and Compliance Initiatives	*[0]*	*[0]*	*0*	*0*	*800*	*[800]*
Federal Zero-Emission Fleet	*[0]*	*[0]*	*0*	*0*	*7,150*	*[7,150]*
FTE	***349***	***342***	***0***	***0***	***33***	***375***
Information Services Program	**21,947**	**21,947**	**269**	**0**	**8,000**	**30,216**
IT Support for R&D, including Cloud and High-Performance Computing	*[2,500]*	*[2,500]*	*0*	*0*	*8,000*	*[10,500]*
FTE	***58***	***58***	***0***	***0***	***13***	***71***
Science Support Total	**96,828**	**95,734**	**2,737**	**0**	**22,950**	**121,421**
FTE	***407***	***400***			***46***	***446***

Mission Area Overview

The USGS Science Support Mission Area provides the executive leadership and business and information services including: acquisitions and grants; financial management; communications; budget and performance; monitoring and evaluation of science quality and integrity; information management and technology services; strategic planning; technology transfer, international partnerships, intellectual property, directives management, human capital, diversity and equal opportunity, and the Freedom of Information Act. Each of these programs are crucial to providing the guidance, direction, support, and oversight as part of conducting USGS quality science.

Selected Mission Area Accomplishments

- In response to the COVID-19 pandemic, Science Support came together to provide support to ensure the bureau continued performing its mission requirements. Subject matter experts across multiple critical disciplines worked to develop new policies, procedures, and guidelines USGS centers used

to navigate their new operating environment and expand or continue their operations in a safe manner. The bureau's stable operating environment is a direct result of the team's efforts.

- Expanded the Anti-Harassment Executive Steering Committee to be the Workplace Equity Engagement and Excellence Council (WE3). The WE3 serves as the executive body that provides general direction, guidance, and oversight for the programs, policies, procedures, and practices that address issues and concerns impacting the culture of the USGS, and the proactive and preventative initiatives, activities, and efforts designed to improve work environment.
- The Office of Science Quality and Integrity (OSQI) developed a scalable Quality Management System (QMS) Manual comprised of requirements designed to meet the quality needs of 500 USGS laboratories across the country. The QMS is continuously improved and maintained to ensure high scientific standards and integrity.
- The Office of the Associate Chief Information Officer (ACIO) implemented an enterprise cellular modem management solution to better secure, manage, and standardize usage that supports a wide range of sensors, data loggers, and cameras across the bureau. In addition, on-premise laboratory devices were integrated into the bureau network, creating avenues for specialized instruments to increase efficiencies with more robust modeling.
- The Office of the ACIO implemented two High-Performance Computing services that allow integration of on-premise High-Performance Computing, cloud resources, and big data transfer capabilities to provide USGS the availability to share data securely with our science cooperators. The increasing complexity of USGS science requires all available resources to provide the level of computing power needed for multi-dimensional and multi-year modeling. This new service supports more sophisticated modeling and prediction that informs decision makers in many capacities.
- The Budget and Science Information System Plus (BASIS+) team and consultants across the bureau began a major initiative to modernize our science and business planning processes and the applications that encompass that information. Accomplishments this year include a renewed focus on data integrity, linking Mission Area requirements to projects, and improved reporting capabilities.

For additional information about these programs, please visit the USGS website (www.usgs.gov).

Science Support
Administration and Management

Science Support $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Administration and Management Program	**74,881**	**73,787**	**2,468**	**0**	**14,950**	**91,205**
Scientific Integrity, Diversity, and Support	*[1,628]*	*[1,628]*	*0*	*0*	*7,000*	*[8,628]*
DOI Diversity, Inclusion, and Initiatives	*[0]*	*[0]*	*0*	*0*	*800*	*[800]*
Federal Zero Emission Vehicle Fleet	*[0]*	*[0]*	*0*	*0*	*7,150*	*[7,150]*
FTE	***349***	***342***	***0***	***0***	***33***	***375***

2022 Program Changes

The 2022 budget request for Administration and Management is $91,205,000 and 375 FTE, a program change of $14,950,000 and 33 FTE above the 2021 Enacted budget.

Scientific Integrity, Diversity, and Support (+$7,000,000/+32 FTE) – The USGS would enhance the core functions that make it possible to produce world class science, including scientific integrity, diversity, and business services.

The USGS would protect and enhance scientific integrity for the Department and within USGS by implementing and maintaining key recommendations from a staff survey about scientific integrity, through the use of best practices from the DOI Scientific Integrity Officers Council, and through the use of Presidential Memoranda on scientific integrity. The recommendations include strengthening USGS scientific integrity policies, safeguarding protections against political interference, enhancing the culture of science quality and integrity, and providing opportunities for the professional development and advancement of USGS scientists.

The USGS would also develop a plan to build and sustain human capital pipelines for underserved communities and continue to develop a skilled and a high-performing workforce needed to meet the USGS 21st Century Science Strategy, serving the Nation and advancing diversity goals. These opportunities include engaging Tribal youth in USGS science to support scientific diversity in STEM education and underserved communities; financial assistance (grants and cooperative agreements), research, internships, scholarships, and fellowships to the Nation's Historically Black Colleges and Universities (HBCUs), Minority Serving Institutions (MSI), and eligible community colleges to encourage students to continue studies and pursue advanced degrees in natural science fields that are critical to the USGS.

The USGS would also create science partnerships and internships for Tribal youth through work with Tribes and Native American organizations, emphasizing traditional ecological knowledge (TEK) to acknowledge the understanding and wisdom of Tribal elders and respect Tribal teachings. This initiative will support a team of Tribal youth at the Native Youth Community Adaptation Leadership Congress and provide USGS internships for college students on the team.

This funding invests in the enterprise support required to assist the highest science budget priorities detailed in the President's Budget. These core functions make it possible for the USGS to excel and conduct world-class science. Business services include acquisitions and grants, finance, internal controls, human capital, communications, budget and performance, international engagement and partnerships, and human capital. As the science portfolio has grown, this investment will also begin to help restore capacity to the Science Support budget activity.

DOI Diversity, Equity, Inclusion, and Accessibility Initiative (+$800,000/+2 FTE) – The USGGS budget includes $800,000 as part of a Departmentwide Diversity, Equity, Inclusion, and Accessibility budget initiative to address identified high-priority needs in support of Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, and Executive Order 13988, Preventing and Combating Discrimination on the Basis of Gender Identity and Sexual Orientation. As part of this initiative, the Department, bureaus, and offices will jointly conduct a review of the Diversity, Equity, Inclusion, and Accessibility program across Interior to identify gaps, challenges, and best practices and to examine Department and bureau roles, responsibilities, and governance.

Zero Emission Vehicle Fleet Conversions (+$7,150,000/+1 FTE) – The 2022 budget includes funding to convert approximately 31 percent of the USGS sedan fleet to zero emission vehicles (ZEVs) and provide approximately 50 charging stations and hydrogen fueling stations to support those vehicles and future ZEVs. This conversion will immediately reduce the Interior's contributions to greenhouse gas emissions and dependence upon hydrocarbons. The investment in infrastructure will support these new vehicles and ensure charging infrastructure is available for subsequent ZEVs. This project is being coordinated across Interior and with other agencies to maximize utility of charging and hydrogen fueling stations in areas where multiple agencies operate. The funding also supports a small planning and coordination function to effectively deploy the fleet and charging infrastructure.

Program Overview

The offices and personnel that make up Administration and Management include the Director's Office and the Offices of Administration; Budget, Planning, and Integration; Communications and Publishing; Science Quality and Integrity; International Programs; the Freedom of Information Act Officer, and Diversity and Equal Opportunity.

These activities, along with Information Services, have historically required approximately 12 percent of the total USGS budget to meet the statutory and regulatory requirements, as well as other standards that are the expected level of good business practice for any federal scientific agency and for the Department of the Interior. The two Science Support programs represent the largest share of bureau funds used for these necessary support activities and the rest comes from the science programs, with an appropriate cost

allocation between funds appropriated to USGS and reimbursable funding. Additional information can be found in the USGS Account and Sundry Exhibits chapter under Section 403 Compliance.

Administration and Management, within Science Support, provides bureau-wide leadership and direction; establishes organizational vision, mission, goals and scientific priorities; develops and enforces standards for scientific rigor and integrity; plans, obtains, and manages necessary resources, including people, budget authority, facilities, and equipment; provides resource management systems; implements statutory and regulatory requirements and monitors and enforces compliance; and communicates the USGS mission and science to Congress and the public.

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Science Support
Information Services

Science Support $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Information Services Program	**21,947**	**21,947**	**269**	**0**	**8,000**	**30,216**
IT Support for R&D, including Cloud and High-Performance Computing	*[2,500]*	*[2,500]*	*0*	*0*	*8,000*	*[10,500]*
FTE	***58***	***58***	***0***	***0***	***13***	***71***

2022 Program Changes

The 2022 budget request for Information Services is $30,216,000 and 71 FTE, a program change of $8,000,000 and 13 FTE from the 2021 Enacted budget.

IT Support for R&D, including Cloud and High-Performance Computing (+$8,000,000; +13 FTE) – The USGS would invest in breakthrough IT capabilities that strengthen mission capabilities and support forecasting and foundational predictive science. The continued advancement of USGS science and services depends on increasing computing networks' storage and capacity—fundamental IT requirements for the USGS that will allow for seamless integration across data, applications, and locations.

The USGS would focus on infrastructure, security, and application components to a Cloud Smart architecture, which will support the achievement of goals related to the USGS's 21st Century Science Mission and Vision, alongside 21st Century IT. The USGS would create an integrated, agile, and secure hosting environment that advances analytical and visualization capabilities, artificial intelligence (AI), emerging machine-assisted processes, and service delivery models supporting mission requirements.

Program Overview

The Information Services subactivity includes the Office of the Associate Chief Information Officer (ACIO). The Information Services subactivity provides the critical Information Management and Technology (IMT) foundation for the USGS science mission by implementing advances in IMT and using them to facilitate research, data gathering, analysis, modeling, scientific collaboration, knowledge management, and work processes.

These activities, along with Administration and Management activities, have historically required approximately 12 percent of the total USGS budget to meet the statutory and regulatory requirements, as well as other standards that are the expected level of good business practice for any federal scientific agency and for the Department of the Interior. The two Science Support programs represent the largest share of bureau funds used for these necessary support activities and the rest comes from the science programs, with

an appropriate cost allocation between funds appropriated to USGS and reimbursable funding. Additional information can be found in the USGS Account and Sundry Exhibits chapter under Section 403 Compliance.

The Information Services subactivity supports numerous IMT services such as the USGS information assurance program; network capacity and cloud services; applications and customer support; information investment, management, and delivery programs; and supports the Interior IMT activities through the Department of the Interior's Working Capital Fund.

Facilities

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Facilities

Facilities $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Rental Payments and Operations & Maintenance Program	104,719	104,719	5,427	0	0	110,146
FTE	***80***	***80***	***0***	***0***	***0***	***80***
Deferred Maintenance and Capital Improvement Program	76,164	74,664	0	0	0	74,664
FTE	***0***	***0***	***0***	***0***	***0***	***0***
Facilities Total	180,883	179,383	5,427	0	0	184,810
FTE	***80***	***80***	***0***	***0***	***0***	***80***

Mission Area Overview

The USGS Facilities Mission Area provides safe, functional workspace to accomplish the bureau's scientific mission, with an emphasis on the USGS mission driving facility needs. The Facilities Mission Area goal is to meet bureau science needs while optimizing facility locations, distributions, and use to control or reduce costs.

The USGS defines facilities to include all sites where USGS activities are housed and mission related work is conducted. Facilities typically provide space for offices, laboratories, storage, parking, shared support for cafeterias, conference rooms, and other common space uses. The USGS also classifies its eight larger (greater than 45 feet in length) research vessels as laboratory facilities. Owned assets are usually part of a campus of buildings, for example, the Eastern Ecological Science Center includes all associated land, buildings, and other structures.

The USGS Facilities Activity funds support rent; basic facility operations; security; facility maintenance, in compliance with Federal, State, and local standards; and provides a safe, sustainable working environment for employees, visiting partners, and customers.

The Facilities Program partners with other Federal agencies, State and local governments, universities, and the private sector. Collaboration with these partners supports the USGS's scientific work and facilitates communication of the results of this work to the public, emergency managers, and the scientific community. Partners generally have a mission similar to that of the USGS. In these instances, the USGS occupies space

in return for science-related services or space is acquired as part of a larger cooperative agreement. Typically, the USGS pays a reduced rent rate or the cost of operations and maintenance. Co-locations with other bureaus, agencies, or universities is a space management strategy that advances science, creates partnerships, and facilitates recruitment of new talent.

Selected Mission Area Accomplishments

An example of Deferred Maintenance and Capital Improvement (DMCI) funding being used to support the USGS mission is the move from Menlo Park, CA, to Moffett Field, CA. The USGS is relocating more than 200 employees from Menlo Park, CA, to Moffett Field. This 5- to 6-year long endeavor is in partnership with both the General Services Administration (GSA) and the National Aeronautics and Space Administration (NASA) and will result in annual facility savings to USGS, disposal of underutilized real estate in Menlo Park by GSA through the Federal Asset Sale Transfer Act (FASTA) and subsequent cost-savings in operations and maintenance. The project will also reduce the USGS footprint for the relocated operations by 40 to 50 percent. DMCI funds are being used to relocate employees and labs, as well as renovate space in Moffett Field for USGS to occupy.

Another example: following the eruption of the Kīlauea Volcano, in 2018, and the subsequent loss of the Hawaiian Volcano Observatory (HVO) USGS facility in Hawaii Volcanoes National Park, was the move from HVO into new long term, but temporary, facilities in Hilo and Kea‘au, HI. DMCI funding for interim space needs allowed for this mission critical move to happen, ensuring continued monitoring of the volcano.

For additional information about these programs, please visit the USGS website (www.usgs.gov).

Facilities
Rental Payments and Operations and Maintenance

Facilities $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Rental Payments and Operations & Maintenance Program	**104,719**	**104,719**	**5,427**	**0**	**0**	**110,146**
FTE	***80***	***80***	***0***	***0***	***0***	***80***

2022 Program Changes

The 2022 budget request for Rental Payments and Operations and Maintenance is $110,146,000 and 80 FTE, level with the FY 2021 Enacted budget.

Program Overview

The Rental Payments and Operations and Maintenance Program provides the USGS with the majority of funding needed to pay for annual recurring rent and operations and maintenance (O&M). Rental payments are made to GSA, other Federal sources, private lessors, and cooperators for space occupied by the USGS. The USGS is working to continually enhance facilities efficiencies, in terms of both costs and mission needs. For example, the consolidation of USGS employees into the Bureau of Reclamation facility in Boulder City, NV, provides both enhanced collaboration opportunities between the two DOI bureaus as well as lower and more stable facilities costs for the foreseeable future.

As mentioned, the Rental Payments and Operations and Maintenance program represents the largest share of bureau funds used for both rental payments (GSA and others) and O&M funding of space where USGS has delegated O&M requirements either in lieu of rent or as part of reduced rent. The balance of the funding for these costs is paid by the science programs using the space with an appropriate cost allocation between funds appropriated to USGS and reimbursable funding. Additional information can be found in the USGS Account and Sundry Exhibits chapter under Section 403 Compliance.

The USGS has unique facility requirements for supporting science functions and relies heavily on the GSA to meet those needs, including modern laboratory space.

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Facilities
Deferred Maintenance and Capital Improvements

Facilities $ in thousands	2020 Enacted	2021 Enacted	2022 Fixed Costs	2022 Internal Transfers	2022 Program Changes	2022 President's Request
Deferred Maintenance and Capital Improvement Program	**76,164**	**74,664**	**0**	**0**	**0**	**74,664**
FTE	***0***	***0***	***0***	***0***	***0***	***0***

2022 Program Changes

The 2022 budget request for Deferred Maintenance and Capital Improvements is $74,664,000 and 0 FTE, level with the 2021 Enacted budget.

- There are no proposed changes for Deferred Maintenance and Capital Improvement.

Program Overview

Deferred Maintenance and Capital Improvement (DMCI) funding provides for construction and deferred maintenance/repair projects on USGS-owned and maintained assets and infrastructure. Funding is provided to the highest priority facility requirements in support of USGS mission needs. Prioritization follows annual DOI budget guidelines and funding is primarily directed toward projects that stabilize, restore, replace, or improve life-cycle performance of assets that are mission critical or mission dependent. Projects that facilitate space consolidation, improve utilization, and reduce the bureau space footprint also receive DMCI funding as do other facilities maintenance and management activities that identify, document, track, and remediate maintenance needs.

The FY 2022 budget provides USGS with $74.7 million to fund DMCI projects in the first year of the USGS DMCI 5-year plan. The following table provides a description of how those funds will be used.

Approximate FY 2022 Amount (000)	Project Title	Description
$28,500	Replacement Facility for Denver Federal Center (DFC)-based Laboratories	Initial funding for the replacement facilities for DFC based laboratories currently located in aging and inadequate space identified for disposal by GSA.
$30,000	Menlo to Moffett	Concludes funding for the Menlo to Moffett project, including construction of office and laboratory space at Moffett Field, transfer of staff and equipment, and decommissioning of current facilities to return that facility to GSA for disposal under FASTA
$16,164	Deferred Maintenance Projects	Fund high priority deferred maintenance projects that slow the growth of bureau deferred maintenance backlog.
(Total) $74,664		

Major Project Descriptions and 2022 Estimates

1. Replacement Facility for DFC-Based Laboratories ($28.5 Million)

The USGS Geology, Geophysics, and Geochemistry and Energy laboratories are currently located in Building 20 at the Denver Federal Center. This facility is significantly past its useful life and does not support the existing science requirements of the USGS.

The GSA intends to decommission Building 20 by 2025. The USGS is the only tenant without a relocation solution due to the significant laboratory mission requirement. The USGS had a fully developed agreement with the Colorado School of Mines to co-locate the labs on the university campus with its geophysics department in a newly-constructed building paid for by the university. The COVID-19 pandemic and its financial effects caused the State bond funding for the construction to be withdrawn a few weeks before ground would have been broken for the construction in spring 2020.

The USGS is exploring a number of options for replacing the labs and related space in Building 20 and the 2022 budget funds the initial phase (of an undetermined total) to implement any of those options once a path is identified.

2. Menlo to Moffett ($30 Million)

The USGS is vacating high-cost GSA leased space in Menlo Park, CA, to move to space at Moffett Field, CA. This project involves the construction and renovation of facilities on the NASA campus at Moffett Field. The overall project cost is approximately $120 million, primarily funded through a combination of a GSA rent exemption (e.g., GSA forgoing a portion of the rent for the expressed purpose of the USGS using the funds to vacate Menlo Park). The balance of the work has been funded by various programs within the USGS.

The 2022 budget includes approximately $30 million to complete funding for the second phase of the project. The total cost of the second phase (constructing of laboratory, office, and warehouse space at Moffett Field, decommissioning Menlo Park, and moving personnel and equipment to Moffett Field) is approximately $93 million and is scheduled to be completed in 2023.

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USGS Working Capital Fund

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Working Capital Fund

The Working Capital Fund (WCF) was made available for expenses necessary for furnishing materials, supplies, equipment, work, and services in support of the USGS programs, and as authorized by law, to agencies of the Federal Government and others.

The WCF consists of:

- The WCF Investment Component provides a mechanism to assist the USGS managers in planning for and acquiring goods and services that are too costly to acquire in a single fiscal year or that, due to the nature of services provided, must operate in a multi- as opposed to a single-year basis of funding. Investments are supported by documented investment plans that include estimated acquisition/replacement costs, a schedule of deposits, and approval of the plans, deposits, and expenditures by designated USGS officials.

- The WCF Fee-for-Service Component provides a continuous cycle of client services for fees established in a rate-setting process. Fees are predicated upon both direct and indirect costs associated with providing the services, including amortization of equipment required to provide the services.

- The GSA buildings delegation component is used to manage funds received under the delegated authority for the J.W. Powell Building and Advanced Systems Center in Reston, VA, as provided by 40 U.S.C. 121 (d) and (e) (formerly subsections 205 (d) and (e) of the Federal Property and Administrative Services Act of 1949, as amended, and 40 U.S.C. 486 (d) and (e), respectively). Delegated functions include building operations, maintenance, cleaning, overseeing fire and life safety, maintaining high voltage switchgear and fire alarms, recurring repairs, minor alterations, historic preservation, concessions, and energy management. Because of the size of the Reston buildings and the need to expend the facility funds in a manner corresponding to GSA's no-year funding (Federal Buildings Fund) mechanisms and the GSA National Capital Region long-range capital improvement plan, no-year funding is a prerequisite to administering the delegation. Public Law 104–208, Section 611, provides that, for the fiscal year ending September 30, 1997, and thereafter, any department or agency that has delegated authority shall retain that portion of the GSA rental payment available for operation, maintenance, and repair of the building and the funds shall remain available until expended. This component was established in 2004 to provide the USGS with this no-year flexibility.

Appropriation Language and Citations

P.L. 101-512 Department of the Interior and Related Agencies Appropriations Act, 1991. This authority established a Working Capital Fund account in 1991. The Telecommunications Amortization Fund was included as part of the WCF and all balances of the Telecommunications Amortization Fund existing at the end of 1990 were transferred to the WCF. These balances were to be used for the same purposes as originally authorized.

P.L. 103-332 Department of the Interior and Related Agencies Appropriations Act, 1995. This authority expanded the use to partially fund laboratory operations and facilities improvements and to acquire and replace publication and scientific instrumentation and laboratory equipment.

WORKING CAPITAL FUND

Employment Summary

Identification Code 14-4556-0-4-306		2020 Actual	2021 Estimate	2022 Estimate
	Reimbursable:			
2001	Civilian full-time equivalent employment	102	102	102

USGS Accounts

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USGS Accounts

Appropriations Language

SURVEYS, INVESTIGATIONS, AND RESEARCH

For expenses necessary for the United States Geological Survey to perform surveys, investigations, and research covering topography, geology, hydrology, biology, and the mineral and water resources of the United States, its territories and possessions, and other areas as authorized by 43 U.S.C. 31, 1332, and 1340; classify lands as to their mineral and water resources; give engineering supervision to power permittees and Federal Energy Regulatory Commission licensees; administer the minerals exploration program (30 U.S.C. 641); conduct inquiries into the economic conditions affecting mining and materials processing industries (30 U.S.C. 3, 21a, and 1603; 50 U.S.C. 98g(a)(1)) and related purposes as authorized by law; and to publish and disseminate data relative to the foregoing activities; **[$1,315,527,000]** *$1,642,437,000,* to remain available until September 30, **[2022]** *2023*; of which **[$84,337,000]** *$84,788,000* shall remain available until expended for satellite operations; and of which $74,664,000 shall be available until expended for deferred maintenance and capital improvement projects that exceed $100,000 in cost: *Provided*, That none of the funds provided for the ecosystem research activity shall be used to conduct new surveys on private property, unless specifically authorized in writing by the property owner: *Provided further*, That no part of this appropriation shall be used to pay more than one-half the cost of topographic mapping or water resources data collection and investigations carried on in cooperation with States and municipalities. *(Department of the Interior, Environment, and Related Agencies Appropriations Act, 2021.)*

ADMINISTRATIVE PROVISIONS

From within the amount appropriated for activities of the United States Geological Survey such sums as are necessary shall be available for contracting for the furnishing of topographic maps and for the making of geophysical or other specialized surveys when it is administratively determined that such procedures are in the public interest; construction and maintenance of necessary buildings and appurtenant facilities; acquisition of lands for gauging stations, observation wells, and seismic equipment; expenses of the United States National Committee for Geological Sciences; and payment of compensation and expenses of persons employed by the Survey duly appointed to represent the United States in the negotiation and administration of interstate compacts: *Provided*, That activities funded by appropriations herein made may be accomplished through the use of contracts, grants, or cooperative agreements as defined in section 6302 of title 31, U.S. Code: *Provided further*, That the United States Geological Survey may enter into contracts or cooperative agreements directly with individuals or indirectly with institutions or nonprofit organizations, without regard to 41 U.S.C. 6101, for the temporary or intermittent services of students or recent graduates, who shall be considered employees for the purpose of chapters 57 and 81 of title 5, United States Code, relating to compensation for travel and work injuries, and chapter 171 of title 28, United States Code, relating to tort claims, but shall not be considered to be Federal employees for any other purposes. *(Department of the Interior, Environment, and Related Agencies Appropriations Act, 2021.)*

Authorizations

A full listing of USGS authorizations is available at the USGS Office of Budget, Planning, and Integration website.

Website: https://www.usgs.gov/about/organization/science-support/budget/authorizations

Expiring Authorizations

None.

Summary of Requirements

Activity/Subactivity/ Program Element	2020	2021 Enacted		Fixed Costs	Internal Transfers		Program Changes		2022 Request		Change from 2021	
	$	FTE	$		FTE	$	FTE	$	FTE	$	FTE	$
Environmental Health Program	23,495	121	24,745	+494		500		+0	121	25,739	+0	+994
Species Management Research Program	53,714	246	53,914	+1,004		-500	+22	+12,500	268	66,918	+22	+13,004
Land Management Research Program	56,681	275	56,681	+1,122		+0	+30	+17,500	305	75,303	+30	+18,622
Biological Threats and Invasive Species Research Program	36,149	172	38,249	+702		+0	+10	+5,000	182	43,951	+10	+5,702
Cooperative Research Units Program	24,000	124	25,000	+506		+0		+0	124	25,506	+0	+506
Climate Adaptation Science Center and Land Change Science Program	57,488	199	60,488	+812		+0	+105	+59,500	304	120,800	+105	+60,312
Ecosystems Total	**251,527**	**1,137**	**259,077**	**+4,640**	**+0**	**+0**	**+167**	**+94,500**	**1,304**	**358,217**	**+167**	**+99,140**
Mineral Resources Program	59,869	286	59,869	+1,368		+0	+46	+25,000	332	86,237	+46	+26,368
Energy Resources Program	30,172	118	30,172	+564		+0	+21	+23,000	139	53,736	+21	+23,564
Energy and Mineral Resources	**90,041**	**404**	**90,041**	**+1,932**	**+0**	**+0**	**+67**	**+48,000**	**+471**	**+139,973**	**+67**	**+49,932**
Earthquake Hazards Program	84,903	253	85,403	+1,234		+0	+14	+6,000	267	92,637	+14	+7,234
Volcano Hazards Program	30,266	157	30,266	+766		+0	+9	+2,500	166	33,532	+9	+3,266
Landslide Hazards Program	4,038	29	8,038	+141		+0	+6	+3,000	35	11,179	+6	+3,141
Global Seismographic Network	7,153	12	7,153	+59		+0	+0	+0	12	7,212	+0	+59
Geomagnetism Program	4,000	12	4,114	+59		+0	+2	+1,500	14	5,673	+2	+1,559
Coastal-Marine Hazards and Resources Program	40,510	206	40,510	+1,005		+0	+28	+16,000	234	57,515	+28	+17,005
Natural Hazards Total	**170,870**	**669**	**175,484**	**+3,264**	**+0**	**+0**	**+59**	**+29,000**	**728**	**207,748**	**+59**	**+32,264**

Activity/ Subactivity/ Program Element	2020	2021 Enacted		Fixed Costs	Internal Transfers		Program Changes		2022 Request		Change from 2021	
	$	FTE	$		FTE	$	FTE	$	FTE	$	FTE	$
Water Resources Research Act Program	10,000	1	11,000	+0		+0	+0	+0	1	11,000	+0	+0
Water Availability and Use Science Program	47,487	401	57,987	+1,514		+0	+67	+10,000	468	69,501	+67	+11,514
Groundwater and Streamflow Information Program	84,173	524	100,673	+1,978		+0	+34	+10,000	558	112,651	+34	+11,978
National Water Quality Program	92,460	472	93,460	+1,782		+0	+0	+0	472	95,242	+0	+1,782
Water Resources Total	**234,120**	**1,398**	**263,120**	**+5,274**	**+0**	**+0**	**+101**	**+20,000**	**1,499**	**288,394**	**+101**	**+25,274**
National Geospatial Program	79,454	247	79,454	+1,144		+0	+1	+5,000	248	85,598	+1	+6,144
National Cooperative Geologic Mapping Program	34,397	115	40,397	+534		-350	+0	+0	115	40,581	+0	+184
Science Synthesis, Analysis and Research Program	25,972	82	25,972	+381		+350	+4	+72,100	86	98,803	+4	+72,831
National Land Imaging Program	106,865	135	106,865	+627		+0	+30	+9,400	165	116,892	+30	+10,027
Core Science Systems Total	**246,688**	**579**	**252,688**	**+2,686**	**+0**	**+0**	**+35**	**+86,500**	**614**	**341,874**	**+35**	**+89,186**
Administration and Management	74,881	342	73,787	+2,468		+0	+33	+14,950	375	91,205	+33	+17,418
Information Services	21,947	58	21,947	+269		+0	+13	+8,000	71	30,216	+13	+8,269
Science Support Total	**96,828**	**400**	**95,734**	**+2,737**	**+0**	**+0**	**+46**	**+22,950**	**446**	**121,421**	**46**	**+25,687**
Rental Payments and Operations & Maintenance	104,719	80	104,719	+5,427		+0		+0	80	110,146	+0	+5,427
Deferred Maintenance and Capital Improvement	76,164	0	74,664	+0		+0		+0	0	74,664	+0	+0
Facilities Total	**180,883**	**80**	**179,383**	**+5,427**	**+0**	**+0**	**+0**	**+0**	**80**	**184,810**	**+0**	**+5,427**
Total, USGS	**1,270,957**	**4,667**	**1,315,527**	**25,960**	**0**	**0**	**475**	**300,950**	**5,142**	**1,642,437**	**475**	**326,910**

Fixed Costs

United States Geological Survey
Justification of Fixed Costs and Internal Realignments
(Dollars in Thousands)

Fixed Cost Changes and Projections	2021 Change	2021 to 2022 Change
Change in Number of Paid Days	-2,071	+0
This column reflects changes in pay associated with the change in the number of paid days between FY 2021 and FY 2022, which is the same number of paid days in both FY 2021 and FY 2022 (261 days or 2,088 hours).		
Pay Raise	+8,334	+14,799
The President's Budget for FY 2022 includes one quarter of a planned 1.0 percent pay raise and three quarters of a planned 2.7 percent pay raise.		
Employer Share of Federal Employee Retirement System	+5,053	+5,153
The change reflects a 1.1 percent (and 1.8 percent for Law Enforcement) increase in the employer contribution to the Federal Employees Retirement System.		
Departmental Working Capital Fund	+158	+1,240
This change reflects the final FY 2022 Central Bill approved by the Working Capital Fund Consortium.		
Worker's Compensation Payments	+280	-470
The amount reflects final chargeback costs of compensating injured employees and dependents of employees who suffer accidental deaths while on duty. Costs for FY 2022 will reimburse the Department of Labor, Federal Employees Compensation Fund, pursuant to 5 U.S.C. 8147(b) as amended by Public Law 94-273.		
Unemployment Compensation Payments	-72	+103
The amounts reflect projected changes in the costs of unemployment compensation claims to be paid to the Department of Labor, Federal Employees Compensation Account, in the Unemployment Trust Fund, pursuant to Public Law 96-499.		
Rental Payments	+2,584	+5,135
The amounts reflect changes in the costs payable to General Services Administration (GSA) and others for office and non-office space as estimated by GSA, as well as the rental costs of other currently occupied space. These costs include building security; in the case of GSA space, these are paid to the Department of Homeland Security. Costs of mandatory office relocations, i.e., relocations in cases where due to external events there is no alternative but to vacate the currently occupied space, are also included.		
Baseline Adjustments for O&M Increases	+0	+0
In accordance with space maximization efforts across the Federal Government, this adjustment captures the associated increase to baseline operations and maintenance (O&M) requirements resulting from movement out of GSA or direct-leased (commercial) space and into Bureau-owned space. Although the GSA portion of fixed costs will go down as a result of these moves, Bureaus often encounter an increase to baseline O&M costs not otherwise captured in fixed costs. This category of funding properly adjusts the baseline fixed cost amount to maintain steady-state funding for these requirements.		

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Account and Sundry Exhibits

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Account and Sundry Exhibits

Employment Summary

SURVEYS, INVESTIGATIONS, AND RESEARCH

Identification Code 14-0804-0-1-306		2020 Actual	2021 Estimate	2022 Estimate
	Direct:			
1001	Civilian full-time equivalent employment	4,511	4,667	5,142
	Reimbursable:			
2001	Civilian full-time equivalent employment	2,931	2,931	2,931
	Allocation account:			
3001	Civilian full-time equivalent employment	17	17	17

CONTRIBUTED FUNDS

Identification Code 14-8562-0-7-306		2020 Actual	2021 Estimate	2022 Estimate
	Direct:			
1001	Civilian full-time equivalent employment	4	4	4

Employee Count by Grade

(Total Employment)

		2020 Actual	2021 Estimate	2022 Estimate
Executive Level V		1	1	1
SES		17	18	18
	Subtotal	18	19	19
SL – 00		9	9	9
ST – 00		35	36	37
	Subtotal	44	45	46
GS/GM – 15		433	431	459
GS/GM – 14		712	709	754
GS/GM – 13		1,119	1,114	1,185
GS – 12		1,515	1,509	1,605
GS – 11		1,338	1,333	1,417
GS – 10		15	15	16
GS – 9		974	970	1,032
GS – 8		229	228	243
GS – 7		619	616	656
GS – 6		255	254	270
GS – 5		326	325	345
GS – 4		115	115	122
GS – 3		47	47	50
GS – 2		9	9	10
GS – 1		5	5	5
	Subtotal	7,711	7,680	8,168
Other Pay Schedule Systems		209	209	209
Total employment (actual/estimate)		**7,982**	**7,953**	**8,442**

Section 403 Compliance

This section describes details related to any assessments to, or within, the USGS to support bureau-wide services and functions to support governmentwide, DOI-wide, bureau-wide and regional administrative functions, headquarters, and central operations.

External Administrative Costs	2022 Estimate ($000)
Department of the Interior Working Capital Fund and Payments to Other Federal Agencies	
WCF Centralized Billings	*$19,542*
WCF Direct Billings	*$15,191*
Worker's Compensation Payments	*$1,682*
Unemployment Compensation Payments	*$545*
GSA Rental Payments	*$115,132*
Bureau Administrative Costs	
Shared Program Costs	*$40,000*
Bureau-Level Costs	*$39,000*
Reimbursable Overhead	*$43,000*

Department of the Interior Working Capital Fund and Payments to Other Federal Agencies

The Department's Working Capital Fund was established pursuant to 43 U.S.C. 1467, to provide common administrative and support services efficiently and economically at cost. The Fund is a revolving fund, whereby capital is expended to provide services for customers who pay for the services. Customers consist of the Department's bureaus and offices, as well as other Federal agencies. Through the use of centrally provided services, the Department standardized key administrative areas such as commonly used administrative systems, support services for those located in and around the Main Interior building complex, and centrally managed departmental operations that are beneficial to the bureaus and offices. **Centralized billing** is used whenever the product or service being provided is not severable or it is inefficient to bill for the exact amount of product or service being procured. Customers are billed each year using a pre-established basis that is adjusted annually to reflect change over time. These bills are paid for by both the Administrative and Management and the Information Services subactivities within Science Support, and payment may be adjusted accordingly between these lines during the year of execution based on the enacted appropriation.

Direct billing is used whenever the product or service provided is severable but is sold through a time and materials reimbursable support agreement or similar contractual arrangement.

More information related to payments to other Federal agencies can be found in the USGS Account chapter under the fixed cost exhibit.

Bureau Administrative Costs

Shared Program Costs

The USGS maintains an estimated (up to) five percent of its budget submission for other bureau-wide support and science-related activities. These funds are used for initiatives which may be unfunded mandates, are crosscutting in nature, or respond to new bureau priorities. The USGS is developing new program assessments for emerging scientific and support issues.

The funding for the initiatives in the Shared Program Costs are assessed at the budget activity level, based upon one of two methodologies: proportionately based on total appropriated funds for the mission area; or proportionately based on total funds for the mission area, including reimbursable funding sources. The methodology used is tied to the nature of the initiative. For instance, an initiative that is crosscutting to all the mission areas but is purely an Interior priority (one in which an external partner is not a stakeholder, nor receives direct benefit of the service) would receive its funding based upon a calculation on appropriated funds only. Conversely, an initiative where all customers of the USGS either directly or indirectly receive benefit, such as information technology compliance or security upgrades, would be calculated to each of the mission areas based upon all funding sources, both appropriated and reimbursable. The initiatives on the Shared Program Cost Chart are vetted each year with the Executive Leadership Team of the USGS and are decided upon in a voting process to ensure bureau-wide concurrence.

Bureau-Level Costs

The USGS manages overhead costs at two levels—the bureau and science center. Bureau-level costs include headquarters and area executive, managerial, supervisory, administrative, and financial functions and bureau-wide systems. Funding appropriated to the Science Support budget subactivities pays much of the bureau-level costs. For this reason, bureau-level costs collected on reimbursable support agreements are deposited within Science Support program areas as well. Additionally, the USGS may allocate costs for these activities typically funded out of the science support program to the direct appropriation for those programs when those costs exceed amounts allocated to science support subactivities in the appropriation. At the 2022 request level, these costs are approximately three percent of the science program appropriations. Taken as a whole, support for science mission areas is up to 12 percent of the USGS operating budget of appropriated programmatic funding to pay for science support costs.

At the science center level, as there generally is not a direct appropriated funding source to pay the local overhead (common services) costs, both the direct appropriated and reimbursable funding are assessed to cover science center-level costs. Science center common services costs include center costs that are not directly attributable to a specific activity or project, such as managerial, supervisory, administrative, and financial functions and related systems, as well as costs incidental to providing services and products, such as postage, training, miscellaneous supplies and materials. During 2020, the cost for the local overhead totaled $201 million; however, these costs are not included in Section 403 estimates.

Reimbursable Overhead

The USGS also assesses a bureau overhead rate, estimated to remain at 12 percent, on reimbursable work from non-Interior customers to recoup their share of bureau-level costs. In some cases, the USGS assesses

a special or reduced rate when it can be demonstrated that indirect costs are substantially and consistently less than the norm and the amount collected covers the full costs, such as with pass-through funding where the USGS does not perform any of the actual work.

In recognition of the USGS role as the science bureau for the Department of the Interior, the USGS is continuing to give Interior bureaus and offices a "preferred" customer rate on overhead charges for a significant portion of reimbursable work, to the extent that matching funds are available within the USGS budget. The maximum rate that cost centers may charge other Interior bureaus for common services and bureau costs combined remains 15 percent net. In 2020, of the 15 percent, 7.5 percent is applied to bureau costs, and the remaining 7.5 percent is applied to common services costs. Cost centers must fund the common services costs not recovered (e.g., the difference between the cost center's standard common services costs and the 7.5 percent) from USGS appropriated funds. In this way, the USGS is partnering on the science needs of Interior from both the bureau and cost centers.

The Associate Director for Administration establishes the USGS bureau special rate for each fiscal year. The special rate for 2022 is estimated to remain at three percent. Cost centers do not charge more than the bureau special rate for facilities-related costs or their standard common services rate when funding is approved for a bureau-level special rate. Special rates are applied under the following circumstances:

- When the USGS receives funds from a non-USGS organization and awards a grant to a third-party entity.
- When the USGS receives funds from one or more non-USGS organizations to support, under USGS leadership, a strategic science objective that includes the USGS passing through funds to one or more third-party entities.
- When the USGS receives funds from a non-USGS organization for the purpose of the customer acquiring services through the Cartographic Services or the Remotely Sensed Data Contracts. The special rate helps encourage other Federal agencies to use these contracts for cartographic services and remotely sensed data, rather than establishing and managing their own contracts, and ensures greater data consistency through the use of common service providers.

USGS Organizational Chart