



Report to the Ranking Member,
Committee on Armed Services, U.S.
Senate

December 2020

CLIMATE RESILIENCE

DOD Coordinates with Communities, but Needs to Assess the Performance of Related Grant Programs

Accessible Version

GAO Highlights

Highlights of [GAO-21-46](#), a report to the Ranking Member, Committee on Armed Services, U.S. Senate

Why GAO Did This Study

DOD manages a domestic real-estate portfolio with an estimated replacement value of nearly \$930 billion. DOD has acknowledged climate change and extreme weather as threats to its installations, operations, and readiness; and has noted the importance of coordinating with state and local governments to improve climate change preparedness and resilience.

GAO was asked to review DOD's efforts to coordinate with communities surrounding its installations to limit the exposure to climate change and extreme weather. This report assesses the extent to which DOD (1) reports using the physical infrastructure and support services of communities surrounding domestic installations, and the vulnerabilities to such infrastructure and services from climate change and extreme weather, and (2) coordinates with such communities to limit installation exposure to the effects of climate change and extreme weather, and is able to determine the effectiveness of related community coordination grants. GAO surveyed 65 domestic military installations, reviewed documents related to climate resilience, and interviewed DOD and community officials.

What GAO Recommends

GAO is making three recommendations related to developing performance measures for DOD's community grant programs. DOD concurred with all three recommendations.

View [GAO-21-46](#). For more information, contact Elizabeth A. Field at (202) 512-2775 or FieldE1@gao.gov.

December 2020

CLIMATE RESILIENCE

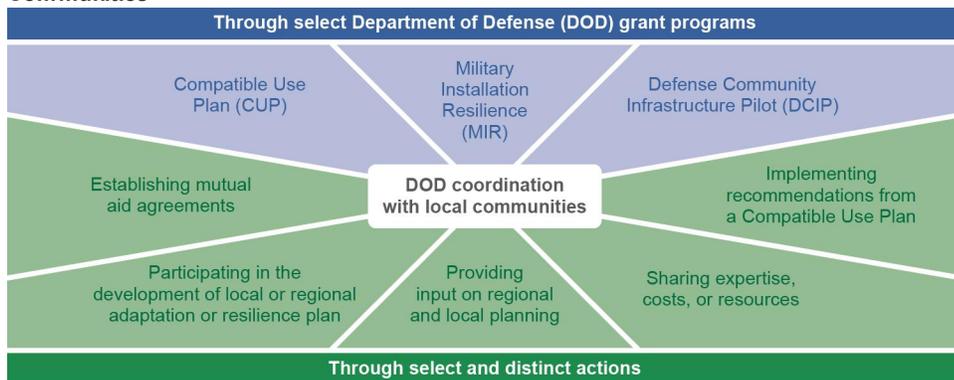
DOD Coordinates with Communities, but Needs to Assess the Performance of Related Grant Programs

What GAO Found

Department of Defense (DOD) domestic installations report extensive and varied use of community infrastructure and support services—such as roads, bridges, electricity, water, and medical facilities—that are vulnerable to disruptions from climate change and extreme weather. For example, 62 of the 63 installations (98 percent) that responded to GAO's survey report relying on communities for electricity, access roads or bridges, and telecommunications.

DOD installations also report taking a range of actions to coordinate with organizations—including public utilities, county governments, and state agencies—to limit installation exposure to the effects of climate change and extreme weather.

Department of Defense's Climate Change and Extreme Weather Coordination Efforts with Communities



Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

Note: CUP studies result in recommendations that address threats to installation readiness; MIR studies identify risks to infrastructure outside an installation; and DCIP provides construction funds to communities to address, among other things, deficiencies in community infrastructure that support military installation resilience.

DOD administers three grant programs that support community coordination with local installations on climate change and extreme weather—the longstanding Compatible Use Plan (CUP), and the Military Installation Resilience (MIR) and Defense Community Infrastructure Pilot (DCIP) programs established in fiscal year 2020. DOD and community officials emphasized the value of these grant programs as a means of facilitating and funding coordination with surrounding communities, including through joint land use studies and community infrastructure development. In fiscal year 2020, about \$67 million was awarded under the three grant programs.

While DOD monitors the status of individual CUP grant expenditures and deliverables—and plans to similarly monitor its MIR and DCIP grants—it is unable to determine the effectiveness of the grant programs. Specifically, DOD has not developed performance measures to benchmark and to track overall program performance. Without establishing performance measures for these grant programs, DOD and Congress are limited in determining whether desired outcomes are being achieved and whether current and future investments in the grant programs are delivering their intended value.

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Abbreviations

CUP	Compatible Use Plan
DCIP	Defense Community Infrastructure Pilot
DOD	Department of Defense
MIR	Military Installation Resilience
OEA	Office of Economic Adjustment

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December 10, 2020

The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate
Dear Mr. Reed:

The Department of Defense (DOD) manages a domestic real-estate portfolio with an estimated replacement value of almost \$930 billion, including installations in all regions of the continental United States, Alaska, and Hawaii. These installations are critical to maintaining military readiness and supporting military servicemembers and their families. To accomplish their missions, installations rely on the infrastructure and support services of surrounding communities.¹ For example, servicemembers use community roads and bridges to access installations for work and installations rely on community providers to repair infrastructure on base, such as downed electric poles.² Since 2010, DOD has acknowledged climate change and extreme weather as a threat to its installations and operations,³ and in January 2016 issued guidance noting

¹For this report we use the term infrastructure to include (1) access roads and bridges; (2) access rail lines; (3) ports; (4) airports; (5) public transportation; (6) dams, levees, and seawalls; (7) medical facilities; (8) stormwater management infrastructure; and (9) commodity infrastructure systems and commodities, such as natural gas, telecommunications, water, wastewater, and electricity. Support services include the provision of (1) any repair or maintenance of installation transportation infrastructure, (2) any repair or maintenance of on installation commodity infrastructure, (3) any public safety services, and (4) any wildfire prevention activities.

²For purposes of this report, extreme weather events are events that are unusual or unusually severe for a particular place. By definition, the characteristics of what is referred to as “extreme weather” may differ from place to place. Extreme weather events may typically include extreme heat or cold and extreme precipitation events.

³DOD, *Quadrennial Defense Review Report* (February 2010).

the importance of engaging with state and local governments to improve climate change preparedness and resilience.⁴

The U.S. Global Change Research Program's *Fourth National Climate Assessment* states that climate-related events and extreme weather will become more frequent and more intense in a warmer world, creating greater risks of infrastructure disruption.⁵ When hurricanes or other extreme weather events occur, community infrastructure may not operate as well or for as long as planned, negatively affecting DOD operations and infrastructure. For example, extreme precipitation can cause flooding that makes roads impassable and prevents people from getting to the installation for work, while wildfires can destroy off-installation electrical infrastructure and result in power outages on the installation.

Because of the federal government's fiscal exposure from climate change and extreme weather, in February 2013, we placed *Limiting the Federal Government's Fiscal Exposure by Better Managing Climate Change Risks* on our High-Risk List.⁶ As part of our work in this area, we have reported on the effects of climate change and extreme weather on DOD installations and on DOD's efforts to increase its climate resilience.⁷ For example, in June 2019 we reported that DOD installations had not

⁴Department of Defense Directive 4715.21, *Climate Change Adaptation and Resilience* (Jan. 14, 2016) (incorporating change 1, effective Aug. 31, 2018). The John S. McCain National Defense Authorization Act for Fiscal Year 2019 amended 10 U.S. C. § 101(e) by defining military installation resilience as the ability to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions, that do, or have the potential to, adversely affect the military installation or essential transportation, logistical, or other necessary resources outside of the military installation that are necessary in order to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions. Pub. L. No. 115-232, § 2805(e) (2018).

⁵U.S. Global Change Research Program, *Fourth National Climate Assessment, Volume II Impacts, Risks, and Adaptation in the United States* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)] (Washington, D.C.: 2018).

⁶GAO, *High-Risk Series: An Update*, [GAO-13-283](#) (Washington, D.C.: Feb. 14, 2013). See also *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas*, [GAO-19-157SP](#) (Washington, D.C.: Mar. 6, 2019).

⁷See, e.g., GAO, *Climate Change Adaptation: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts*, [GAO-14-446](#) (Washington, D.C.: May 30, 2014), and *Climate Change Adaptation: DOD Needs to Better Incorporate Adaptation into Planning and Collaboration at Overseas Installations*, [GAO-18-206](#) (Washington, D.C.: Nov. 13, 2017).

consistently assessed risks from climate change and extreme weather events or consistently used climate projections to anticipate future climate conditions in developing selected installation master plans and selected individual facilities' project designs.⁸ We also found that selected individual facilities' project designs at the installations we reviewed generally did not consider climate projections, according to installation officials. We made eight recommendations, including that the military departments update master planning criteria to require an assessment of climate change and extreme weather risks, and that they incorporate, as appropriate, DOD guidance on the use of climate projections into facilities' design standards. In October 2019, the military departments updated the Unified Facilities Criteria for installation master planning to require that each installation identify and assess the risks to the installation from the effects of climate change and extreme weather, and develop plans to address those risks. Further, they expect to subsequently issue guidance on the use of climate projections in facilities design standards.

You asked us to review DOD's efforts to coordinate with communities surrounding its installations to limit the exposure of installations to climate change and extreme weather. This report assesses the extent to which DOD (1) reports using the physical infrastructure and support services of communities surrounding its domestic installations, along with vulnerabilities to such infrastructure and services resulting from climate change and extreme weather, and (2) coordinates with communities surrounding its domestic installations to limit installation exposure to the effects of climate change and extreme weather, and is able to determine the effectiveness of related community coordination grants.

To address both of our objectives, we surveyed a nongeneralizable sample of 65 domestic DOD installations. The survey addressed, among other things, the installations' reliance on the physical infrastructure and support services of surrounding communities, and the extent to which climate change and extreme weather events have affected or are

⁸GAO, *Climate Resilience: DOD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs*, [GAO-19-453](#) (Washington, D.C.: June 12, 2019).

projected to affect such infrastructure and services.⁹ The survey also collected information on the extent to which the installations coordinate with communities to limit installation exposure to the effects of climate change and extreme weather events, challenges to such coordination, and potential actions that could be taken to improve installations' ability to coordinate with surrounding communities on these issues. Our survey sample included domestic installations that DOD identified as having significant vulnerabilities to the effects of climate change and extreme weather, and installations that the military services report as being most vulnerable to those effects.¹⁰ We received responses from 63 of the 65 installations, for a response rate of 97 percent.

For both objectives, we also reviewed documents and interviewed officials from the Office of the Secretary of Defense, the military service installation commands, and select communities surrounding military installations.¹¹ We visited or contacted seven military installations, which we selected based on factors such as location, military service representation, and the type of climate change and extreme weather events each faced. We included joint bases to gain perspective on unique issues that may face such installations. We also considered whether installations had participated in a planning study with the surrounding community, which we considered an indication of coordination with communities.

⁹We chose five effects of climate change (recurrent flooding, drought, desertification, wildfire, and thawing permafrost) identified by DOD as affecting its installations to include in our review. See Office of the Under Secretary of Defense for Acquisition and Sustainment, *Report on Effects of a Changing Climate to the Department of Defense* (January 2019). We also included three types of extreme weather events—extreme heat, extreme cold, and extreme precipitation.

¹⁰In March 2019, DOD provided Congress with a list of 46 installations that it determined were vulnerable to climate change and extreme weather. The military services later provided additional lists to Congress comprising the installations most vulnerable to climate change and extreme weather. Our sample of 65 domestic installations comprises 63 unique installations from across the lists, and one installation DOD identified as being vulnerable to thawing permafrost. We also surveyed Naval Weapons Station Earle, New Jersey, after having identified actions taken by that installation to coordinate with surrounding communities to limit installation exposure to the effects of climate change and extreme weather.

¹¹We interviewed community officials from Bay County, Florida; the Flint Hills region, Kansas; the Hampton Roads region, Virginia; Monmouth County, New Jersey; Prince George's County, Maryland; and the San Diego region, California.

For objective two, we compared installation and DOD actions identified through our survey, interviews, and review of documents, such as community-installation studies, with DOD guidance on climate change adaptation.¹² We evaluated DOD's community coordination grant programs with DOD guidance that establishes grant program oversight responsibilities for the DOD Office of Economic Adjustment (OEA)¹³ and elements of our *Disaster Resilience Framework* related to using federal investments to reduce the overall impact of disasters and stimulate additional investment by nonfederal partners.¹⁴ We also determined that the risk assessment component of internal control was significant to this objective, along with the underlying principle that management should define program objectives in measurable terms so that performance toward achieving those objectives can be assessed.¹⁵ To determine the extent to which DOD is able to determine the effectiveness of its community coordination grant programs, we interviewed officials responsible for those programs and reviewed documents related to program oversight. We also assessed these documents against our prior

¹²DOD Directive 4715.21.

¹³Department of Defense Instruction 3030.03, *Joint Land Use Study (JLUS) Program* (July 13, 2004), (incorporating change 1, Aug. 31, 2018).

¹⁴GAO, *Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters*, [GAO-20-100SP](#) (Washington, D.C.: October 2019). Our *Disaster Resilience Framework* is organized around three broad overlapping principles—information, integration, and incentives—and provides questions that those who provide oversight or management of federal efforts can consider when analyzing opportunities to enhance their contribution to national disaster resilience. The Framework is based on (1) a large and expanding literature on resilience, (2) the findings and recommendations of over 50 related GAO reports, (3) expert review of the Framework, (4) internal review by GAO subject matter experts, and (5) technical comments from federal, state, and non-profit bodies with expertise in resilience.

¹⁵GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#), (Washington, D.C.: Sept. 10, 2014).

work on performance measurement leading practices.¹⁶ Further details on our scope and methodology can be found in appendix I, and a copy of our survey questions can be found in appendix II.

We conducted this performance audit from June 2019 to December 2020 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

While this audit was conducted through December 2020, audit work concluded in August 2020. The publication of the final report was delayed for approximately two months while DOD conducted a review of the contents of the report to ensure that no classified or sensitive information was present.

Background

Climate Change, Extreme Weather Events, and Infrastructure Risk

Climate change and extreme weather events can damage the infrastructure of DOD installations and the communities surrounding

¹⁶See GAO, *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, [GAO-03-143](#) (Washington, D.C.: Nov. 22, 2002), for a description of how we developed the attributes. In [GAO-03-143](#), we identified nine attributes of performance measures from multiple sources, such as Office of Management and Budget Circular No. A-11, the Government Performance and Results Act of 1993, the Internal Revenue Service's handbook on Managing Statistics in a Balanced Measures System, and various sources of performance-management literature. In addition, we drew on previous GAO work including *GPRA Performance Reports*, [GAO/GGD-96-66R](#) (Washington, D.C.: Feb. 14, 1996) and *The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans*, [GAO/GGD-10.1.20](#) (Washington, D.C.: April 1998). In subsequent reports, we identified a 10th attribute—baseline and trend data. See, for example, *Defense Health Care Reform: Additional Implementation Details Would Increase Transparency of DOD's Plans and Enhance Accountability*, [GAO-14-49](#) (Washington, D.C.: Nov. 6, 2013).

them, directly affecting installation functions. According to the *Fourth National Climate Assessment*, climate change is altering the characteristics of many climate-related and extreme weather events.¹⁷ Some of these events have already become more frequent, intense, widespread, or longer in duration, and many are expected to continue to increase or worsen. Further, according to the Assessment, many places are subject to more than one climate-related impact. Examples include extreme rainfall combined with coastal flooding, or extreme heat coupled with drought. The compounding effects of these impacts can result in increased risks to infrastructure.

In its *Report on the Effects of a Changing Climate to the Department of Defense* and other documents, DOD identified, among others, eight climate change and extreme weather events that pose a risk to its installations.¹⁸ These are:

- **Recurrent flooding.** Recurrent flooding can be coastal or riverine. Coastal flooding occurs as gradual sea level changes eventually result in recurrent or permanent inundation of coastal property, with increasing coverage of land from nuisance flooding during high tides. Coastal flooding can also cause saltwater intrusion into fresh water sources. Riverine flooding can occur if precipitation events or ice melt routinely cause an inland waterway to overflow its banks or manmade flow control infrastructure.
- **Drought.** Drought is a period of abnormally dry weather sufficiently prolonged to cause serious problems such as water supply shortages in areas dependent on surface water. Droughts dry out vegetation and significantly reduce soil moisture. This may result in deep or wide cracks in the soil, which may affect infrastructure. Drought may also increase the chance and severity of wildfire.
- **Desertification.** Prolonged drought can cause desertification. Desertification reduces vegetation cover, leading to increases in runoff from precipitation events. Greater runoff contributes to higher erosion rates, increased stream sediment loads, and deposition of sediment in unwanted areas, reducing the effectiveness of flood risk

¹⁷*Fourth National Climate Assessment, Volume II Impacts, Risks, and Adaptation in the United States.*

¹⁸See, e.g., *Report on the Effects of a Changing Climate to the Department of Defense*; Department of Defense, *REPI: Readiness and Environmental Protection Integration Program 2019, 13th Annual Report to Congress* (March 2019); and Naval Facilities Engineering Command, *Climate Change Planning Handbook: Installation Adaptation and Resilience* (January 2017).

management infrastructure while increasing the potential for siltation of water supply reservoirs. Eroded soil may be less suitable for native vegetation, resulting in bare land or revegetation with non-native, weedy species.

- **Wildfire.** Wildfires are uncontrolled fires in an area of combustible vegetation that occur in the wilderness or countryside. People and communities feel the damage to infrastructure from wildfires at the wildland-urban interface, where human development meets undeveloped wildland. As we found in 2014, wildfires can also affect DOD installations by, for example, reducing the availability of training areas.¹⁹
- **Thawing permafrost.** Thawing permafrost is melting of in-ground ice to water at or near 32°F. Thawing of permafrost affects soil strength, ground subsidence, and stability, which can decrease the structural stability of foundations, buildings, and transportation infrastructure and require costly mitigation responses that disrupt planning, operations, and budgets. In addition, thawing permafrost exposes coasts to increased erosion and can increase wetland areas.
- **Extreme heat, cold, or precipitation.** Extreme heat, cold, or precipitation are three weather phenomena that can also affect installations and communities. According to the Naval Facilities Engineering Command, extreme weather events are events that are unusual or unusually severe for a particular place. By definition, the characteristics of what is called “extreme” may differ from place to place.²⁰

Climate Resilience

We and others, such as the National Academies of Sciences, Engineering, and Medicine, have recommended enhancing climate resilience as one strategy to help limit the federal government’s fiscal exposure to the effects of climate change. Enhancing climate resilience means being able to plan and prepare for, absorb, recover from, and more successfully adapt to climate-related impacts, such as those identified by the U.S. Global Change Research Program in the 2018

¹⁹[GAO-14-446](#).

²⁰*Climate Change Planning Handbook: Installation Adaptation and Resilience*.

Fourth National Climate Assessment.²¹ Examples of resilience measures to protect infrastructure include raising river or coastal dikes to reduce the risks to infrastructure from sea level rise, building higher bridges, and increasing the capacity of stormwater systems. As we have previously reported, enhancing climate resilience can add additional costs up front, but can also reduce potential future costs incurred because of damage from climate-related events.²²

DOD Roles and Responsibilities for Planning for and Managing the Effects of Climate Change and Extreme Weather Events

DOD Directive 4715.21, *Climate Change Adaptation and Resilience*, states that maintaining an effective and efficient U.S. military requires that the department be able to adapt current and future operations to address the impacts of climate change.²³ This involves deliberate preparation, close cooperation, and coordinated planning by DOD to facilitate state, local, tribal, private sector, and nonprofit sector efforts to improve climate preparedness and resilience, and provide for the continuity of DOD operations, services, and programs.

²¹The National Academies of Sciences, Engineering, and Medicine defines resilience as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. The National Academies, Committee on Increasing National Resilience to Hazards and Disasters and Committee on Science, Engineering, and Public Policy, *Disaster Resilience: A National Imperative* (Washington, D.C.: 2012). We reported in 2016 that two related sets of actions that can enhance climate resilience by reducing risk include climate change adaptation and hazard mitigation. Adaptation involves adjustments to natural or human systems in response to actual or expected climate change, including increases in the frequency or severity of weather-related disasters. Hazard mitigation refers to actions taken to reduce the loss of life and property by lessening the effects of adverse events and applies to all hazards, including terrorism and natural hazards such as health pandemics or weather-related disasters. For more information, see, for example, GAO, *Climate Change: Selected Governments Have Approached Adaptation through Laws and Long-Term Plans*, [GAO-16-454](#) (Washington, D.C.: May 12, 2016), and *Fourth National Climate Assessment, Volume II Impacts, Risks, and Adaptation in the United States*. DOD defines adaptation as adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative efforts, and defines resilience as the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. DOD Directive 4715.21.

²²GAO, *High-Risk Series: Progress on Many High-Risk Areas, While Substantial Efforts Needed on Others*, [GAO-17-317](#) (Washington, D.C.: Feb. 15, 2017).

²³DOD Directive 4715.21.

Primary responsibility for overseeing and implementing DOD Directive 4715.21 lies with the Under Secretary of Defense for Acquisition and Sustainment. DOD has assigned these and other responsibilities for planning for and managing the effects of climate change and extreme weather as follows:

- **Office of the Assistant Secretary of Defense for Sustainment.** The Office of the Assistant Secretary of Defense for Sustainment is DOD's primary climate change adaptation office. As such, this office leads coordination and collaboration on climate change adaptation and resilience policy across DOD to, among other things, integrate climate change considerations in appropriate existing policies, procedures, and programs.
 - **Office of Economic Adjustment (OEA).** Founded in 1961, OEA is a field activity under the Office of the Assistant Secretary of Defense for Sustainment that assists communities by providing technical and financial assistance in planning and carrying out adjustment strategies in response to defense actions. OEA is the primary DOD office responsible for assisting communities, regions, and states affected by significant defense actions including base closures and realignments. OEA has long directed assistance toward communities that lost military and civilian personnel because of the closure or major realignment of a base, but has increasingly focused on working with communities to enhance the resilience of military installations against climate and extreme weather events.
- **Military departments, service installation commands, and installations.** Under DOD Directive 4715.21, the military departments are to integrate climate change considerations into their policy, guidance, plans, and operations; collaborate with internal and external stakeholders to address common climate change challenges and opportunities; and assess and manage risks to infrastructure, encroachment management, and emergency management operations. The military departments have generally assigned these responsibilities to their respective military service installation commands, which have delegated or are in the process of delegating some responsibilities to subordinate installations. For example:

- Within the Department of the Army, the Office of the Assistant Secretary of the Army for Installations, Energy and Environment establishes policy for all Army environment and installation matters, advised by the Deputy Chief of Staff, G-9 (Installations), who serves as the principal military advisor on, among other things, installation resilience and sustainability. As a subordinate command of Army Materiel Command, the Army Installation Management Command delivers support to and handles day-to-day operations for most Army installations.²⁴ Army Regulation 210-20, *Real Property Master Planning for Army Installations* states that garrison commanders are responsible for cooperating with local community planning groups by providing information, policy, and position statements on unclassified installation programs and activities.²⁵ Separately, Army policy guidance states that installations should account for climate risk in planning how future mission changes may affect installation energy and water resources.²⁶ According to an Army official, Army Regulation 210-20 was being revised as of July 2020 and is expected to be finalized in early 2021. Army officials stated that the updated regulation is expected to assign installation commanders responsibility for overseeing installation coordination on climate change and extreme weather. More broadly, the updated regulation will likely also task Army Installation Management Command for nominating installations for participation in OEA community grant programs²⁷ and overseeing coordination of climate change adaptation and resilience planning.²⁸

²⁴The U.S. Army Corps of Engineers, Army Materiel Command, Army Reserve, and Army National Guard also have installation responsibilities.

²⁵Army Regulation 210-20, *Real Property Master Planning for Army Installations* (May 16, 2005).

²⁶Department of the Army, *Policy Guidance for Installation Energy and Water Plans* (July 11, 2018).

²⁷Communities can also apply for grants, as we discuss later in this report.

²⁸Officials expect the same responsibilities to apply to all Army land holding commands under the update of Army Regulation 210-20.

- Within the Department of the Navy, the Office of the Assistant Secretary of the Navy for Energy, Installations, and Environment establishes policy for both the Navy and Marine Corps. The Commanders of Navy Installations Command and Marine Corps Installations Command have responsibility for managing their respective service's installations, and Naval Facilities Engineering Command provides technical support to the installations of both services.²⁹ Installation commanders or their designated surrogates³⁰ serve as the lead for interacting with surrounding communities on encroachment matters, which may include installation sustainment and readiness challenges such as climate change and extreme weather.³¹
- Within the Department of the Air Force, the Assistant Secretary of the Air Force for Energy, Installations, and Environment has responsibility for promulgating policy on installation management. According to Air Force Instruction 32-1015, *Integrated Installation Planning*, installation commanders are responsible for engaging external stakeholders, including local jurisdictions, on installation development issues when necessary, and assessing and managing infrastructure risks associated with the effects of climate change.³² Additionally, Air Force Instruction 90-2001, *Mission Sustainment*, provides guidelines for how installations are to assess and manage hazards—including climate change and extreme weather—that pose risk to current and future operations.³³

²⁹Naval Facilities Engineering Command provides technical support for, among other things, climate adaptation, and resilience. See *Climate Change Planning Handbook: Installation Adaptation and Resilience*.

³⁰Both Navy and Marine Corps installation commanders can appoint Community Plans and Liaison Officers to serve as primary points of contact for community relations and related matters of interest outside the installation.

³¹Commander, Navy Installations Command Instruction 11010.1A, *Readiness Sustainment and Compatibility Program* (May 29, 2018); and Marine Corps Order 11011.23, *Marine Corps Encroachment Management Program* (Sept. 23, 2015).

³²Air Force Instruction 32-1015, *Integrated Installation Planning* (July 30, 2019).

³³Air Force Instruction 90-2001, *Mission Sustainment* (July 31, 2019).

Installations Report Extensive Use of Community Infrastructure and Support Services That Officials Say Are Vulnerable to Disruptions from Climate and Extreme Weather

DOD Domestic Installations Report Extensive and Varied Use of Infrastructure and Support Services of Surrounding Communities

Our analysis of DOD domestic installations' responses to our survey show these installations report extensive and varied use of infrastructure and support services of surrounding communities, such as roads, bridges, electricity, water, and medical facilities. Specifically, all 63 responding installations report using at least some of the 18 types of infrastructure and support services included in our survey, with 51 (81 percent) using 10 or more types.³⁴ Additionally, 62 installations (98 percent) report using access roads or bridges, telecommunications, and electricity services, while only three report using six or fewer types of infrastructure and support services from surrounding communities identified in our survey.³⁵ Tables 1 and 2 show the extent and types of physical infrastructure and support services the 63 DOD installations that responded to our survey report using from surrounding communities.

³⁴For example, Naval Station Norfolk, Virginia; Naval Weapons Station Earle, New Jersey; Naval Base Coronado, California; and Fort Bliss, Texas report using all but one of the relevant infrastructure and support services. Similarly, Vandenberg Air Force Base, California; Elgin Air Force Base, Florida; Hawthorne Army Ammunition Depot, Nevada; Joint Base Anacostia-Bolling, Washington, D.C.; and Washington Navy Yard, Washington, D.C report using all but two of the relevant infrastructure and support services.

³⁵McAlester Army Ammunition Plant, Oklahoma reports using six types of infrastructure and support services. Pine Bluff Arsenal, Arkansas reports using only five of the relevant infrastructure and support services and Yuma Proving Ground, Arizona, reports only using four of the relevant types.

Table 1: Number and Percentage of Surveyed Department of Defense (DOD) Installations Reporting Use of Surrounding Communities' Infrastructure

In numbers and (percentages) of installations

Infrastructure	Number and (percentage)
Access roads or bridges	62 (98)
Access rail lines	30 (48)
Access inland or coastal water ports	22 (35)
Access airports	31 (49)
Public transportation systems (e.g., buses or subways) providing installation access	32 (51)
Dams, levees, or seawalls	21 (33)
Medical facilities	45 (71)
Storm water management infrastructure (e.g., storm sewer pipes, outlets, and/or managed floodplains)	43 (68)
Commodity infrastructure systems (e.g., water pipes, sewage treatment plants, electrical substation)	58 (92)
Natural gas	55 (87)
Telecommunications (including any or all: phone, cable, cellular network)	62 (98)
Water (including any or all: potable, non-potable, industrial, but excluding wastewater)	48 (76)
Wastewater	46 (73)
Electricity	62 (98)

Source: GAO analysis of GAO survey of 65 DOD installations. | GAO-21-46

Note: Not all infrastructure are applicable to all installations we surveyed. GAO surveyed a nongeneralizable sample of 65 DOD domestic installations across the four military services and received 63 responses, for a response rate of 97 percent. In the table, Reserve and National Guard installations are included with their respective home service, while joint installations are included with the lead military service on those installations.

Table 2: Number and Percentage of Surveyed Department of Defense (DOD) Installations Reporting Use of Surrounding Communities' Support Services

In numbers and (percentages) of installations

Support service	Number and (percentage)
Any operation, repair, or maintenance of on-installation commodity infrastructure systems (e.g., water pipes, sewage treatment plants, electric lines, telephone poles, natural gas pipes)	51 (81)
Any repair or maintenance of on-installation transportation infrastructure (e.g., roads, bridges, rail lines, ports, airports)	33 (52)
Any public safety services (e.g., emergency ambulatory or hospital services, law enforcement, firefighting)	43 (68)
Any wildfire prevention activities (e.g., fuel removal, creation of fire breaks)	18 (29)

Source: GAO analysis of GAO survey of 65 DOD installations. | GAO-21-46

Note: Not all support services are applicable to all installations we surveyed. GAO surveyed a nongeneralizable sample of 65 DOD domestic installations across the four military services and received 63 responses, for a response rate of 97 percent. In the table, Reserve and National Guard installations are included with their respective home service, while joint installations are included with the lead military service on those installations.

As shown in table 1, the installations that responded to our survey report relying heavily on the commodities of surrounding communities—electricity, water, wastewater, telecommunications, and natural gas. According to our analysis, 40 installations (63 percent) report relying on communities for each of these five commodities. Separately, as shown in table 2, 51 installations (81 percent) report relying on communities for the operation, repair, or maintenance of such on-installation commodity infrastructure systems. According to military department officials, this reliance is due in part to DOD's efforts to privatize the installation utilities supplying these commodities to the extent possible. In 1997, Congress provided the military departments with statutory authority to convey, or privatize, utility systems under military jurisdiction, such as those on military installations.³⁶ When privatizing a utility, the Secretary of a military department makes a decision to convey a system to a private or public entity, and then awards a utility services contract. As of December 2019,

³⁶National Defense Authorization Act for Fiscal Year 1998, Pub. L. No. 105-85, § 2812 (1997), codified as amended at 10 U.S.C. § 2688. Additionally, since 1988, the military departments have used other authorities for specific utilities privatization efforts. For example, the Army had privatized some systems after obtaining congressional authority for each specific case.

the military departments had privatized roughly a quarter of the utility systems on military installations (614 of the 2,590 systems).³⁷

Climate Change and Extreme Weather Disrupted Past Community Infrastructure and Support Services to Installations and Could Be Problematic in the Future, Installations Report

Domestic military installations are vulnerable to disruptions from climate change and extreme weather, installation officials report. According to our survey,

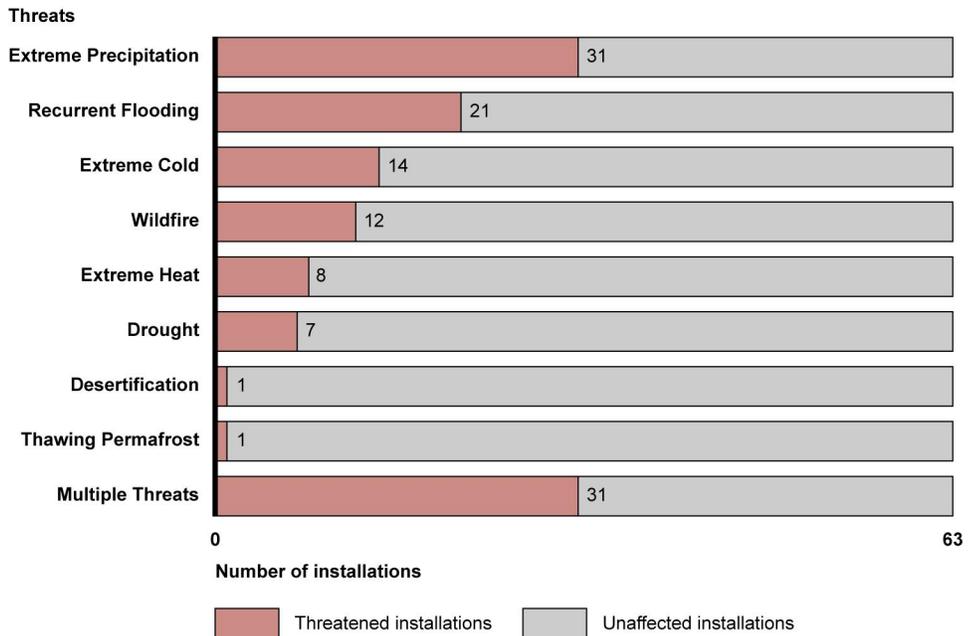
- 43 of the 63 installations (68 percent) report past disruptions in the supply of community infrastructure and support services that aid installation functions due to at least one type of climate change or extreme weather event in the last 5 years; and
- 17 installations report no disruptions for each of the eight climate change and extreme weather events, and three installations report not knowing of any disruptions resulting from any of the eight events or a combination of no disruptions and not knowing.
- Extreme precipitation events (31 installations) and recurrent flooding (21 installations) are the most reported extreme weather events causing past disruptions. Thawing permafrost and desertification are the least reported, with one installation reporting being affected by one and another installation by the other.

Figure 1 shows the number of installations reporting past disruptions caused by climate change and extreme weather events.³⁸

³⁷GAO, *DOD Utilities Privatization: Improved Data Collection and Lessons Learned Could Help Reduce Time to Award Contracts*, GAO 20-104 (Washington, D.C.: Apr. 2, 2020).

³⁸Appendix III provides additional information regarding the geographic location of installations reporting disruptions in the supply of community infrastructure and support services due to climate change or extreme weather from fiscal years 2014 through 2019.

Figure 1: Number of Installations Reporting Disruptions in the Supply of Community Infrastructure and Support Services Due to Climate Change or Extreme Weather, by Event, Fiscal Years 2014 through 2019



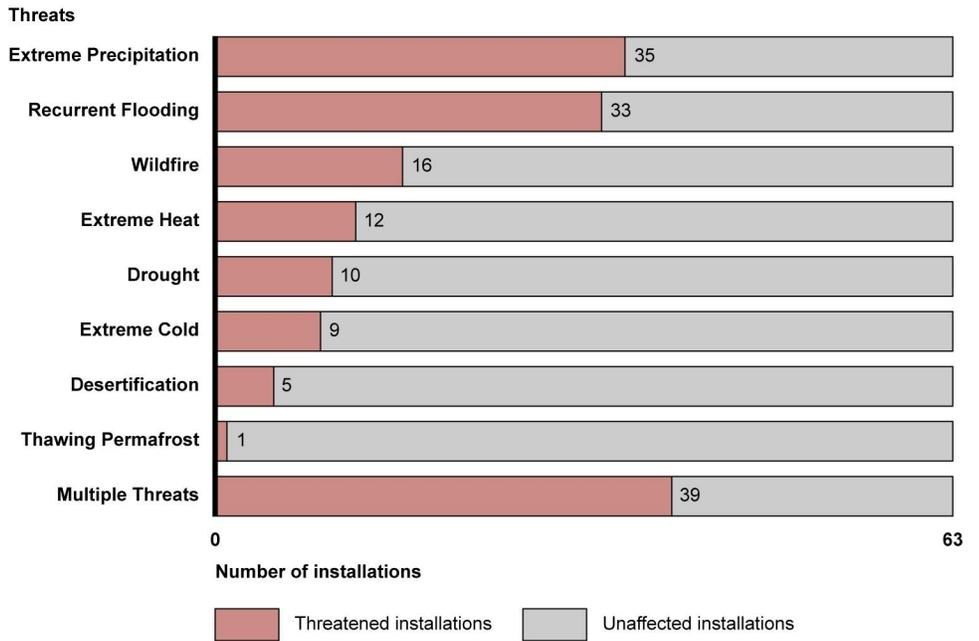
Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

Respondents to our survey also report projected disruptions to community infrastructure and support services due to climate change or extreme weather in the next 20 years, from fiscal years 2020 through 2039. Specifically,

- 49 of 63 installations (78 percent) report projected negative effects in the supply of community infrastructure and support services that aid installation functions from at least one type of climate change or extreme weather; and
- 6 installations report no projected negative effects and eight installations report a mixture of no effects or not knowing of any projected negative effects.
- Extreme precipitation (35 installations) and recurrent flooding (33 installations) are the most reported projected events, while thawing permafrost was the least (one installation). For example, officials at Naval Support Activity Hampton Roads report extreme precipitation could cause flooding that would make roads onto the installation impassable.

Figure 2 shows the number of installations reporting projected disruptions that could be caused by climate change and extreme weather.³⁹

Figure 2: Number of Installations Reporting Projected Disruptions to Community Infrastructure and Support Services Due to Climate Change or Extreme Weather, by Event, Fiscal Years 2020 through 2039



Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

³⁹Appendix III provides additional information regarding the geographic location of installations reporting projected disruptions in the supply of community infrastructure and support services due to climate change or extreme weather from fiscal years 2020 through 2039.

Damage to a Rail Line at Marine Corps Base Camp Lejeune, North Carolina, Caused by Hurricane Florence in 2018



Source: U.S. Marine Corps/Allie Erenbaum | GAO-21-46

Survey respondents also provided information on the ways in which climate change and extreme weather events can negatively affect installation operations both directly and indirectly by damaging the infrastructure surrounding DOD installations. For example, according to installation officials, in 2014, an ice storm at Fort Gordon, Georgia caused power outages throughout the installation that lasted up to 2 weeks in some areas. Additionally, in 2018, Hurricane Florence caused damage to the rail line at Marine Corps Base Camp Lejeune, North Carolina, which delayed II Marine Expeditionary Force deployments and redeployments on and off installation and impacted operational readiness (see sidebar). Table 3 shows some observed and potential effects to infrastructure associated with climate change and extreme weather that DOD has documented and respondents report in our survey.

Table 3: Effects of Climate Change and Extreme Weather on Infrastructure Documented by DOD and Observed by Installations Surveyed

Climate change and extreme weather event	Observed and potential effects on physical infrastructure
Flooding	<ul style="list-style-type: none"> • Coastal erosion (e.g., shoreline facilities) and damage to coastal infrastructure (e.g., piers and utilities) • Inundation of inland sites, damage to infrastructure, stormwater and wastewater disposal issues, and shifting river flows • Impassable access roads and bridges • Increased debris flow into harbors
Extreme temperatures	<ul style="list-style-type: none"> • Hot: Strained electricity supply, changing demand for cooling of buildings, erosion and facility damage from thawing permafrost, water supply shortages, and increased maintenance requirements for runways or roads • Cold: Strained electricity supply, changing demand for heating of buildings, water main breaks, and impassable access roads and bridges
Drought	<ul style="list-style-type: none"> • Water supply shortages
Wildfire	<ul style="list-style-type: none"> • Burning of infrastructure
Desertification	<ul style="list-style-type: none"> • Reductions in vegetation cover leading to increases in the amount of runoff from precipitation events
Thawing permafrost	<ul style="list-style-type: none"> • Soil strength reduction, ground subsidence, decreases in the structural stability to foundations, buildings, and transportation infrastructure • Coastal erosion (e.g., shoreline facilities), and damage to coastal infrastructure (e.g., piers and utilities)

Source: GAO analysis of GAO survey of 65 Department of Defense (DOD) installations and the 2010 Quadrennial Defense Review, 2012 DOD Climate Change Adaptation Roadmap (Roadmap), 2014 Roadmap, Fiscal Year 2015 DOD Strategic Sustainability Performance Plan (Sustainability Plan), Fiscal Year 2016 Sustainability Plan, 2018 Department of Defense Climate-Related Risk to DoD Infrastructure Initial Vulnerability Assessment Survey (SLVAS) Report, and 2019 Report on Effects of a Changing Climate to the Department of Defense. | GAO-21-46

The extent to which climate change and extreme weather events affect installation operations may depend in part on each installation's ability to independently provide commodities and support services, and for what duration. For example, an installation that is unable to independently provide electricity for any period of time may immediately face reduced operations, while an installation that can provide its own electricity for more than a week could sustain critical operations until community infrastructure is repaired.

The installations we surveyed report being limited in their ability to independently provide three of the five commodities included in our survey, yet more could independently provide the four support services for 1 or more days than could not. Specifically, more installations report having no ability to independently provide natural gas, telecommunications, and wastewater services than those that could independently provide such commodities for one or more days. Conversely, more installations report having some ability to independently provide the following support services—commodity and transportation infrastructure services, public safety services, and wildfire prevention—than reported they did not. None of the installations we surveyed report being able to independently provide all nine commodities and support services, although Tinker Air Force Base, Oklahoma, reports being able to independently provide everything except natural gas for at least 1 day or more.

Some installations report taking action to sustain or improve their ability to independently provide commodities and support services, and limit installation exposure to the effects of climate change and extreme weather. For example, out of 63 survey respondents,

- 49 respondents (78 percent) told us that their installation had planned, begun, or completed installing or upgrading on-installation back-up systems for commodities such as electricity;
- 22 respondents (35 percent) stated their installation had planned, begun, or completed securing resources to independently perform support services, if necessary;
- 55 respondents (87 percent) told us that their installation had planned, begun, or completed developing or updating installation plans for maintaining mission continuity (e.g., mission assurance plans), installation operations, or disaster response to limit the effects of off-installation disruptions; and

-
- 9 respondents (14 percent) stated that they had planned, begun, or completed permanently moving some mission operations to different locations on the installation to limit the effects of off-installation disruptions.

DOD Coordinates with Communities on Climate Change and Extreme Weather, but Is Not Able to Determine the Effectiveness of Its Grant Programs Focused on Enhancing Installation and Community Resilience

DOD Coordinates with Surrounding Communities on Climate Change and Extreme Weather through Community Coordination Grants and Other Means

Consistent with DOD Directive 4715.21, DOD administers three community grants to facilitate coordination between communities and neighboring installations to limit installation exposure to the effects of climate change and extreme weather—the Compatible Use Plan (CUP) program, the Military Installation Resilience (MIR) program, and the Defense Community Infrastructure Pilot (DCIP) program.⁴⁰ While CUP is long-standing, MIR and DCIP are new for fiscal year 2020. OEA awarded a total of about \$67 million in grants to communities under these programs in fiscal year 2020, according to DOD documentation and an OEA official.

⁴⁰OEA's Military Installation Sustainability program encompasses both CUP and MIR community grants. However, CUP and MIR studies are funded under different federal domestic assistance listings, and therefore, for purposes of this report, we refer to CUP and MIR as separate grant programs. OEA's Military Installation Sustainability program documentation states that CUP and MIR grants can address factors such as installation and key infrastructure access; tidal flooding and storm surge; stormwater and floodwater management; extreme weather events including wildfire and drought; and energy and water security.

CUP, formerly the Joint Land Use Study Program. Established in 1985, CUP provides financial and technical assistance to communities to help them work with local installations to produce studies with recommendations aimed at identifying and mitigating activities that potentially impair the long-term readiness and military value of the installations.⁴¹ For a community to be eligible for a CUP grant, it should receive a letter of support from the installation commander and his or her concurrence with their proposed scope for the study.⁴² Once approved, the community forms a policy committee and technical working groups to guide the study, with installation personnel participating on an ex-officio basis. From fiscal years 2016 through 2019, OEA awarded CUP grants to communities to conduct 82 studies.⁴³ According to an OEA official, the 2016 through 2019 grants totaled about \$29 million, and in fiscal year 2020 OEA awarded 25 grants, totaling \$11.46 million.

⁴¹CUP grants are also given to communities to enable updates to completed studies or to conduct implementation studies. According to OEA officials, implementation studies are usually targeted at a subset of recommendations that stakeholders consider most important from the earlier study. We previously reported that CUP and a selection of completed CUP studies were consistent with each of eight key considerations identified in our work on agencies' implementation of the Government Performance and Results Act as important for successfully implementing interagency collaboration. See GAO, *Defense Infrastructure: DOD Efforts to Prevent and Mitigate Encroachment at Its Installations*, [GAO-17-86](#) (Washington, D.C.: Nov. 14, 2016).

⁴²Installation commanders may also nominate communities for participation in CUP.

⁴³Not all of the communities receiving CUP grants from fiscal years 2016 through 2019 have completed their respective studies. In addition, some communities received grants to enable updates to completed studies or implementation studies. In addition, OEA sometimes awards CUP grants to states for work with multiple installations in the state.

**Damage to Tyndall Air Force Base, Florida,
from Hurricane Michael, October 2018**



Source: U.S. Air Force/Staff Sgt. Ryan Conroy and Staff Sgt. Alexander Henninger | GAO 21 46

Installation and community officials we surveyed and spoke with emphasized the value of CUP community grants as a means of facilitating and funding coordination with surrounding communities on climate change and extreme weather issues, and cited actions taken as a result of CUP study recommendations. For example,

- Officials from a regional organization focused on installation and community coordination in Virginia told us that OEA's funding for CUP studies is invaluable and highly effective because it ensures the participation of many different experts needed to coordinate on complex climate change and extreme weather issues.
- Bay County, Florida, officials stated that after Hurricane Michael caused extensive damage to Tyndall Air Force Base (see sidebar) and surrounding communities in October 2018, they enlarged the scope of their ongoing CUP study to address enhancing infrastructure resilience to the effects of climate change and extreme weather events as the Air Force rebuilds the base.
- According to Hampton, Virginia officials, in 2019 the city council approved spending \$25 million on the first set of projects for Joint Base Langley-Eustis, Virginia, resulting from the city's 2018 CUP addendum. Projects include retrofitting drainage systems along a creek that empties into a river next to the installation, rebuilding part of the road to the installation's west gate to improve drainage, and elevating the road and adding tidal gates that lead to another access gate to the installation. Separately, the City of Hampton also purchased about \$14 million of high elevation land around Joint Base Langley-Eustis, Virginia, so that the city may provide land to the installation in the future if sea level rise requires retreat from the current installation fence line, according to officials.
- Officials at Marine Corps Air Station Beaufort, South Carolina, reported to us that the local council of governments had acted on a recommendation in their 2015 CUP to conduct a sea level rise study that considers how issues outside the installation affect the base. We reviewed that study, completed in 2017, and found that it resulted in a model that planners can apply to determine risk, sensitivity to flooding, and adaptation costs for six categories of infrastructure, such as roads and sewers, based on an asset's elevation, location, and exposure to projected sea level rise for five time horizons from 2020 through 2085.

MIR. Established in fiscal year 2020, MIR is designed to provide planning and technical funds to communities to perform military installation resilience reviews to identify risks to infrastructure outside the installations necessary to conduct critical missions and to develop associated remediation strategies. As with CUP grants, communities should demonstrate installation support as part of their application through a letter of support from the installation commander.⁴⁴ To support its efforts to implement the fiscal year 2020 MIR program, OEA has developed a template for MIR studies that includes using storm and environmental data and models and collaborating with installation personnel to assess the impact of threats to resilience. According to an OEA official, OEA awarded 11 MIR grants in fiscal year 2020, totaling \$5.74 million.⁴⁵

DCIP. A 10-year pilot program initially funded by Congress for \$50 million in fiscal year 2020, DCIP is a competitive grant program that provides construction funds to state and communities to address deficiencies in community infrastructure that supports military installations.⁴⁶ To be eligible, a community must submit a letter of support from the commander of the local installation that includes, among other things, how the proposed project will improve existing conditions that affect installation resilience or the military value of the installation.⁴⁷ The Secretary of Defense approved the program on May 6, 2020, and OEA awarded 16 grants for fiscal year 2020, totaling the full \$50 million.

Installation and community officials told us they expect the MIR and DCIP programs will be useful mechanisms for facilitating and funding coordination between communities and local installations. For example,

⁴⁴Installation commanders may also nominate communities for participation in the MIR program. According to OEA officials, they are updating the CUP federal funding opportunity to incorporate MIR.

⁴⁵OEA originally identified 26 installations for grants in fiscal year 2020, including eight of the installations we surveyed. According to an OEA official, OEA deferred nine of the 26 MIR grants to fiscal year 2021. In addition, the official told us that seven of the fiscal year 2020 CUP grants would also include a resilience review and determine remediation strategies, essentially combining the elements of CUP and MIR studies. In addition, OEA officials stated that OEA might combine the CUP and MIR grants into a single grant after fiscal year 2020.

⁴⁶OEA officials stated that there is no linkage between the DCIP program and the MIR and CUP programs, and that a community can receive a DCIP grant without having previously done a CUP or MIR study.

⁴⁷For fiscal year 2020, the program prioritized enhancing military family quality of life as the top consideration in awarding DCIP grants, followed by improving resilience.

officials at four of the seven installations we visited or contacted told us that these programs could be useful for building installation resilience. In addition, OEA officials stated that DCIP would help address community funding challenges, particularly since it will enable OEA to provide funds directly to communities for construction to improve community infrastructure. Twenty-two of 63 survey respondents cited funding as a coordination challenge, including nine that specifically referred to the need for DOD to provide communities with additional funds to support resilience initiatives. For example, officials from Naval Weapons Station Earle, New Jersey, noted that funding for off-installation actions had been limited and that the MIR and DCIP programs could improve installations' ability to coordinate on off-installation resilience. Similarly, officials from the Hampton Roads Planning District Commission, Virginia, stated that funding for the deteriorating Hampton Roads Bridge Tunnel is critical given the area's history of severe weather events and sizable military presence, and that while DCIP is a step in the right direction, more funding from DOD is needed.

In addition to the grant programs, installations we surveyed and contacted reported taking a range of other actions to coordinate with various community organizations to limit installation exposure to the effects of climate change and extreme weather.⁴⁸ Specifically, 62 of the 63 installations that responded to our survey reported having coordinated with organizations in surrounding communities.⁴⁹ For example, 59 installations (94 percent) reported coordinating with public utilities; 54 (86 percent) reported coordinating with a state government or agency; and 56 (89 percent) reported coordinating with a county or municipal government or agency. MacDill Air Force Base, Florida, responded, for example, that installation officials had met with the state's Chief Resiliency Officer to discuss funding for a regional resiliency plan, as well as with the city of Tampa and the local Water Management District on storm and floodwater management issues. Table 4 provides the number of installations that reported coordinating with different types of community organizations.

⁴⁸As part of our work, we also identified actions taken by select non-DOD entities to coordinate on climate change and extreme weather. See Appendix IV for additional information.

⁴⁹The respondent for Yuma Proving Ground, Arizona, noted that the installation is in a remote location with no nearby communities with which to coordinate.

Table 4: Number and Percentage of Surveyed Installations That Reported Coordinating with Different Organizations to Limit Installation Exposure to the Effects of Climate Change and Extreme Weather

In numbers and (percentages) of installations

Organization	Number and (percentage)
Public utilities	59 (94)
County or municipal government or agency	56 (89)
Emergency response organization	55 (87)
State government or agency	54 (86)
Water, wastewater, or storm water planning board, regulatory body, or other similar organization	49 (78)
Land use, development, or conservation planning board, regulatory body, or other similar organization	48 (76)
Regional governmental organization or council of governments	48 (76)
Local public works department	45 (71)
Transportation planning board, regulatory body, or other similar organization	42 (67)
Tribal government or agency ^a	11 (17)

Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

Note: GAO surveyed a nongeneralizable sample of 65 Department of Defense domestic installations across all four military services and received 63 responses for a response rate of 97 percent. Survey respondents included 23 Army installations, 14 Navy installations, 17 Air Force installations, and 9 Marine Corps installations. For the purpose of analysis, Reserve and National Guard installations were included in their home service, and joint bases were included with the lead service on the installation.

^aNot all of the installations in our sample were located near tribal reservations.

State Actions to Support Military Installations

Some states have programs that support efforts to improve installation resilience and enhance military value as well. For example, Texas's Defense Economic Adjustment Assistance Grant Program provides funding to communities for infrastructure projects that, among other things, are to increase the military value or resilience of a local installation and will benefit both the community and the installation. In April 2020, the program awarded grants to the City of El Paso to expand a desalination plant that provides water for both the city and Fort Bliss, and to the Alamo Area Council of Governments to improve power distribution for the City of San Antonio and Joint Base San Antonio.

Source: GAO analysis of State of Texas documents. | GAO-21-46.

Survey respondents also reported on specific actions their installations have taken in coordination with communities. For example, 60 installations reported having planned, begun, or completed one or more

of the specific coordinative actions we asked about to limit installation exposure to the effects of climate change and extreme weather events. These actions include, among others, establishing mutual aid agreements for emergency response or disaster recovery (50 installations, or 79 percent); participating in the development of local or regional adaptation or resilience plans (24 installations, or 38 percent); and providing input into transportation planning efforts (44 installations, or 70 percent). For example, the respondent for Marine Corps Base Camp Lejeune, North Carolina, reported that installation personnel were working with the North Carolina Department of Transportation as it studied road construction options to ensure access to the installation, which can become entirely inaccessible due to flooding. Table 5 provides the number of surveyed installations that reported having planned, begun, or completed specific actions to coordinate with surrounding communities to limit installation exposure to the effects of climate change and extreme weather.

Table 5: Number and Percentage of Surveyed Installations That Reported Having Planned, Begun, or Completed an Action in Coordination with Surrounding Communities

Action	Number and (percentage)
Established general mutual aid agreements for emergency response or disaster recovery	50 (79)
Provided input on transportation planning	44 (70)
Provided input on changes to communities' building or land use codes	35 (56)
Implemented recommendations from a Joint Land Use Study/Compatible Use Plan	28 (44)
Established cooperative agreements or mechanisms to manage natural resource allocation or protection issues	25 (40)
Partnered or participated in the development of local or regional adaption or resiliency plans	24 (38)
Shared expertise on how to increase the resilience of off-installation physical infrastructure or to sustain commodity supplies	24 (38)
Secured funding for Readiness and Environmental Protection Integration program projects specifically to increase resilience ^a	19 (30)
Established cooperative agreements or plans specifically for repair or restoration of disrupted on-installation physical infrastructure	17 (27)
Shared costs or resources, or fully funded actions, to increase the resilience of off-installation physical infrastructure	14 (22)
Established cooperative agreements or plans specifically for repair or restoration of disrupted off-installation physical infrastructure	12 (19)

Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

Note: GAO surveyed a nongeneralizable sample of 65 DOD domestic installations across all four military services and received 63 responses for a response rate of 97 percent. Survey respondents included 23 Army installations, 14 Navy installations, 17 Air Force installations, and 9 Marine Corps installations. For the purpose of analysis, Reserve and National Guard installations were included in their home service, and joint bases were included with the lead service on the installation.

^aThe Readiness and Environmental Protection Integration program allows installations to work with local communities to purchase and manage land around installations in order to prevent encroachment on the installation, such as by reducing habitat and thus limiting installations' ability to engage in testing and training. Section 313(i) of Public Law 115-232 expanded DOD's authority, allowing program funding to be used specifically to maintain or improve military installation resilience.

Military service, installation, and community officials we contacted also provided us with specific examples of coordination to limit the effects of climate change and extreme weather on infrastructure.

- **Mountain Home Air Force Base, Idaho:** Air Force officials stated that the complexity of water law in the western United States—an area susceptible to drought—has affected many Air Force installations in the region, including Mountain Home Air Force Base, Idaho. This installation worked with the state and surrounding communities to develop an alternate water supply for the base, as the groundwater aquifer it and surrounding communities used was declining.⁵⁰
- **Naval Base Ventura County, California:** Naval Facilities Engineering Command officials told us that because Naval Base Ventura County, California, faces erosion problems, the installation is using Readiness and Environmental Protection Integration program funds to work with the Nature Conservancy to address erosion both on the installation and in the surrounding community.⁵¹
- **Naval Weapons Station Earle, New Jersey:** Officials at this base collaborated with a local township and non-profit organization, according to installation and community officials, to construct an oyster reef within the restricted zone around the Navy pier to reduce wave energy and storm surge extent (see figure 3). Further, in July 2018, the installation established a 5-year agreement with the county for management of stormwater drainage infrastructure on base, which, according to the Navy, provides a mechanism for the installation and community to continue to work together to minimize flooding on and off the installation.

⁵⁰According to officials, the base entered into a utility service agreement for municipal water. According to the U.S. Global Change Research Program, Idaho is part of a region that expects to face periods of prolonged drought in the future. See *Fourth National Climate Assessment, Volume II Impacts, Risks, and Adaptation in the United States*.

⁵¹DOD installations can use Readiness and Environmental Protection Integration program funds to limit any development or use of real property that would be incompatible with the mission of the installation, to preserve off-base habitat to relieve current or avoid future environmental restrictions on military operations, or to maintain or improve military installation resilience (10 U.S.C. § 2684a).

Figure 3: Oyster Reef to Reduce Impact of Waves Caused by Storms



An oyster castle before being placed in the water to form a living reef that can dissipate wave energy and reduce waves' storm impacts.

A populated oyster castle similar to those at Naval Weapon Station Earle, New Jersey, from a project in Virginia.

Source: NY/NJ Baykeeper and Lynnhaven River Now. | GAO-21-46

Naval Station Norfolk, Virginia: Officials told us that the installation had collaborated with the surrounding community to develop a flood plan for the Mason Creek Watershed. The plan led to the U.S. Army Corps of Engineers building a floodgate on base that helps control high tides, storm surges, and floodwaters to prevent flooding on the installation and roadways outside the installation (see figure 4).

Figure 4: Flood Control Gate, Naval Station Norfolk, Virginia



Source: GAO. | GAO-21-46

DOD Monitors the Status of Individual Grants, but Is Not Able to Determine the Effectiveness of Its Grant Programs Focused on Enhancing Installation and Community Resilience

OEA monitors the status of individual CUP grants during the period of the grant and plans to similarly monitor the MIR and DCIP grants. Specifically, OEA officials stated that after a CUP proposal is accepted, OEA project managers work with communities to develop an appropriate scope of work for their grant, which includes a timeline and list of deliverables. To monitor the completion of deliverables, project managers are required to conduct site visits at least twice per year during the grant period, and to brief OEA management annually on the status of past and ongoing projects, according to officials.⁵² To facilitate OEA monitoring activities, communities are required to submit status reports to OEA

⁵²OEA officials also told us that based on feedback sessions they had conducted with former grantees, they are working on a CUP guidebook that they expect to publish at the end of January 2021.

during the period of project execution, along with a final grant closeout report within 90 days after completion.

OEA's reports and annual briefings provide limited information on the effectiveness of the CUP program. In reviewing four grant closeout reports, we found that they included information on how funds had been expended and specific actions that had been taken, such as implementing certain recommendations and producing the deliverables that had been established for the grant. Similarly, an annual briefing we reviewed addressed funding and provided summary updates for each project, including deliverables and selected follow-on actions. However, the grant closeout reports and the annual briefing generally did not include comprehensive information—such as the overall number of recommendations, their implementation status, and expected implementation timelines—that would allow DOD to track and assess long-term outcomes or return on investment for the overall CUP program.

OEA, installation, and community officials emphasized the importance of implementing CUP recommendations. For example, OEA officials told us the principal value to DOD in awarding grants for studies is the implementation of study recommendations. Similarly, officials at Naval Air Station Oceana, Virginia, and with Monmouth County, New Jersey, told us while the CUP program is helpful for establishing relationships, study recommendations need to be implemented in order to achieve lasting benefits. However, officials we surveyed and interviewed indicated that recommendations from CUP studies have been implemented to varying degrees. Specifically, of the 63 installations that responded to our survey, 16 reported that they had implemented one or more recommendations from a CUP study, while 12 reported that they plan or have begun to do so, and 10 reported that they had discussed taking action.⁵³ Similarly, officials from MacDill Air Force Base, Florida, reported that some recommendations from a 2006 CUP study had not been implemented, while officials from Joint Base Langley-Eustis, Virginia, told us that they are just beginning to implement recommendations from a CUP study completed in March 2018.

Monitoring the effectiveness and progress of programs is critical in determining whether programs are achieving intended goals. DOD Instruction 3030.03, *Joint Land Use Study (JLUS) Program*, assigns OEA

⁵³Not every installation we surveyed had participated in a CUP study.

responsibility to monitor, review, and evaluate the effectiveness of the CUP program.⁵⁴ According to our *Disaster Resilience Framework*, federal investments in disaster resilience—such as the CUP, MIR, and DCIP programs—provide an opportunity to reduce the overall impact of disasters by stimulating additional investment by nonfederal partners such as state, local, and tribal governments.⁵⁵ The Framework also states that federal programs can help monitor progress toward risk-reduction goals within their mission areas by providing clear guidance on applicable metrics. Further, *Standards for Internal Control in the Federal Government* states that management overseeing federal programs should establish objectives for those programs in measurable terms so that performance toward achieving those objectives can be assessed.⁵⁶ By using performance measures, decision makers can obtain feedback for improving both policy and operational effectiveness. Our body of work on leading performance management practices has identified ten key attributes of effective performance measures, including among others, that they be clear, quantifiable, objective, and have a baseline measurement, as shown in table 6.⁵⁷

⁵⁴Department of Defense Instruction 3030.03, *Joint Land Use Study (JLUS) Program* (July 13, 2004) (incorporating change 1, Aug. 31, 2018).

⁵⁵GAO, *Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters*, [GAO-20-100SP](#), (Washington, D.C.: October 2019). Our *Disaster Resilience Framework* is organized around three broad overlapping principles—Information, Integration, and Incentives—and provides questions that those who provide oversight or management of federal efforts can consider when analyzing opportunities to enhance their contribution to national disaster resilience. The Framework is based on (1) a large and expanding literature on resilience, (2) the findings and recommendations of over 50 related GAO reports, (3) expert review of the Framework, (4) internal review by GAO subject matter experts, and (5) technical comments from federal, state, and non-profit bodies with expertise in resilience.

⁵⁶[GAO-14-704G](#).

⁵⁷See GAO, *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, [GAO-03-143](#) (Washington, D.C.: Nov. 22, 2002), for a description of how we developed the attributes. In [GAO-03-143](#), we identified nine attributes of performance measures from various sources, such as earlier GAO work, Office of Management and Budget Circular No. A-11, the Government Performance and Results Act, the Internal Revenue Service's handbook on Managing Statistics in a Balanced Measures System, and various sources of performance-management literature. In subsequent reports, we identified a 10th attribute, baseline and trend data. See, for example, *Defense Health Care Reform: Additional Implementation Details Would Increase Transparency of DOD's Plans and Enhance Accountability*, [GAO-14-49](#) (Washington, D.C.: Nov. 6, 2013).

Table 6: Key Attributes of Effective Performance Measures

Attribute	Definition
Balance	A suite of measures ensures that an organization’s various priorities are covered.
Clarity	Measure is clearly stated, and the name and definition are consistent with the methodology used to calculate it.
Core program activities	Measures cover the activities that an entity is expected to perform to support the intent of the program.
Government-wide priorities	Each measure covers a priority such as quality, timeliness, and cost of service.
Limited overlap	Measures provide new information beyond that provided by other measures.
Linkage	Measure is aligned with division and agency-wide goals and mission and is clearly communicated throughout the organization.
Measurable target	Measure has a numerical goal.
Objectivity	Measure is reasonably free from significant bias or manipulation.
Reliability	Measure produces the same result under similar conditions.
Baseline and trend data	Measure has a baseline and trend data associated with it to identify, monitor, and report changes in performance and to help ensure that performance is viewed in context.

Source: GAO. | GAO-21-46

While OEA monitors the status of its individual community grants, it is unable to determine fully the effectiveness of the community grant programs or their returns on investment because it has not developed performance measures to benchmark and track overall program performance. OEA officials stated that they recognize the need to measure overall program performance, but have not yet had the time to develop performance measures for these programs and as of July 2020 were focused on reviewing proposals and awarding grants for MIR and DCIP. However, as noted earlier, DOD established CUP in 1985; therefore, it has had ample time to establish performance measures for the program. Additionally, OEA officials noted that any future CUP, MIR, and DCIP performance measures would likely focus on recommendation implementation and construction progress, as appropriate, but that they had not taken steps to identify such measures or track associated information—such as by aggregating the number of CUP recommendations implemented.

The CUP, MIR, and DCIP programs provide key mechanisms and funding for military installations and surrounding communities to coordinate on readiness and resilience issues related to climate change and extreme weather, and OEA officials have described their principal goal as enhancing installation value and resilience. However, without establishing clear, quantifiable, and objective performance measures with a baseline measurement of current performance, decision makers in DOD and

Congress will not have visibility of whether DOD's growing portfolio of community grant programs is on track to increase installation and community resilience to the current and projected effects of climate change and extreme weather. Moreover, they will lack a full understanding of whether current and future investments in these programs are delivering the intended value.

Conclusions

Climate change and extreme weather constitute a threat to current and future DOD installation operations that are critical to maintaining military readiness and supporting servicemembers and their families. DOD installations report relying heavily on the infrastructure and support services of surrounding communities—such as roads, bridges, water, and medical facilities—that are vulnerable to the effects of climate change and extreme weather. The department has long acknowledged the urgent nature and growing threat of such events to its installations, and has issued policy assigning responsibilities for coordinating with government, private, and nonprofit entities to help improve climate preparedness and resilience, and provide for the continuity of installation operations. Consistent with this policy, DOD installations report various actions to coordinate with community organizations to limit exposure to the effects of climate change and extreme weather. Additionally, DOD's three community grant programs—CUP, and the newly created MIR and DCIP—provide key mechanisms and funding for military installations and communities to coordinate on climate resilience issues, including through joint land use studies and community infrastructure development.

With the department's investment in these programs growing, it is important that there be reliable ways to assess program outcomes. Without establishing performance measures for CUP, MIR, and DCIP that are clear, quantifiable, objective, and provide for the baseline measurement of current performance, decision makers in DOD and Congress may find it difficult to determine whether current and future investments in these programs are achieving their intended outcomes or delivering their expected value. Moreover, the absence of such measures may hamper decision makers' ability to prioritize resources when considering these programs' efficacy vis-à-vis other means for enhancing installation resilience to the effects of climate change and extreme weather.

Recommendations for Executive Action

We are making the following three recommendations to DOD:

The Secretary of Defense should ensure that the director of OEA establish performance measures for its Compatible Use Plan grant program. At minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance. (Recommendation 1)

The Secretary of Defense should ensure that the director of OEA establish performance measures for its Military Installation Resilience grant program. At minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance. (Recommendation 2)

The Secretary of Defense should ensure that the director of OEA establish performance measures for its Defense Community Infrastructure Pilot grant program. At minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance. (Recommendation 3)

Agency Comments and Our Evaluation

We provided a draft of this report to DOD for review and comment. In its written comments, reproduced in their entirety in appendix V, DOD concurred, with comment, with all three of our recommendations. DOD also provided technical comments on the draft report, which we incorporated as appropriate.

In concurring, with comment, with our first recommendation to establish performance measures for its CUP grant program, DOD stated that many times the benefits of the program are not evident until after the grant expires and the OEA program of assistance is complete. DOD further noted that under this program, OEA works closely with communities to ensure plans yield actionable recommendations, and that plans and resulting recommendations are typically responsive to the military department and installation involved. As a result, DOD stated, site-specific responses versus common responses complicate the application of standard performance measures. DOD also noted that better collaboration can take periods of time beyond those OEA can reasonably

require a recipient to report back on the project outcomes. As noted in our report, CUP studies are intended to produce recommendations aimed at identifying and mitigating activities that potentially impair installations' long-term readiness and military value, providing a common basis for measurement. These recommendations offer one possible method for measuring performance. For example, OEA could develop performance measures and collect information on the overall number of study recommendations produced, their implementation status, and expected implementation timelines. In addition, OEA currently collects quantitative information for its CUP grant closeout reports and annual summary briefings—such as fund expenditures and deliverable status—that could be comprehensively tracked against performance measures to assess program performance and return on investment. We are encouraged that DOD also stated in its comments that it will continue to work with the CUP customer base to consider the application of more performance measures. We will support DOD in this effort through our regular recommendation follow up process. By developing performance measures for CUP, DOD will enhance decision makers' ability to determine whether current and future investments will achieve their intended outcomes and deliver expected value.

DOD also concurred, with comment, with our second recommendation to establish performance measures for its MIR grant program, stating that OEA monitors the effectiveness of its programs and that many times the benefits of such a program are not evident until after the grant expires and the OEA program of assistance is complete. DOD also stated it will continue to work with the customer base for this program to consider the application of more performance measures. As stated in our report, DOD plans to monitor the status of individual grants during the period of the grant, and OEA officials stated that future MIR performance measures would likely focus on construction progress. By developing performance measures for the MIR program, DOD will enable decision makers in DOD and Congress to better determine whether the program is on track to increase community resilience to the current and projected effects of climate change and extreme weather, and provide a fuller understanding of whether the program is delivering its intended value.

Finally, in concurring, with comment, with our third recommendation to establish performance measures for its DCIP grant program, DOD noted that although resilience is one of the three issue areas the program seeks to enhance for local installations, the Secretary of Defense prioritized the enhancement of military family quality of life projects for the fiscal year 2020 execution of the program. DOD also stated OEA will work with the customer base of the program to consider more performance measures in

the event that future appropriations are provided, and the program activities prioritize military value or installation resiliency. However, monitoring the effectiveness and progress of DCIP is critical to determining whether it is achieving its intended goals, regardless of program focus. As stated in our report, performance measures allow decision makers to obtain feedback for improving both policy and operational effectiveness. Additionally, as noted in our report, DCIP was authorized to address, among other things, deficiencies in community infrastructure that affect installation resilience or the military value of the installation. While the Secretary prioritized quality of life projects in May 2020 for fiscal year 2020 grants, DCIP is a 10-year pilot program and the Secretary may place greater emphasis on resilience in setting future program priorities. By developing performance measures for DCIP, DOD should meet the intent of our recommendation and therefore provide decision makers in DOD and Congress with enhanced visibility over whether investments in the program are delivering the intended value.

We are sending copies of this report to the appropriate congressional committees; the Secretary of Defense; the Under Secretary of Defense for Acquisition & Sustainment; the Secretaries of the Army, the Air Force, and the Navy; and the Commandant of the Marine Corps. In addition, this report will be available at no charge on the GAO website at <http://www.gao.gov>

If you or your staff have any questions about this report, please contact me at (202) 512-2775 or fielde1@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VI.

Sincerely yours,



Elizabeth A. Field
Director, Defense Capabilities and Management

Appendix I: Objectives, Scope, and Methodology

This report assesses the extent to which the Department of Defense (DOD) (1) reports using the physical infrastructure and support services of communities surrounding its domestic installations, along with vulnerabilities to such infrastructure and services resulting from climate change and extreme weather, and (2) coordinates with communities surrounding its domestic installations to limit installation exposure to the effects of climate change and extreme weather, and is able to determine the effectiveness of related community coordination grants.

To determine installations' reliance on and coordination with communities, we reviewed documents, including DOD and military service guidance¹ and reports,² other federal and nonfederal reports,³ installation agreements with communities,⁴ and community publications and studies,

¹See, for example, Department of Defense Instruction 6055.17, *DOD Emergency Management (EM) Program* (Feb. 13, 2017) (incorporating change 3, June 12, 2019); Army Regulation 525-26, *Infrastructure Risk Management (Army)* (June 22, 2004); Commander, Navy Installations Command Instruction 11010.1A, *Readiness Sustainment and Compatibility Program* (May 29, 2018); and Naval Facilities Engineering Command, *Climate Change: Installation Adaptation and Resilience Planning Handbook* (January 2017).

²See, for example, Office of the Under Secretary of Defense for Acquisition and Sustainment, *Report on the Effects of a Changing Climate to the Department of Defense*, (January 2019); and Office of the Under Secretary of Defense for Acquisition and Sustainment, *REPI: Readiness and Environmental Protection Integration Program 2019, 13th Annual Report to Congress* (March 2019).

³See, for example, U.S. Global Change Research Program, *Fourth National Climate Assessment, Volume II Impacts, Risks, and Adaptation in the United States* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)] (Washington, D.C.: 2018); and Lachman, Beth E., Resetar, Susan A., Kalra, Nidhi, et. al. *Water Management, Partnerships, Rights, and Market Trends: An Overview for Army Installation Managers*, (RAND Corporation: 2016).

⁴These agreements included, for example, memorandums of understanding and contracts for support services.

to include studies funded by the DOD Office of Economic Adjustment.⁵ We also visited or contacted seven domestic military installations located in Virginia, Washington, D.C., and Maryland. We considered the following factors in selecting the installations: geographic proximity to one another, installations that would represent multiple military services, and those considered by DOD to be vulnerable to climate change. Specifically, we chose installations that faced one or more of three effects of climate change—drought, wildfires, and recurrent flooding—as identified in DOD’s January 2019 *Report on Effects of a Changing Climate to the Department of Defense*.⁶ We included joint base installations to gain perspective on unique issues that may face such installations. We also considered whether installations had participated in a planning study with the surrounding community, which we considered an indication of coordination with communities. We supplemented our sample of installations visited or contacted with a survey of 65 installations, as discussed below. In addition, we interviewed officials from, among others, the Office of the Secretary of Defense, the military services installation commands, and select communities surrounding military installations. We selected community officials to interview based on the communities’ proximity to installations we visited, contacted, or surveyed and professional judgment. Table 7 provides a full list of the offices, installations, and communities we contacted.

⁵See, for example, National Association of Counties, *Working with Local Governments: A Practical Guide for Installations*, (May 2012); and Lowcountry Council of Governments, *Marine Corps Recruit Depot Parris Island and Lowcountry Council of Governments Joint Land Use Study*, (Mar. 27, 2015).

⁶*Report on the Effects of a Changing Climate to the Department of Defense*. This report also identified thawing permafrost and desertification as effects of climate change.

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Table 7: Organizations Contacted by GAO

Organization	Sub-organization
Office of the Secretary of Defense	Office of the Under Secretary of Defense, Acquisition and Sustainment
Office of the Secretary of Defense	Office of the Assistant Secretary of Defense for Sustainment
Office of the Secretary of Defense	Office of Economic Adjustment
Department of the Army	Army Deputy Chief of Staff, G-9, (Installations)
Department of the Army	Assistant Secretary of the Army (Installations, Energy, and Environment)
Department of the Army	Installation Management Command, U.S. Army, Texas
Department of the Army	Fort Detrick, Maryland
Department of the Navy	Chief of Naval Operations
Department of the Navy	Commander, Navy Installations Command
Department of the Navy	Commander, Navy Installations Command Regions Northwest, Southwest, Southeast, Mid-Atlantic, Naval District Washington
Department of the Navy	Deputy Assistant Secretary of the Navy, Installations, Energy, and Facilities
Department of the Navy	Naval Facilities Engineering Command
Department of the Navy	Marine Corps Installations Command
Department of the Navy	Joint Base Anacostia Bolling, Washington, D.C.
Department of the Navy	Naval Air Station Oceana, Virginia
Department of the Navy	Naval Station Norfolk, Virginia
Department of the Navy	Washington Navy Yard, Washington, D.C.
Department of the Air Force	Assistant Secretary of the Air Force, Energy, Installations, and Environment
Department of the Air Force	Air Force Installation and Mission Support Center, Texas
Department of the Air Force	Air Force Civil Engineer Center, Texas
Department of the Air Force	Joint Base Andrews, Maryland
Department of the Air Force	Joint Base Langley-Eustis, Virginia
Local Governments and Organizations	Bay County, Florida
Local Governments and Organizations	City of Hampton, Virginia
Local Governments and Organizations	City of Newport News, Virginia
Local Governments and Organizations	Flint Hills Regional Council, Kansas
Local Governments and Organizations	Hampton Roads Military and Federal Facilities Alliance, Virginia
Local Governments and Organizations	Hampton Roads Planning District Commission, Virginia
Local Governments and Organizations	Monmouth County, New Jersey
Local Governments and Organizations	Prince George's County, Maryland
Local Governments and Organizations	San Diego Association of Governments, California
Local Governments and Organizations	Association of Defense Communities

Source: GAO. | GAO-21-46

Note: Unless otherwise noted, organizations are located in or near Washington, D.C. All installation locations are provided. Joint bases are listed according to the lead military service at each base.

To address both objectives, we also conducted a web-based survey of a nongeneralizable sample of 65 domestic DOD installations. The sample included installations that DOD identified as having significant vulnerabilities to the effects of climate change and extreme weather. It also included installations that the military services report as being most vulnerable to those effects, and one installation we identified through preliminary audit work to be a useful example of installation coordination with surrounding communities.⁷ Based on general information we provided on the topics covered by the survey, the military services identified appropriate points of contact at each installation to serve as the survey respondent. However, we requested in our survey instructions that respondents consult with other installation subject matter experts (e.g., weather and climate experts) as necessary to provide complete and accurate answers to the questions.

To conduct the survey, we developed questions covering, among other things, (1) the installations' reliance on the physical infrastructure, commodities, and services of surrounding communities to support installation operations and the effects on those operations in the event of disruptions caused by climate change and extreme weather events; and (2) the extent to which climate change and extreme weather events have or are projected to affect off-installation physical infrastructure and commodity supplies. The survey also collected information on (3) the extent to which installations coordinate with surrounding communities to limit installation exposure to the effects of climate change and extreme weather, including the organizations coordinated with and the actions taken by installations and communities. In addition, we included questions on (4) existing challenges to coordination and potential actions that could be taken to improve installations' ability to coordinate with surrounding communities on these issues. A survey specialist helped to develop these questions and another survey specialist provided independent feedback on the questions.

⁷In March 2019, DOD provided Congress with a list of 46 installations that it determined were vulnerable to climate change and extreme weather. The military services later provided additional lists to Congress comprising the installations most vulnerable to climate change and extreme weather. Our sample of 65 domestic installations comprises 63 unique installations from across the lists, and one installation DOD identified as being vulnerable to thawing permafrost. We added Naval Weapons Station Earle, New Jersey, after having identified extensive actions taken by that installation to coordinate with surrounding communities to mitigate the effects of climate change and extreme weather.

To minimize errors that might occur from respondents interpreting our questions differently than we intended or that might introduce concerns related to classified material, we provided a draft of the questions to headquarters organizations of all four military services for feedback and incorporated their input as appropriate. We also developed a glossary of terms used in the survey based on DOD documents and our professional judgment. We pretested our survey with six volunteer reviewers from separate installations across the four military services who their organization had identified as an appropriate point of contact and respondent for their installation.⁸ During each pretest, all of which were conducted by phone, we tested whether (1) the instructions and questions were clear and unambiguous, (2) the terms we used were accurate, and (3) pretest participants could offer a potential solution to any problems identified. We noted any potential problems identified by the reviewers and through the pretests and modified the questionnaire based on the feedback received. A full copy of the survey questions and related glossary of terms is provided in appendix II.

We conducted the survey between February 27, 2020, and April 8, 2020. To maximize our response rate, we sent notification emails, reminder emails, and contacted non-respondents by telephone to encourage them to complete the survey. In total, we received responses from 63 of 65 installations, for a response rate of 97 percent. Because of this response rate, we did not assess the potential for non-response bias. Table 8 lists the 65 installations we surveyed.

⁸The pretests included reviewers from one Army installation, one Navy installation, two Marine Corps installations, and two Air Force installations.

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Table 8: Military Service Installations Surveyed by GAO

Military Service	Installation	State
Army	Camp Roberts	California
Army	Fort Belvoir	Virginia
Army	Fort Bliss	Texas
Army	Fort Bragg	North Carolina
Army	Fort Detrick	Maryland
Army	Fort Gordon	Georgia
Army	Fort Greely	Alaska
Army	Fort Hood ^a	Texas
Army	Fort Huachuca	Arizona
Army	Fort Irwin	California
Army	Fort Meade	Maryland
Army	Fort Shafter	Hawaii
Army	Hawthorne Army Depot	Nevada
Army	Lake City Army Ammunition Plant	Missouri
Army	McAlester Army Ammunition Plant	Oklahoma
Army	Military Ocean Terminal Concord	California
Army	Military Ocean Terminal SunnyPoint	North Carolina
Army	Pine Bluff Arsenal	Arkansas
Army	Pueblo Chemical Depot	Colorado
Army	Radford Army Ammunition Plant	Virginia
Army	Tooele Army Depot	Utah
Army	Watervliet Arsenal	New York
Army	White Sands Missile Range	New Mexico
Army	Yuma Proving Ground	Arizona
Navy	Joint Base Anacostia Bolling	Washington, D.C.
Navy	Joint Base Pearl Harbor Hickam	Hawaii
Navy	Naval Air Station Key West	Florida
Navy	Naval Air Station Oceana	Virginia
Navy	Naval Base Coronado	California
Navy	Naval Base San Diego	California
Navy	Naval Magazine Indian Island	Washington, D.C.
Navy	Naval Station Norfolk	Virginia
Navy	Naval Submarine Base Kings Bay	Georgia
Navy	Naval Support Activity Hampton Roads	Virginia

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Military Service	Installation	State
Navy	Naval Support Activity Hampton Roads – Northwest	Virginia
Navy	Naval Support Facility Indian Head	Maryland
Navy	Naval Weapons Station Earle	New Jersey
Navy	Washington Navy Yard	Washington, D.C.
Air Force	Beale Air Force Base	California
Air Force	Dover Air Force Base	Delaware
Air Force	Eglin Air Force Base	Florida
Air Force	Greeley Air National Guard Station	Colorado
Air Force	Hill Air Force Base	Utah
Air Force	Homestead Air Force Base	Florida
Air Force	Hurlburt Field	Florida
Air Force	Joint Base Andrews	Maryland
Air Force	Joint Base Charleston	South Carolina
Air Force	Joint Base Langley-Eustis	Virginia
Air Force	Joint Base San Antonio (Lackland/Sam Houston/Randolph)	Texas
Air Force	MacDill Air Force Base	Florida
Air Force	Malmstrom Air Force Base	Montana
Air Force	Patrick Air Force Base	Florida
Air Force	Shaw Air Force Base ^b	South Carolina
Air Force	Tinker Air Force Base	Oklahoma
Air Force	Tyndall Air Force Base	Florida
Air Force	Vandenberg Air Force Base	California
Marine Corps	Marine Corps Air Station Beaufort	South Carolina
Marine Corps	Marine Corps Base Camp Lejeune	North Carolina
Marine Corps	Marine Corps Base Camp Pendleton	California
Marine Corps	Marine Corps Base Hawaii	Hawaii
Marine Corps	Marine Corps Base Quantico	Virginia
Marine Corps	Marine Corps Recruit Depot Parris Island	South Carolina
Marine Corps	Marine Corps Recruit Depot San Diego	California
Marine Corps	Marine Corps Reserve Forces New Orleans	Louisiana
Marine Corps	Marine Corps Support Facility Blount Island	Florida

Source: GAO survey of 65 Department of Defense installations. | GAO-21-46

Note: GAO sent surveys to all 65 of the above installations and received 63 completed responses. Reserve and National Guard installations are listed with their respective service.

^aFort Hood did not respond to the survey. A Fort Hood official told us that they were unable to do so because of the resource demands of preparing for simultaneous unit deployments and redeployments and taking steps to prevent the spread of Coronavirus Disease 2019 (COVID-19) on the installation.

^bShaw Air Force Base did not respond to the survey. According to an Air Force official, the personnel positions that would be most appropriate to respond were unfilled at the time of the survey and that taking steps to prevent the spread of COVID-19 prevented committing resources to the survey.

We calculated the frequency of responses to our closed-ended survey questions and reviewed responses to the open-ended questions to identify examples relevant to our objectives. A data analysis specialist performed the quantitative analysis and another data analysis specialist reviewed it to ensure its accuracy. For all open-ended survey questions, three analysts independently reviewed the responses to identify examples relevant to our objectives. In addition, for select open-ended survey questions, we used professional judgment based on our interviews with installation and Office of the Secretary of Defense officials to identify common themes from across the responses and determine their frequencies. In order to do so, one analyst evaluated question responses and coded the information into categories. A different analyst checked the information for accuracy. The analysts then discussed and resolved any initial disagreements in the coding to arrive at final themes.

To determine the extent to which DOD coordinates with communities surrounding its domestic installations to limit installation exposure to the effects of climate change and extreme weather, and is able to determine the effectiveness of related community coordination grants, we compared installation and DOD actions identified through our survey, interviews, and review of documents such as community-installation studies against DOD guidance on climate change adaptability.⁹ We also evaluated DOD's community coordination grant programs with DOD guidance that establishes grant program oversight responsibilities for the DOD Office of Economic Adjustment (OEA)¹⁰ and elements of our *Disaster Resilience Framework* related to using federal investments to reduce the overall impact of disasters and stimulate additional investment by nonfederal partners such as state, local, and tribal governments.¹¹ We also determined that the risk assessment component of internal control was significant to this objective, along with the underlying principle that management should define program objectives in measurable terms so

⁹Department of Defense Directive 4715.21, *Climate Change Adaptation and Resilience* (Jan. 14, 2016) (incorporating change 1, Aug. 31, 2018).

¹⁰Department of Defense Instruction 3030.03, *Joint Land Use Study (JLUS) Program* (July 13, 2004) (incorporating change 1, Aug. 31, 2018).

¹¹GAO, *Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters*, [GAO-20-100SP](#) (Washington, D.C.: Oct. 23, 2019).

that performance toward achieving those objectives can be assessed.¹² To determine the extent to which DOD is able to determine the effectiveness of its community coordination grant programs, we spoke to officials responsible for those programs and reviewed documents related to program oversight. We also assessed these documents against our prior work on performance measurement leading practices.¹³

We also identified selected approaches that non-DOD entities use to coordinate on climate change and extreme weather. To identify the approaches, we worked with a GAO methodologist and a librarian/research specialist to conduct a literature review to identify examples of:

- Foreign military or any other foreign cooperation or collaboration with their communities on climate change and natural disasters (response, planning, adaptation, mitigation).
- Intergovernmental cooperation or collaboration across government levels on climate change and natural disasters (response, planning, adaptation, mitigation).
- Cooperation or collaboration between governmental and non-governmental entities on climate change and natural disasters (response, planning, adaptation, mitigation).
- Best or leading practices for cooperation or collaboration on climate change mitigation, resilience, and adaptation.

¹²GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#), (Washington, D.C.: Sept. 10, 2014).

¹³See GAO, *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, [GAO-03-143](#) (Washington, D.C.: Nov. 22, 2002), for a description of how we developed the attributes. In [GAO-03-143](#), we identified nine attributes of performance measures from multiple sources, such as Office of Management and Budget Circular No. A-11, the Government Performance and Results Act of 1993, the Internal Revenue Service's handbook on Managing Statistics in a Balanced Measures System, and various sources of performance-management literature. In addition, we drew on previous GAO work including *GPRA Performance Reports*, [GAO/GGD-96-66R](#) (Washington, D.C.: Feb. 14, 1996) and *The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans*, [GAO/GGD-10.1.20](#) (Washington, D.C.: April 1998). In subsequent reports, we identified a 10th attribute, baseline and trend data. See, for example, *Defense Health Care Reform: Additional Implementation Details Would Increase Transparency of DOD's Plans and Enhance Accountability*, [GAO-14-49](#) (Washington, D.C.: Nov. 6, 2013).

To identify relevant sources for the literature review, we conducted keyword searches of various databases, including ProQuest, ProQuest Dialog, Rand.org, Scopus, and EBSCO.¹⁴ The searches were scoped using parameters that limited our results to, among other things, those published in English from 2009 through 2019. They included articles from scholarly journals, government reports, books, conference papers, trade or industry publications, dissertations, general news articles, working papers, and association, nonprofit and think tank publications. The search generated 341 titles and abstracts.

During an initial screening of the 341 titles and abstracts, one analyst reviewed each; recommended exclusion of any dissertations, general news articles, working papers, and associations;¹⁵ and determined which ones covered the topics above. The analyst also focused on whether a source discussed (1) local cooperation, collaboration or coordination among two or more foreign, federal, state, local, or private entities, as described above, or could be identified as a “best” or “leading” practice for cooperation or coordination at a local level; and (2) involved climate change or natural disaster mitigation, resilience, adaptation, response, or planning.¹⁶ This resulted in 261 sources recommended for exclusion by the analyst because they did not meet the above criteria. A second analyst familiar with the topic and the conclusions that the first analyst reached then reviewed the titles and abstracts of the 261 sources and either agreed or disagreed. The analysts then discussed and resolved any differences, as necessary. All 261 were excluded.

During a subsequent screening of the remaining 80 sources, one analyst conducted a detailed, full text review of each source, focusing on (1) confirming the relevance of specific sources and (2) identifying themes across the examples discussed in the sources. Two additional analysts familiar with the topic and the conclusions that the first analyst reached then conducted sequential, full text reviews of the same articles, with one analyst reviewing articles that the first analyst recommended for

¹⁴Among others, we used keywords such as “coordinat*,” “intergovernmental,” “climate change,” “military OR militaries OR defense OR defence,” and “mitigat*.”

¹⁵These articles were included in the initial search only to identify other information sources for possible review.

¹⁶While the criteria we applied in scoping our literature review included identifying sources that mentioned best or leading practices, we did not evaluate whether such practices met established criteria to be considered as such.

advancement and the other those recommended for exclusion. The analysts discussed and resolved any differences, as necessary. At the conclusion of this screening, 29 sources met our criteria for inclusion in the report.

In addition to the sources identified through the literature search, we also spoke with subject matter experts and reviewed our relevant reports and internet-based sources,¹⁷ identifying nine additional articles. To determine their relevance, one analyst conducted a detailed, full text review of each source, focusing on (1) confirming the relevance of the source and (2) identifying themes across the examples discussed in the sources. A second analyst familiar with the topic and the conclusions that the first analyst reached conducted a full text review of the same sources to confirm their relevance and identify themes. There were no disagreements, so each of the nine articles met our criteria for potential inclusion in the report.

We selected eight of the 38 sources (29 from literature review and nine from additional sources) to highlight non-DOD examples of coordination and collaboration on climate change and extreme weather adaptation and mitigation in our report (see appendix IV). Three analysts collectively used professional judgment to select the eight based on a range of geographic diversity, a variety of climate-related issues and community partnerships, diverse collaborative approaches, and themes identified across examples discussed in the sources. The results are not intended to be representative of leading practices. Instead, they are a sampling of some practices that non-DOD entities use to collaborate on climate change and extreme weather.

We conducted this performance audit from June 2019 to December 2020 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

¹⁷For example, GAO, *Climate Resilience: A Strategic Investment Approach for High-Priority Projects Could Help Target Federal Resources*, [GAO-20-127](#) (Washington, D.C.: Oct. 23, 2019) and *Climate Resilience: DOD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs*, [GAO-19-453](#) (Washington, D.C.: June 12, 2019).

Appendix I: Objectives, Scope, and Methodology

While this audit was conducted through December 2020, audit work concluded in August 2020. The publication of the final report was delayed for approximately two months while DOD conducted a review of the contents of the report to ensure that no classified or sensitive information was present.

Appendix II: Survey of Select DOD Installations

We administered the survey questions shown in this appendix to learn more about (1) the extent to which DOD uses the infrastructure and support services of communities surrounding its domestic installations, along with the associated effects of climate change and extreme weather and (2) the extent to which DOD coordinates with communities surrounding its domestic installations to limit installation exposure to the effects of climate change and extreme weather. All survey questions with response options also included an option to provide open-ended comments. Survey questions without response options were open-ended. This appendix accurately shows the content of the web-based survey but the format of the questions and response options have been changed for readability in this report. Terms used in the survey were defined at their first appearance in the survey and provided to respondents through pop-ups in subsequent questions, as well as included in the glossary that appears at the end of this appendix. For more information about our methodology for designing and administering the survey, see appendix I.

- 1. Does your installation utilize each of the following types of off-installation physical infrastructure or commodities provided to your installation from off installation, to support at least some installation functions?** By “installation,” we mean a military base, camp, post, station, yard, center, homeport facility for any ship, or other activity under the jurisdiction of DOD, including leased space that is controlled by or primarily supports department activities. An installation may consist of one or more sites, but we include only sites in the United States, to exclude U.S. territories and foreign sites. By “physical infrastructure,” we mean a real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land. Infrastructure supports, among other things, transportation and service and commodities provision. By “commodity,” we mean a product provided to your installation (e.g., electricity, natural gas) but not the infrastructure systems used to provide it. Please select one answer per row. *If any item in a row below supports installation functions, please select “Yes” for that row. If no item in a row below supports installation functions, please select “No” for the row.*

Appendix II: Survey of Select DOD Installations

Category	Yes	No	Don't know
Physical Infrastructure: Access roads or bridges			
Physical Infrastructure: Access rail lines			
Physical Infrastructure: Access inland or coastal water ports			
Physical Infrastructure: Access airports			
Physical Infrastructure: Public transportation systems (e.g., buses, subways) providing installation access			
Physical Infrastructure: Dams, levees, or seawalls			
Physical Infrastructure: Medical facilities			
Physical Infrastructure: Storm water management infrastructure (e.g., storm sewer pipes, outlets, managed floodplains)			
Physical Infrastructure: Commodity infrastructure systems (e.g., water pipes, sewage treatment plants, electrical substation)			
Commodity: Natural gas			
Commodity: Telecommunications (including any or all: phone, cable, cellular network)			
Commodity: Water (including any or all: potable, non-potable, industrial, but excluding wastewater)			
Commodity: Wastewater			
Commodity: Electricity			
Commodity: Other off-installation infrastructure or commodities			

1. Other infrastructure or commodities. Please specify.

- A. Of the physical infrastructure items for which you answered “Yes,” (i.e., “access roads or bridges” to “commodity infrastructure systems”), please choose one or more items and give the best example of the effects on installation functions of an off-installation disruption of those physical infrastructure items lasting longer than could be provided using installation or other resources.**
- B. Of the commodities for which you answered “Yes,” (i.e., “natural gas” to “electricity”), please choose one or more commodities and give the best example of the effects on installation functions of an off-installation disruption of those commodities lasting longer than could be provided using installation or other resources.**
- C. If there is additional information that you would like to share relative to Question 1, then please enter that here.**

- 2. Does a surrounding community or private contractor provide each of the following commodities or support services to your installation to support at least some installation functions? By “surrounding community,” we mean a non- DOD, non-federal community, political jurisdiction, governing body, or public or private organization with boundaries contiguous to, or responsibilities that may affect or support, a military installation and its operations. This can include state, tribal, and regional governments and government agencies. By “support service,” we mean a service provided to an installation that supports installation functions—for example, operation and maintenance of on-installation commodity infrastructure systems, waste management, facilities maintenance, and snow removal. *If any example in a row below applies, please select “Yes.” If no examples in a row apply, please select “No” for the row. Please select one answer for each row.***

Appendix II: Survey of Select DOD Installations

3.

Commodity or Support Service	Yes	No	Don't know	Not applicable
Water (including any or all: potable, non-potable, industrial, but excluding wastewater)				
Wastewater				
Electricity				
Natural gas				
Telecommunications (including any or all: phone, cable, cellular network)				
Any operation, repair or maintenance of on-installation commodity infrastructure systems (e.g., water pipes, sewage treatment plants, electric lines, telephone poles, natural gas pipes)				
Any repair or maintenance of on-installation transportation infrastructure (e.g., roads, bridges, rail lines, ports, airports)				
Any public safety services (e.g., emergency ambulatory or hospital services, law enforcement, firefighting)				
Any wildfire prevention activities (e.g., fuel removal, creation of fire breaks)				
Any other support services or commodities (do not include non-essential support services such as stray animal control).				

1. Other services or commodities. Please specify.

- 1. If there is additional information that you would like to share relative to Question 2, then please enter that here.**

- 3. How long, if at all, does your installation plan to be able to independently provide each of the following commodities or support services to sustain core installation functions if the surrounding community or private contractor cannot provide it due to off-installation disruptions?** Please assume that there are not disruptions on your installation. *If more than one example in a row applies, please select the lowest time period that applies to any. For example, if your installation has the capacity to repair or maintain its roads for more than 15 days but has no capacity to repair or maintain an installation bridge, you would select "Not at all, 0 days." Please select one answer for each row.*

Appendix II: Survey of Select DOD Installations

Commodity or Support Service	Not at all, 0 days	1-7 days	8-14 days	15 or more days	Don't know
Water (including any or all: potable, non-potable, industrial, but excluding wastewater)					
Wastewater					
Electricity					
Natural gas					
Telecommunications (including any or all: phone, cable, cellular network)					
Any operation, repair or maintenance of on-installation commodity infrastructure systems (e.g., water pipes, sewage treatment plants, electric lines, telephone poles, natural gas pipes)					
Any repair or maintenance of on-installation transportation infrastructure (e.g., roads, bridges, rail lines, ports, airports)					
Any public safety services (e.g., emergency ambulatory or hospital services, law enforcement, firefighting)					
Any wildfire prevention activities (e.g., fuel removal, creation of fire breaks)					
Any other support services or commodities (do not include non-essential support services such as stray animal control).					

A. If there is additional information that you would like to share relative to how long your installation plans to be able to independently provide the commodities or support services, then please enter that here.

4. Are you aware of any reports or assessments for your installation's surrounding communities that identify how to increase the resilience of any off-installation physical infrastructure or off-installation commodity supplies to the projected effects of extreme weather and other phenomena? By "resilience," we mean the ability to avoid, prepare and plan for, minimize the effect of, adapt to, and recover from adverse events. By "projected effects," we mean the effects of a phenomenon that may reasonably be expected to occur in the future based on historical occurrence or predicted future occurrence (such as effects predicted by computer modeling of climate data). By "extreme weather," we mean weather events that are unusual or unusually severe for a particular place. By definition, the characteristics of what is called "extreme weather" (e.g., "heavy precipitation") may differ from place to place. Extreme weather events may typically include extreme heat or cold and extreme precipitation events. By "other phenomena," we mean prolonged or unusually severe drought, desertification, wildfire, recurrent flooding, and thawing permafrost. *Please select one option below.*

Yes Continue to "a" below

No SKIP to Question 5

Don't know SKIP to Question 5

a) Please name and briefly describe the plans or assessments.

A. If there is additional information that you would like to share relative to Question 4, then please enter that here.

5. Are you aware of any reports or assessments that specifically include your installation, other than Joint Land Use Studies or Compatible Use Plans that identify how to increase installation

resilience to the projected effects of extreme weather and other phenomena?

Yes Continue to “a” below

No SKIP to Question 6

Don't know SKIP to Question 6

a) Please name and briefly describe the plans or assessments.

A. If there is additional information that you would like to share relative to Question 5, then please enter that here.

6. At any time during the last 5 calendar years (2014-2019), have any of the following extreme weather or other phenomena disrupted off-installation physical infrastructure or off-installation commodity supplies that support your installation's functions? If necessary, please consult the appropriate weather or climate subject matter expert(s) for your installation or military service to answer this question. *Please select an answer for each row.*

Appendix II: Survey of Select DOD Installations

Phenomenon	Yes	No	Don't know
Extreme heat (i.e., heat that was unusual or unusually severe for your location)			
Extreme cold (i.e., cold that was unusual or unusually severe for your location)			
Extreme precipitation event(s) (i.e., precipitation event that was unusual or unusually severe for your location)			
Recurrent flooding (coastal or riverine)			
Drought that was prolonged or unusually severe for your location			
Desertification (i.e., reduced vegetation cover, increased erosion and the spread of barren land, generally due to prolonged drought)			
Wildfire			
Thawing permafrost			

A. If there is additional information that you would like to share relative to Question 6, then please enter that here.

- 7. Are any of the following extreme weather or other phenomena projected to affect off-installation physical infrastructure or off-installation commodity supplies that support your installation's functions at any time during the next 20 years?** Please consult the appropriate weather or climate subject matter expert(s) for your installation or military service to answer this question. *Please select an answer for each row.*

Appendix II: Survey of Select DOD Installations

Phenomenon	Yes	No	Don't know
Extreme heat (i.e., heat that is unusual or unusually severe for your location)			
Extreme cold (i.e., cold that is unusual or unusually severe for your location)			
Extreme precipitation event(s) (i.e., precipitation event that is unusual or unusually severe for your location)			
Recurrent flooding (coastal or riverine)			
Drought that is prolonged or unusually severe for your location			
Desertification (i.e., reduced vegetation cover, increased erosion and the spread of barren land, generally due to prolonged drought)			
Wildfire			
Thawing permafrost			

A. If there is additional information that you would like to share relative to Question 7, then please enter that here.

- 8. For only the extreme weather or other phenomena you answered “Yes” to in Question 7, how severe, if at all, would the effect be on your installation’s functions if each phenomenon disrupted off-installation physical infrastructure or off-installation commodity supplies that support your installation for longer than could be provided using installation or other resources at any time during the next 20 years?** By “negligible,” we mean there would be little or no effect on installation functions, with little or no need for workarounds. By “moderate,” we mean there would be restriction or disruption of at least some installation functions, but workarounds would be available. By “significant,” we mean there would be restriction or disruption of at least some installation functions with few or no workarounds available. *Please select an answer for each applicable row.*

Appendix II: Survey of Select DOD Installations

Phenomenon	Negligible	Moderate	Significant	Don't know
Extreme heat (i.e., heat that is unusual or unusually severe for your location)				
Extreme cold (i.e., cold that is unusual or unusually severe for your location)				
Extreme precipitation event(s) (i.e., precipitation event that is unusual or unusually severe for your location)				
Recurrent flooding (coastal or riverine)				
Drought that is prolonged or unusually severe for your location				
Desertification (i.e., reduced vegetation cover, increased erosion and the spread of barren land, generally due to prolonged drought)				
Wildfire				
Thawing permafrost				

A. If there is additional information that you would like to share relative to Question 8, then please enter that here.

- 9. Has your installation taken any of the following actions to limit the exposure of installation functions to the effects that could occur if extreme weather or other phenomena were to disrupt off-installation physical infrastructure or off-installation commodity supplies or support services provided to your installation, at any time during the next 20 years?** If more than one answer in a row applies, please select the answer that indicates the highest level of completion that applies to any action in that row. For example, if your installation has not completed any plans, but has started updating a mission assurance plan and discussed updating an installation operations plan, you would select “Yes, actions planned...” If you have not discussed, planned, nor begun any action in a row, please select “No” for that row. *Please select only one answer for each row.*

Appendix II: Survey of Select DOD Installations

Action	Yes, completed	Yes, actions planned or begun but not yet completed	Yes, actions discussed but not yet planned or begun	No	Don't know
Developed or updated any installation plans for maintaining mission continuity (e.g., mission assurance plans), installation operations, or disaster response to limit the effects of off-installation disruptions					
Incorporated projected effects of extreme weather or other phenomena into any facilities sustainment, restoration, maintenance, or military construction plans and actions					
Installed or upgraded any on-installation back-up systems for commodities normally provided by an off-installation provider to support at least some installation functions					
Secured or developed any on-installation commodity supplies (e.g., developed ground water supply or installed solar array to mitigate against disruption of off-installation provision of water or electricity)					
Built new or renovated existing installation physical infrastructure (e.g., storm sewers or levees) specifically to limit installation exposure to the effects of off-installation disruptions					
Permanently moved any mission operations to different locations on your installation to limit exposure to the effects of off-installation disruptions					
Permanently moved any mission support operations to different locations on your installation to limit exposure to the effects of off-installation disruptions					
Permanently moved any mission or mission support operations to different installations to limit exposure to the effects of off-installation disruptions					
Secured any resources for independently conducting support services if necessary (e.g., procuring bulldozers for wildfire fuel removal)					
Other actions. Please describe below.					

j.1. Other actions. Please specify.

A. If there is additional information that you would like to share relative to Question 9, then please enter that here.

10. Do officials from your installation coordinate with any of the following organizations to increase the resilience of on- or off-installation physical infrastructure, or to protect or manage on- or off-installation commodity supplies, to mitigate the effects of extreme weather or other phenomena? Please note that we are not asking about coordination with FEMA or other federal agencies in this question. *Please select one answer for each organization.*

Appendix II: Survey of Select DOD Installations

Organizations	Yes	No	Don't know	Not applicable
State government or agency				
County or municipal government or agency				
Regional governmental organization or council of governments				
Tribal government or agency				
Local public works department				
Public utilities				
Emergency response organization				
Water, wastewater, or storm water planning board, regulatory body, or other similar organization				
Land use, development, or conservation planning board, regulatory body, or other similar organization				
Transportation planning board, regulatory body, or other similar organization				
Other planning boards, regulatory bodies, or other organizations.				

k.1. Other organizations. Please specify.

A. If there is additional information that you would like to share relative to Question 10, then please enter that here.

11. Has your installation taken any of the following actions with surrounding communities to limit exposure of installation functions to the effects of extreme weather and other phenomena projected to occur at any time during the next 20 years? If more than one answer in a row applies, please select the answer that indicates the highest level of completion that applies to any action in that row. For example, if your installation has not coordinated on water rights, but has started planning to coordinate on water rights and discussed coordinating on sustaining water supplies but has no plans yet, you would select “Yes, actions planned...” If you have not discussed, planned, nor begun any action in a row, please select “No” for that row. *Please select one answer for each of the actions listed.*

Appendix II: Survey of Select DOD Installations

Action	Yes, completed	Yes, actions planned or begun but not yet completed	Yes, actions discussed but not yet planned or begun	No	Don't know	Not applicable
Established cooperative agreements or mechanisms to manage natural resource allocation or protection issues (e.g., water rights or sustainment of water supply)						
Established cooperative agreements or plans specifically for repair or restoration of disrupted off-installation physical infrastructure						
Established cooperative agreements or plans specifically for repair or restoration of disrupted on-installation physical infrastructure						
Established general mutual aid agreements for emergency response or disaster recovery						
Implemented recommendations from a Joint Land Use Study or Combined Use Plan						
Secured funding for Readiness and Environmental Protection Integration (REPI) program projects specifically to increase resilience						
Provided input on transportation planning (e.g., planning in regard to off-installation access routes to the installation)						
Provided input on changes to communities' building or land use codes						
Shared expertise on how to increase the resilience of off-installation physical infrastructure or to sustain commodity supplies						
Shared costs or resources, or fully funded actions, to increase the resilience of off-installation physical infrastructure or to sustain commodity supplies						
Partnered or participated in the development of local or regional adaptation or resilience plans						
Other actions. Please describe below.						

I.1. Other actions. Please specify.

A. If there is additional information that you would like to share relative to Question 11, then please enter that here.

12. Have any surrounding communities or private contractors funded or otherwise taken action on or off your installation that was either intended to limit or had the effect of limiting the exposure of installation functions to the projected effects of extreme weather or other phenomena occurring at any time during the next 20 years? Please select one answer.

Yes Continue to “a” and “b” below

No SKIP to Question 13

Don't know SKIP to Question 13

a) Please provide an example of an on-installation action, describing the non-DOD entity involved, the relevant projected effects of extreme weather or other phenomena on installation functions, and what action(s) were taken to limit the exposure of installation functions to the effects.

b) Please provide an example of an off-installation action, describing the non-DOD entity involved, the relevant projected effects of extreme weather or other phenomena on installation functions, and what action(s) were taken to limit the exposure of installation functions to the effects.

A. If there is additional information that you would like to share relative to Question 12, then please enter that here.

13. What challenges, if any, does your installation face in coordinating with surrounding communities to increase the resilience of off-installation physical infrastructure, protect or manage commodity supplies, or ensure the delivery of support services to limit the effects of extreme weather and other phenomena on installation functions?

14. What actions, if any, could be taken to improve your installation's ability to coordinate with surrounding communities to increase the resilience of off-installation physical

infrastructure, protect or manage commodity supplies, or ensure the delivery of support services to your installation?

15. If there's anything else on the topics covered in this questionnaire that you would like to tell us, please type it here.

Glossary

Commodity—A product provided to an installation (e.g., electricity, natural gas) but not the infrastructure systems used to provide it. For example, water provided to an installation by an off-installation public utility is a commodity, while the water pipes and treatment plants are part of the commodity infrastructure system.

Extreme weather—Weather events that are unusual or unusually severe for a particular place. By definition, the characteristics of what is called “extreme weather” may differ from place to place. Extreme weather events may typically include extreme heat or cold and extreme precipitation events.

Installation—A military base, camp, post, station, yard, center, homeport facility for any ship, or other activity under the jurisdiction of DOD, including leased space that is controlled by or primarily supports department activities. An installation may consist of one or more sites, but we include only sites in the United States, to exclude U.S. territories and foreign sites.

Other phenomena—The following are weather phenomena within the scope of this survey:

Drought—A period of abnormally dry weather sufficiently prolonged to cause serious problems such as water supply shortages in areas dependent on surface water. Droughts dry out vegetation, increasing wildfire potential/severity, and can cause significant reduction in soil moisture, resulting in deep or wide cracks in the soil and affecting infrastructure.

Desertification—Generally brought on by prolonged drought, desertification reduces vegetation cover, leading to increases in the amount of runoff from precipitation events. Greater runoff contributes to higher erosion rates, increased stream sediment loads, and deposition of sediment in unwanted areas, reducing the effectiveness of flood risk management infrastructure while increasing the potential for siltation of water supply reservoirs. Eroded soil may be less suitable for native vegetation, resulting in bare land or revegetation with non-native, weedy species.

Wildfire—An uncontrolled fire in an area of combustible vegetation that occurs in the wilderness or countryside (although damage is felt by

people primarily at the wildland-urban interface, where human structures/developments meet with undeveloped wildland).

Recurrent flooding—Recurrent flooding can be coastal or riverine. Coastal flooding occurs as gradual sea level changes eventually result in recurrent or permanent inundation of coastal property, with increasing coverage of land from nuisance flooding during high tides. It can also cause saltwater intrusion into fresh water sources. Riverine flooding can occur if precipitation events or ice melt routinely cause an inland waterway to overflow its banks or manmade flow control infrastructure.

Thawing permafrost—The melting of in-ground ice to water at or near 32°F. Thawing of permafrost affects soil strength, ground subsidence, and stability, which can decrease the structural stability of foundations, buildings, and transportation infrastructure and require costly mitigation responses that disrupt planning, operations, and budgets. In addition, thawing permafrost exposes coasts to increased erosion and can increase wetland areas.

Physical infrastructure—A real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land. Infrastructure supports, among other things, transportation and service and commodities provision.

Projected effects—Effects of a phenomenon that may reasonably be expected to occur in the future based on historical occurrence or predicted future occurrence (such as effects predicted by computer modeling of climate data).

Resilience—The ability to avoid, prepare and plan for, minimize the effect of, adapt to, and recover from adverse events.

Support service—A service provided to an installation that supports installation functions—for example, operation and maintenance of on-installation commodity infrastructure systems, waste management, facilities maintenance, and snow removal.

Surrounding community—A non-DOD, non-federal community, political jurisdiction, governing body, or public or private organization with boundaries contiguous to, or responsibilities that may affect or support, a military installation and its operations. This can include state, tribal, and regional governments and government agencies. Surrounding communities do not include private contractors. Examples of surrounding

communities include towns; regional government organizations or councils of governments; state, county, and municipal governments or government agencies; regional water authorities, public utility or service providers; land use and transportation planning authorities; and non-governmental organizations such as land conservancies.

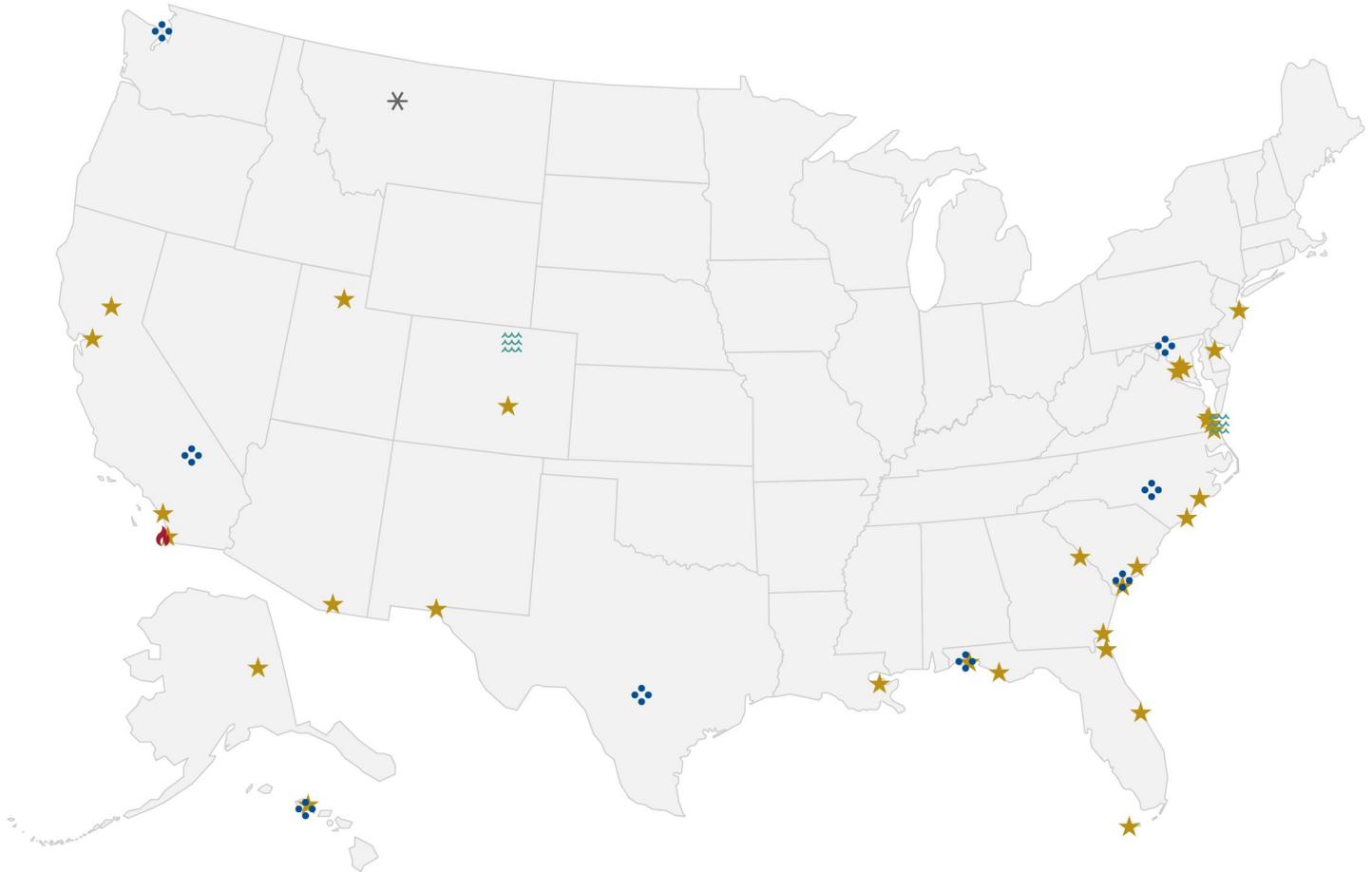
Appendix III: Locations of Installations that Experienced or Project to Experience Climate Change and Extreme Weather

Figures 5 and 6 below show the locations of surveyed installations that report experiencing disruptions to installation operations due to climate change and extreme weather from fiscal years 2014 through 2019, or expect future disruptions from fiscal years 2020 through 2039, respectively.

Forty-three of the 63 installations (68 percent) that responded to our survey report disruptions resulting from climate change and extreme weather events in the past 5 years, including disruptions from extreme cold, extreme heat, extreme precipitation, recurrent flooding, and wildfires. According to our analysis, 31 installations (49 percent) experienced disruptions because of multiple different climate change and extreme weather threats. One installation, Fort Greely, Alaska, reports past disruptions because of thawing permafrost.

Appendix III: Locations of Installations that Experienced or Project to Experience Climate Change and Extreme Weather

Figure 5: Locations of Surveyed Installations Reporting Disruptions in the Supply of Community Infrastructure or Support Services Due to Climate Change or Extreme Weather, by Event, Fiscal Years 2014 through 2019



Military installation affected by: * Extreme cold ● Extreme precipitation ~ Recurrent flooding 🔥 Wildfire ★ Multiple threats

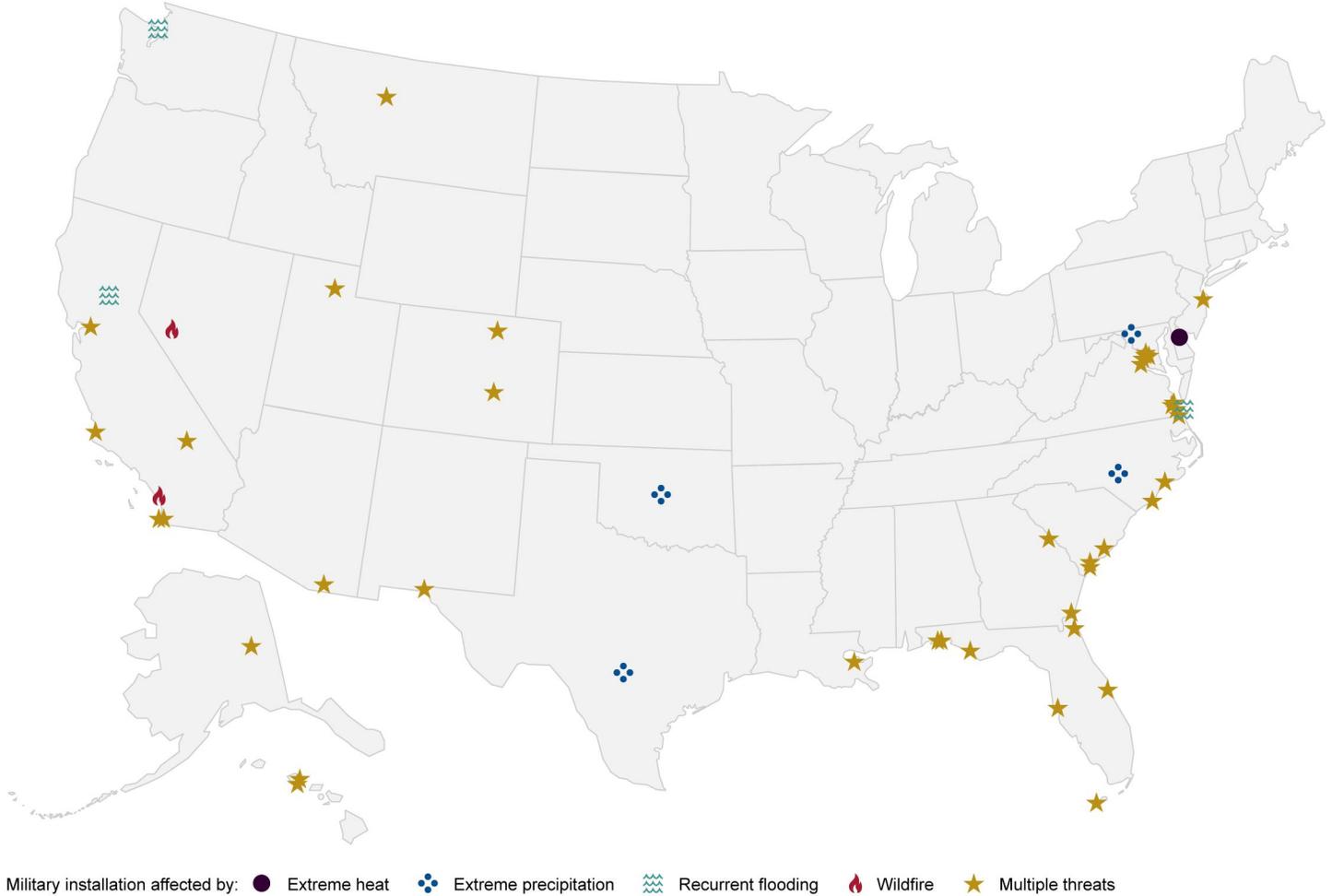
Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

Note: Multiple threats includes any combination of desertification, drought, extreme cold, extreme heat, extreme precipitation, recurrent flooding, thawing permafrost, or wildfire.

Separately, 49 of the 63 installations (78 percent) that responded to our survey report they expect to experience disruptions due to climate change or extreme weather in the next twenty years, including disruptions from extreme cold, extreme heat, extreme precipitation, recurrent flooding, and wildfires. According to our analysis, 39 installations (62 percent) project to experience disruptions because of multiple different climate change and extreme weather threats. One installation, Fort Greely, Alaska, reported projected disruptions because of thawing permafrost.

Appendix III: Locations of Installations that Experienced or Project to Experience Climate Change and Extreme Weather

Figure 6: Locations of Surveyed Installations Reporting Projected Disruptions to Community Infrastructure or Support Services Due to Climate Change or Extreme Weather, by Event, Fiscal Years 2020 through 2039



Source: GAO analysis of GAO survey of 65 Department of Defense installations. | GAO-21-46

Note: Multiple threats includes any combination of desertification, drought, extreme cold, extreme heat, extreme precipitation, recurrent flooding, thawing permafrost, or wildfire.

Appendix IV: Approaches Taken by Select Non-DOD Entities to Coordinate on Climate Change and Extreme Weather

This appendix provides information on approaches taken by select non-DOD entities to coordinate on climate change and extreme weather. As detailed in appendix I, we reviewed relevant reports, conducted internet-based searches, and performed a literature review to identify relevant sources. We then used professional judgement to select the eight sources highlighted in this appendix, basing our decisions on factors including geographic diversity, climate-related issues, community partnerships, diverse collaborative approaches, and themes identified in the sources. The results presented in this appendix are not intended to be representative of leading practices. Instead, they are a sampling of some practices that non-DOD entities use to collaborate on climate change and extreme weather. Table 9 shows collaborative efforts, which are similar to some DOD approaches identified in our site visits or reported to us in our survey. We did not independently verify the actions described in these articles.

**Appendix IV: Approaches Taken by Select
Non-DOD Entities to Coordinate on Climate
Change and Extreme Weather**

Table 9: Examples of Collaborative Efforts by Select Non-DOD Entities on Climate Change and Extreme Weather

Year	Article title	Source	Geographic area
2009	“Private-Public Collaboration to Reintroduce Fire Into the Changing Ecosystems of the Southwestern Borderlands Region”	Fire Ecology Special Issue	U.S. Southwest Borderlands (Arizona and New Mexico)
2011	“Comprehensive Planning in Flood Risk Management”	The Military Engineer	Crookstone, Minnesota
2014	“The role of NGOs in building sustainable community resilience”	International Journal of Disaster Resilience in the Built Environment	Queensland, Australia
2015	“A consensus based vulnerability assessment to climate change in Germany”	International Journal of Climate Change Strategies and Management	Germany
2017	“Hampton Roads Hazard Mitigation Plan”	Hampton Roads Planning District Commission	Hampton Roads Area of Virginia
2017	“Chicago Land Stormwater Collaborative: Models for Climate Resilience Paper”	Water Environment Federation	Chicago, Illinois
2020	“The San Diego Regional Climate Collaborative: Connecting the region to advance climate change solutions”	University of San Diego, School of Leadership & Education Sciences	San Diego, California
2018	“Local Mitigation Strategy Miami-Dade, Whole Community Hazard Mitigation”	Miami-Dade Officials	Miami-Dade County, Florida

Source: GAO analysis of select internet and literature review sources. | GAO-21-46

Note: We did not independently verify the actions described in these articles.

In selecting the examples, we identified the following three approaches that select non-DOD entities use to coordinate on climate change and extreme weather: collaboration on a specific weather-related issue; collaboration on multiple weather-related issues simultaneously; and collaboration on all-hazards, which can include weather.

Collaboration on a Specific Weather-Related Issue

Several sources we identified focused on a specific weather-related issue, such as flooding, stormwater management, and wildfire management.

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- **Flooding.** According to an article in *The Military Engineer*,¹ city officials in Crookston, Minnesota, collaborated with the state of Minnesota and the U.S. Army Corps of Engineers to replace deteriorating levees in all five of its flood-prone neighborhoods.² During the end of construction on an initial two-phase project, the riverbanks began to give out, so the group reconvened and developed a long-term plan to protect the entire city from flooding. The article states that the city of Crookston and the federal government shared costs for the first two phases of the project and secured grants from the Minnesota Department of Natural Resources to fund additional phases. According to the article, the securing of grant funding was partly attributable to the city of Crookston's long-term flood plan, which was recognized by the Minnesota state legislature and the Minnesota Department of Natural Resources. The article also states that if city officials had not monitored their progress or taken steps to reconsider their options throughout the construction process—and before they filed a required letter of map revision at the conclusion of phase two—they would have slightly increased the water surface elevation and unintentionally prevented further levee construction over the final four phases of the project. By postponing the letter of map revision until all six stages of the levee were constructed, officials successfully lowered the net water surface elevation and provided certifiable flood protection for the city of Crookston, according to the article.
- **Stormwater management.** In 2014, according to a *Water Environment Federation* article, the Metropolitan Planning Council established the Calumet Stormwater Collaborative in Chicago, Illinois, to coordinate stormwater actions among different government agencies and stakeholders who control land, infrastructure, financing, and regulatory powers.³ The article states that members established common goals and aimed to continually

¹For ease of reference, we use the term “article” to refer to all scholarly or peer-reviewed journals, government reports, trade or industry publications, conference papers and books relative to this effort.

²Mark Angelo, “Comprehensive Planning in Flood Risk Management,” *The Military Engineer* Vol. 103 No 672 (July-August 2011): 57-58, <https://www.jstor.org/stable/44532285>.

³Danielle Gallet, “Chicago Stormwater Collaborative: Models for Climate Resilience Paper,” *Water Environment Federation* (2017): 2034-2037.

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identify opportunities to align existing initiatives or develop new ones in support of projects that enable them to share knowledge, technology, and financial resources for maximum benefit. Specifically, the article notes that members assist municipalities with planning, conduct market analyses, and build design templates for green infrastructure, use available data to produce regional maps, and maintain an online repository for stormwater best management practices. Further, the article describes this collaboration as one representative of successful stakeholder engagement during which participants remain consistently involved and productive, following a list of lessons learned, which include:

- take time to establish the purpose of the collaboration and build consensus;
 - ensure stakeholders from agencies, communities and individuals have the power to enact change;
 - align missions, structures and initiatives that honor each participant's agency needs as well as the needs of the initiative;
 - identify funding opportunities across agencies or through multiple jurisdictions working together; and
 - have fun and create value through incentives such as a most volunteered participant award that recognizes an individual's value within the partnership.
- **Wildfire management.** Ranchers concerned about natural fire and land management policies to suppress all fires, including those producing beneficial results, formed the Malpai Borderlands Group near Douglas, Arizona, according to a *Fire Ecology Special Issue* article.⁴ Specifically, they collaborated with state and federal land managers, the Nature Conservancy, and the Coronado

⁴“Private-Public Collaboration to Reintroduce Fire Into the Changing Ecosystems of the Southwestern Borderlands Region,” *Fire Ecology Special Issue*, Vol. 5. No. 1 (2009): 85-99.

National Forest to develop the Peloncillo Programmatic Fire Plan.⁵ According to the article, the plan represents a singular framework for fires set and managed by the parties involved. Since 1995, according to the article, the plan has been used to successfully conduct four planned fires that, among other considerations, addressed extreme heat.⁶ As part of this effort, the article states that members also developed a monitoring plan that relied on existing photos, aerial surveys, and remote sensing capabilities to learn more about the effects of fire and identify potentially beneficial modifications to their plan. Their efforts prompted research by U.S. Forest Service scientists, non-governmental scientists, and university faculty and students on the effects of burning during cool and warm seasons as well as wildlife and fire behavior. According to the article, their research and associated outreach to interested parties from around the world will prove increasingly valuable if the effects of projected climate change occur.

Collaboration on Multiple Weather-Related Issues Simultaneously

Some of the sources we identified addressed multiple weather-related issues in relation to disaster resilience, climate solutions, and climate vulnerabilities.

⁵A U.S. Department of Interior, Bureau of Land Management article states that plans for prescribed fires—known as controlled burning—are required for each prescribed fire ignited by land management agencies. Burn plans are official site-specific implementation documents prepared by trained and qualified personnel and approved by the agency administrator. Plans also include criteria for the conditions under which the fire will be conducted to meet the resource objectives.

⁶According to this *Fire Ecology Special Issue* article, planned fires can prevent encroachment of woody vegetation and woody fuels. A U.S. Department of Interior, Bureau of Land Management article identifies vegetative fuel on or near the ground surface as leaf and needle litter, grass, dead branch material, downed logs, bark, tree cones and low grown vegetation.

- **Disaster resilience.** In 2010, Volunteering Queensland’s “Step Up” Natural Disaster Resilience collaboration received competitive grants for six separate natural disaster resilience programs, according to an *International Journal of Disaster Resilience in the Built Environment* article.⁷ The collaboration, which had already been in existence for decades, used that funding to establish:
 - resilience working groups for business owners to, among other factors, assist in the understanding of risks and the need for advanced planning;
 - an Aboriginal and Torres Strait Islander community resilience building project to ensure that all resilience actions are culturally sensitive;⁸
 - an online, interactive emergency volunteer portal to maintain continual connectivity with volunteers during emergencies;
 - a youth communications and resilience project involving smart phone applications that inspire student engagement in resilience efforts;
 - emergency volunteer community workshops that encourage information sharing on lessons learned from prior experiences; and
 - a natural disaster resilience leadership project that, among other things, helps leaders understand resilience and ways to effectively support collaborations.

According to the article, the collaboration leveraged best practices identified through previous extreme weather-related resilience work to

⁷“The role of NGOs in building sustainable community resilience,” *International Journal of Disaster Resilience in the Built Environment* Vol. 5 No.3 (2014): 292-304. These grants became an option for non-government organizations in 2010 after the Minister for Police, Corrective Services, and Emergency Services in Queensland, Australia, recognized volunteers as an integral part of disaster and emergency preparedness, response and recovery.

⁸According to the Australian Human Rights Commission, Aboriginal and Torres Strait Islanders are the original inhabitants of Australia that continue to maintain strong cultural, language and other connections, while contributing to environmental management, economic development, and other efforts.

develop these programs, creating the largest, non-governmental organization-led community resilience building effort in Australia.

- **Climate solutions.** In 2011, the San Diego Regional Climate Collaborative formed to advance climate change solutions that lessen greenhouse gas emissions and can adapt to the effects of climate change.⁹ According to their website, the collaborative—a network of public agencies comprised of regionally focused planning agencies, cities, jurisdictions, nonprofits and academia—provides research, training, and resources that facilitate collaboration on diminishing water supplies, wildfires, coastal erosion, and other climate change-related issues.¹⁰ Its programs include:
 - Coastal Resilience – sea level rise and coastal storms.
 - Climate-Smart Water – water resilient strategies.
 - Climate Adaptation – advancing coordination and understanding adaptation planning needs and opportunities.
 - San Diego Regional Energy Partnership – greenhouse gas reduction strategies.¹¹

According to a University of San Diego publication,¹² collaborative members known as climate education partners—which include world class science educators and researchers, behavioral science researchers, communications experts, and regional leaders in San Diego—have developed a step-by-step guide on leading with a changing

⁹University of San Diego, Climate Collaborative San Diego Region, School of Leadership and Education Sciences, *The San Diego Regional Climate Collaborative: Connecting the region to advance climate change solutions*, accessed July 28, 2020, <https://www.sandiego.edu/soles/hub-nonprofit/initiatives/climate-collaborative/>.

¹⁰University of San Diego, Climate Collaborative San Diego Region, School of Leadership and Education Sciences, *Who We Are: Climate Collaborative San Diego Region*, accessed July 28, 2020, <https://www.sandiego.edu/soles/hub-nonprofit/initiatives/climate-collaborative/who-we-are.php>.

¹¹University of San Diego, Climate Collaborative San Diego Region, School of Leadership and Education Sciences, *Our Programs: Building Climate Resiliency in San Diego*, accessed July 28, 2020, <https://www.sandiego.edu/soles/hub-nonprofit/initiatives/climate-collaborative/programs.php>.

¹²University of San Diego, *Your Community Toolbox for Leading in a Changing Climate*, accessed June 3, 2020, <https://www.sandiego.edu/climate/discover-more>.

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climate, along with educational resources on local climate data to help inform decision makers and integrate best practices into their communications. According to this publication, the collaborative also stores contact and other information critical for project management functions in databases to reduce inefficiencies, coordinate and share information critical to effective teamwork, and evaluate metrics for project refinements.¹³

- **Climate vulnerabilities.** In 2011, a team of research consultants contracted by the German Federal Environment Agency collaborated with relevant federal officials and agencies to establish a Vulnerability Network in Germany.¹⁴ Through 2015, the network collaborated on a nationwide, cross-sectoral¹⁵ vulnerability assessment for climate change that was used to prioritize climate-related threats, according to an *International Journal of Climate Change Strategies and Management* article.¹⁶ According to the article, members' objectives were to:
 - establish the network and the organization of decision processes within it;
 - conduct a semi-quantitative synthesis of supranational, national, and regional studies related to climate change impacts and vulnerability assessments;

¹³According to a Climate Education Partners, University of San Diego publication, Community Education Partners use a database called Constant Contact to store and manage contact information, collect pre-event data, create invitations for events, and track influential involvement. They use another tool called Trello to track events and activities and understand who is responsible for administrative tasks. Their technology sharing includes documents, calendars, and note taking.

¹⁴Federal participants included the Federal Office for Civil Protection and Disaster Assistance, Federal Agency for Nature Conservation; Federal Maritime and Hydrographic Agency; Federal Office of Economics and Export Control; Federal Institute for Geosciences and Natural Resources; Federal Institute of Hydrology; Federal Highway Research Institute; Federal Agency for Technical Relief; Federal Institute for Research on Building, Urban Affairs and Spatial Development; German Agency for International Cooperation; German National Meteorological Service; Federal Research Institute for Rural Areas, Forestry and Fisheries; Kreditanstalt für Wiederaufbau; Project Management Agency in the German Aerospace Center; Federal Institute for Disease Control and Prevention; and Federal Environment Agency.

¹⁵The assessment covers all 16 sectors of Germany, including water, human health, biodiversity, transport, and others.

¹⁶A consensus based vulnerability assessment to climate change in Germany," *International Journal of Climate Change Strategies and Management*, Vol. 7 and No. 3 (2015): 306-326.

- develop a consistent methodology to prioritize climate threats; and
- implement an integrative and nationwide quantitative and narrative assessment

The article states that members held a networking conference and eight network meetings; five workshops with external experts; meetings with federal ministries and other federal state authorities; and numerous bilateral telephone, e-mail, and personal meeting interactions. Scientists associated with the network developed and proposed the methodologies for the assessment and aggregated factors influencing vulnerabilities, which were then discussed and modified with agreement by federal authorities in the network.

Collaboration on All-Hazards Issues, including Weather

Two of the sources we identified were all-hazards strategies that either heavily included weather-related issues or exclusively addressed climate change.

- **Strategy focusing on weather-related issues.** Officials from 22 different cities, counties, and towns collaborated to produce the Hampton Roads Hazard Mitigation Plan, which focuses on a wide range of weather-related and other hazards that have the potential to threaten citizen safety, damage or destroy public and private property and disrupt the local economy.¹⁷ Based on our review of the plan, it recommends specific actions designed to protect residents, business owners, and the developed environment from those hazards that pose the greatest risk. According to the plan, participants voted to determine the most significant, yet addressable natural and manmade hazards, first forming working groups and a steering committee to individually and collectively analyze existing plans or projects, share subject matter expertise, and identify cost-sharing opportunities that would facilitate

¹⁷Hampton Roads Planning District Commission, *Hampton Roads Hazard Mitigation Plan*. (Hampton Roads, Virginia: <https://www.hrpdcva.gov/departments/emergency-management/hampton-roads-hazard-mitigation-plan>, Jan 2017), accessed 08/03/20. The plan operates under the core assumption that pre-disaster investments in hazard mitigation will significantly reduce the need for post-disaster assistance by lessening the need for emergency services, repairs, and reconstruction.

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multiple, ongoing projects.¹⁸ Specifically, this plan included components of each of the following pre-existing plans:

- Southside Hampton Roads Hazard Mitigation Plan
- City of Franklin All-Hazards Mitigation Plan
- Southampton County All-Hazards Mitigation Plan
- Peninsula Hazard Mitigation Plan
- City of Chesapeake, Virginia Hazard Mitigation Plan
- City of Poquoson, Virginia Hazard Mitigation Plan

The collaboration also outlined opportunities to improve the plan and process, including through community feedback and encouraging regional planning authorities to reach out to businesses, military installations, educational and medical institutions, neighborhood associations, non-profits, utilities, and other groups to enhance involvement in the process.

- **Strategy focusing on climate change exclusively.** Officials in Miami-Dade, Florida,¹⁹ collaborate annually to develop an all-hazards local mitigation strategy,²⁰ which is a community-wide, multi-volume strategy aimed to reduce or eliminate hazard-related risks to human life and property.²¹ Based on our review of the 2018 annual strategy, it states that it ensures that projects are

¹⁸Hampton Roads Planning District Commission, *Hampton Roads Hazard Mitigation Plan*. (Hampton Roads, Virginia: <https://www.hrpdcva.gov/departments/emergency-management/hampton-roads-hazard-mitigation-plan>, Jan 2017), accessed 08/03/20.

¹⁹Officials participate from the Miami-Dade Office of Emergency Management; the Florida Division of Emergency Management; the National Oceanic and Atmospheric Administration; the U.S. Army Corps of Engineers; and other county departments, municipalities, state, regional and federal entities; as well as colleges and universities; hospitals and health care facilities; private non-profits; private sector businesses; and others.

²⁰This strategy specifically addresses drought, erosion, flooding, hurricanes and tropical storms, salt-water intrusion, sea level rise, severe storm, tornado, wildfire, winter storm, and natural hazards, by jurisdiction. To address these threats, the strategy contains a Miami-Dade County Critical Facilities Inventory that, among other things, categorizes threats into three levels (facilities that: 1. must remain consistently available in all circumstances, 2. facilities that must be restored within 24 hours or risk dire community consequences, and 3. Facilities that must be restored within 72 hours to avoid major problems.). It also contains a list of identified data sources important to accomplishing its goals.

²¹Miami-Dade County, *Local Mitigation Strategy Miami-Dade, Whole Community Hazard Mitigation*. (Miami-Dade, Florida: <https://www.miamidade.gov/global/emergency/projects-that-protect.page>, Jan. 2018), accessed 08/05/20.

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prioritized and that associated details—such as costs, hazards, and funding sources—are publicly shared. The information available for active projects includes:

- Agency type
- Agency name
- Project title
- Project status
- Type of hazard(s)
- Grant source
- Funding source(s)
- Estimated costs of completion
- Project initiation date
- Anticipated completion or timeframe
- Project description

Each annual strategy provides a list of completed projects, along with funding sources and costs by calendar year, all of which are available online. As one example, the 2018 strategy states that the Florida Department of Transportation and Miami Beach funded completion of a \$2.7 million drainage improvement project along Indian Creek Drive in 2016.

Appendix V: Comments from the Department of Defense

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of Defense



SUSTAINMENT

ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

NOV 10 2020

Ms. Elizabeth A. Field
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Field:

This is the Department of Defense (DoD) response to the General Accountability Office's Draft Report, GAO-21-46, "CLIMATE RESILIENCE: DOD Coordinates with Communities, but Needs to Assess the Performance of Related Grant Programs."

The Department requests modifications to remove protected information from this draft report prior to its publication and public release, and concurs with comment to each of the report's three recommendations. The Defense Office of Prepublication and Security Review assessment of the draft report is enclosed and identifies the specific protected information which must be removed. We appreciate your team working with the Department to address these matters.

My point of contact is Mr. James Holland, Deputy Director for Compliance, Office of Economic Adjustment, at 571-329-5851 or james.p.holland8.civ@mail.mil.

Sincerely,

A handwritten signature in black ink, appearing to read "W. Jordan Gillis".

W. Jordan Gillis

Enclosure:
As stated

cc:
Office of Economic Adjustment

**GAO DRAFT REPORT – DATED AUGUST 12, 2020
GAO CODE 103615/GAO-21-46**

**“CLIMATE RESILIENCE: DOD Coordinates with Communities, but Needs to Assess the
Performance of Related Grant Programs”**

**DEPARTMENT OF DEFENSE COMMENTS
TO THE RECOMMENDATIONS**

RECOMMENDATION 1: The Secretary of Defense should ensure that the director of OEA establish performance measures for its Compatible Use Plan grant program. At a minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance.

DoD RESPONSE: The Department concurs with comment. OEA monitors the effectiveness of its programs and many times the benefits accrue after the OEA program of assistance is complete and the local jurisdictions are working with their local installations to carry out efforts identified through the OEA funding.

Under the Compatible Use (CU) program, OEA works closely with communities to ensure plans prepared with assistance under this program yield actionable recommendations. Moreover, based on the request of communities with completed CU plans, OEA may provide additional financial assistance to carry out some portion of the CU plan recommendations as the applicant proposes. These plans are typically responsive to the compatibility concerns identified by the Military Department nominating and/or owning the installation benefitting from a study. Site-specific responses versus common responses complicate the application of standard performance measures, including local/state legislation, property acquisition, and land use regulation development. Additionally, collaboration between the installation and community over proposed developments can take periods of time beyond those OEA can reasonably require a recipient to report back on the project outcomes.

OEA will continue to work with the customer base for this program and GAO to consider the application of more performance measures given the aforementioned mission environment, including the potential for knowledge management capabilities for performance measure data.

RECOMMENDATION 2: The Secretary of Defense should ensure that the director of OEA establish performance measures for its Military Installation Resilience grant program. At a minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance.

DoD RESPONSE: The Department concurs with comment. OEA monitors the effectiveness its programs and many times the benefits accrue after the OEA program of assistance is complete and the local jurisdictions are working with their local installations to carry out efforts identified through the OEA funding.

As discussed in the report, the Military Installation Resiliency (MIR) program just began in FY 2020 with 11 grant awards totaling \$5.9 million. OEA will continue to work with the customer base for this program and GAO to consider the application of more performance measures given the aforementioned mission

**Appendix V: Comments from the Department
of Defense**

environment, including the potential for knowledge management capabilities for performance measure data.

RECOMMENDATION 3: The Secretary of Defense should ensure that the director of OEA establish performance measures for its Defense Community Infrastructure Pilot grant program. At a minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance.

DoD RESPONSE: The Department concurs with comment. As discussed in the report, the Defense Community Infrastructure Pilot Program (DCIP) began in FY 2020 with 16 grant awards totaling \$49.8 million. While resiliency is one of the three issue areas the DCIP program seeks to enhance for local installations, the Secretary of Defense prioritized the enhancement of military family quality of life projects for the FY 2020 execution of this program. At this time, each funded project is expected to comply with a development schedule for the proposed project that was competitively scored by an internal cross-Service panel that will be the primary focus for performance over the next 3 years for those first awards.

In the event future appropriations are provided, and program activities prioritize military value and/or installation resiliency, OEA will work with the customer base for this program and GAO to consider the application of more performance measures given the aforementioned mission environment, including the potential for knowledge management capabilities for performance measure data.

Appendix VI: GAO Contacts and Staff Acknowledgments

GAO Contact

Elizabeth A. Field, Director, (202) 512-2775 or FieldE1@gao.gov.

Staff Acknowledgments

In addition to the contact above, Ryan D'Amore (Assistant Director), Shawn Arbogast (Analyst in Charge), Christopher Gezon, Alexandra Gonzalez, Chad Hinsch, Tracey Kalinowski, Jean McSween, Clarice Ransom, Mike Silver, Pam Snedden, and Erik Wilkins-McKee made key contributions to this report.

Appendix VII: Accessible Data

Data Tables

Accessible Data for Figure 1: Number of Installations Reporting Disruptions in the Supply of Community Infrastructure and Support Services Due to Climate Change or Extreme Weather, by Event, Fiscal Years 2014 through 2019

Threats	Number of installations
Extreme precipitation	31
Recurrent flooding	21
Extreme cold	14
Wildfire	12
Extreme heat	8
Drought	7
Desertification	1
Thawing permafrost	1
Multiple threats	31

Accessible Data for Figure 2: Number of Installations Reporting Projected Disruptions to Community Infrastructure and Support Services Due to Climate Change or Extreme Weather, by Event, Fiscal Years 2020 through 2039

Threats	Number of installations
Extreme precipitation	35
Recurrent flooding	33
Wildfire	16
Extreme heat	12
Drought	10
Extreme cold	9
Desertification	5
Thawing permafrost	1
Multiple threats	39

Agency Comment Letter

Accessible Text for Appendix V Comments from the Department of Defense

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NOV 10 2020

Ms. Elizabeth A. Field
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Field:

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The Department requests modifications to remove protected information from this draft report prior to its publication and public release, and concurs with comment to each of the report's three recommendations. The Defense Office of Prepublication and Security Review assessment of the draft report is enclosed and identifies the specific protected information which must be removed. We appreciate your team working with the Department to address these matters.

My point of contact is Mr. James Holland, Deputy Director for Compliance, Office of Economic Adjustment, at 571-329-5851 or james.p.holland8.civ@mail.mil.

Sincerely,

W. Jordan Gillis

Enclosure:
As stated

cc:
Office of Economic Adjustment

Page 2

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Under the Compatible Use (CU) program, OEA works closely with communities to ensure plans prepared with assistance under this program yield actionable recommendations. Moreover, based on the request of communities with completed CU plans, OEA may provide additional financial assistance to carry out some portion of the CU plan recommendations as the applicant proposes. These plans are typically responsive to the compatibility concerns identified by the Military Department nominating and/or owning the installation benefitting from a study. Site-specific responses versus common responses complicate the application of standard performance measures, including local/state legislation, property acquisition, and land use regulation development. Additionally, collaboration between the installation and community over proposed developments can take periods of time beyond those OEA can reasonably require a recipient to report back on the project outcomes.

OEA will continue to work with the customer base for this program and GAO to consider the application of more performance measures given the aforementioned mission environment, including the potential for knowledge management capabilities for performance measure data.

RECOMMENDATION 2: The Secretary of Defense should ensure that the director of OEA establish performance measures for its Military Installation Resilience grant program. At a minimum, the performance

measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance.

DoD RESPONSE: The Department concurs with comment. OEA monitors the effectiveness its programs and many times the benefits accrue after the OEA program of assistance is complete and the local jurisdictions are working with their local installations to carry out efforts identified through the OEA funding.

As discussed in the report, the Military Installation Resiliency (MIR) program just began in FY 2020 with 11 grant awards totaling \$5.9 million. OEA will continue to work with the customer base for this program and GAO to consider the application of more performance measures given the aforementioned mission

Page 3

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RECOMMENDATION 3: The Secretary of Defense should ensure that the director of OEA establish performance measures for its Defense Community Infrastructure Pilot grant program. At a minimum, the performance measures should be clear, quantifiable, objective, and provide for the baseline measurement of current performance.

DoD RESPONSE: The Department concurs with comment. As discussed in the report, the Defense Community Infrastructure Pilot Program (DCIP) began in FY 2020 with 16 grant awards totaling \$49.8 million. While resiliency is one of the three issue areas the DCIP program seeks to enhance for local installations, the Secretary of Defense prioritized the enhancement of military family quality of life projects for the FY 2020 execution of this program. At this time, each funded project is expected to comply with a development schedule for the proposed project that was competitively scored by an internal cross-Service panel that will be the primary focus for performance over the next 3 years for those first awards.

In the event future appropriations are provided, and program activities prioritize military value and/or installation resiliency, OEA will work with the customer base for this program and GAO to consider the application of more performance measures given the aforementioned mission

environment, including the potential for knowledge management capabilities for performance measure data.

Related GAO Products

Climate Resilience: Actions Needed to Ensure DOD Considers Climate Risks to Contractors as Part of Acquisition, Supply, and Risk Assessment. [GAO-20-511](#). Washington, D.C.: June 25, 2020.

Water Infrastructure: Technical Assistance and Climate Resilience Planning Could Help Utilities Prepare for Potential Climate Change Impacts. [GAO-20-24](#). Washington, D.C.: January 16, 2020.

Climate Change: Potential Economic Costs and Opportunities to Reduce Federal Fiscal Exposure. [GAO-20-338T](#). Washington, D.C.: December 19, 2019.

Climate Resilience: A Strategic Investment Approach for High-Priority Projects Could Help Target Federal Resources. [GAO-20-317T](#). Washington, D.C.: December 11, 2019.

Water Scarcity: DOD Has Not Always Followed Leading Practices to Identify At-Risk Installations. [GAO-20-98](#). Washington, D.C.: November 27, 2019.

Disaster Resilience Framework: Principles for Analyzing Federal Efforts to Facilitate and Promote Resilience to Natural Disasters. [GAO-20-100SP](#). Washington, D.C.: October 23, 2019.

Climate Resilience: DOD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs. [GAO-19-453](#). Washington, D.C.: June 12, 2019.

Climate Change: Opportunities to Reduce Federal Fiscal Exposure. [GAO-19-625T](#). Washington, D.C.: June 11, 2019.

High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas. [GAO-19-157SP](#). Washington, D.C.: March 6, 2019.

Climate Change: Analysis of Reported Federal Funding. [GAO-18-223](#). Washington, D.C.: April 30, 2018.

Climate Change Adaptation: DOD Needs to Better Incorporate Adaptation into Planning and Collaboration at Overseas Installations. [GAO-18-206](#). Washington, D.C.: November 13, 2017.

Climate Change: Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure. [GAO-17-720](#). Washington, D.C.: September 28, 2017.

High-Risk Series: Progress on Many High-Risk Areas, While Substantial Efforts Needed on Others. [GAO-17-317](#). Washington, D.C.: February 15, 2017.

Climate Change: Improved Federal Coordination Could Facilitate Use of Forward-Looking Climate Information in Design Standards, Building Codes, and Certifications. [GAO-17-3](#). Washington, D.C.: November 30, 2016.

Defense Infrastructure: DOD Efforts to Prevent and Mitigate Encroachment at Its Installations. [GAO-17-86](#). Washington, D.C.: November 14, 2016.

Climate Change: Selected Governments Have Approached Adaptation through Laws and Long-Term Plans. [GAO-16-454](#). Washington, D.C.: May 12, 2016.

Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information. [GAO-16-37](#). Washington, D.C.: November 23, 2015.

Federal Supply Chains: Opportunities to Improve the Management of Climate-Related Risks. [GAO-16-32](#). Washington, D.C.: October 13, 2015.

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