Report to Congress

Resilient Defense Infrastructure and Military Installations Resiliency

August 2020

Office of the Under Secretary of Defense for Acquisition and Sustainment

3010 Defense Pentagon

Washington, DC 20310-3010

As required by House Report 116-63, pages 10 and 18, accompanying H.R. 2745, the Military Construction, Veterans Affairs, and Related Agencies Appropriations Bill, 2020

The estimated cost of this report or study for the Department of Defense is approximately $30,000 for the 2020 Fiscal Year. This includes $15,000 in expenses and $15,000 in DoD labor.
Generated on 2020Jul28 RefID: D-69FE13F

Report to Congress
Resilient Defense Infrastructure and Military Installations Resiliency

Requirement

This report is submitted in response to House Report 116-63, pages 10 and 18, accompanying H.R. 2745, the Military Construction, Veterans Affairs, and Related Agencies Appropriation Bill, 2020. House Report 116-63 included two similar provisions regarding Department of Defense (DoD) plans to develop lasting and resilient military installations:

Page 10: ***Impacts of Climate Change and Investing in Multi-Hazard Resilient Defense Infrastructure***

"The Committee is concerned by increasing magnitudes and frequencies of environmental shocks (e.g., hurricane-force winds, storm surge, and extreme rainfall) and long-term stresses (e.g., from sea level rise) on DOD facilities worldwide. Recent extreme weather and natural disasters, for example, Hurricane Michael in 2018 that heavily damaged Tyndall Air Force Base in Florida, illustrate the challenges facing DOD in mitigating and preparing for inevitable future disasters and improving the security and readiness of the Nation's coastal military installations and the safety of military housing. The Committee supports the military's continued focus on building lasting and resilience military installations, including methods that update hurricane-resistant building codes for bases, barracks, hospitals, and airfields. It also encourages continued consideration of severe drought and desertification as potential threats to military installations and missions. In addition to Department-wide initiatives, such as revised structure planning, conservation programs and modeling new installations with the threat of sea-level rise in mind, the Committee encourages DoD to prioritize investing in climate-sustainable infrastructure projects. Such investments have yielded positive results including increased resilience and cost savings. The Committee urges DoD to collaborate with existing research universities with federally designated testing facilities to accelerate investments to assess DoD installation vulnerabilities at home and abroad and to develop and test resilient infrastructure and technologies capable of withstanding 200 mph winds and high levels of storm surge and flooding. Furthermore, the Committee directs the Sec of Defense to report to the congressional defense committees no later than 180 days after enactment of this Act detailing DoD's plans to develop lasting and resilient military installations, and what year these projects will appear in the Future Years Defense Plan."

Page 18: ***Natural Disasters and Military Installations Resiliency***

"The Committee supports the military's continued focus on building lasting and resilient military installations, including methods that update hurricane-resistant

building codes for bases, barracks, hospitals, and airfields. It further considers the impact of severe drought and desertification as high potential instability areas and how these two hazards impact bases and missions. In addition to Department-wide initiatives such as revised structure planning, conservation programs and modeling new installations with the threat of sea-level rise in mind, the Committee encourages DoD to prioritize investing in climate-sustainable infrastructure projects. Such investments have yielded positive results like increased resiliency and cost-savings. Accordingly, the Committee requests a report no later than 180 days after enactment of this Act detailing DoD's plans to further develop lasting and resilient military installations."

Scope of the Report

This report addresses both requests in House Report 116-63 relating to resilience to extreme weather and environmental conditions, including impacts due to a changing climate. It does not cover force protection or resilience to cyber threats, energy disruption, or nuclear attack. Section 101(e)(8) of title 10 of the U.S. Code provides this definition of "military installation resilience":

> *Military installation resilience: capability of a military installation 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.*

I. Context

Military installation resilience is of paramount importance to DoD mission accomplishment, and mission priorities drive DoD investment decisions—including the extent to which new or modernized facilities must better withstand extreme weather and changing climate conditions. DoD's Unified Facilities Criteria are robust and are regularly updated to incorporate lessons learned from recent natural disasters, new technology, and industry standards. DoD is further addressing impacts from extreme weather and a changing climate by improving planning and design processes to incorporate additional data on extreme weather and projected future climate factors.

Within this context, several practical challenges exist in designing and constructing installations to withstand these extreme weather and changing climate impacts.

1. **DoD must balance affordable resilience with acceptable risk.** Despite the obvious benefits, it is not economically feasible to design all, or even most, facilities to withstand

the extent of extreme weather that may be experienced. For example, constructing all coastal installation facilities to withstand Category 5 hurricanes is prohibitively costly.

2. **DoD must address increased uncertainty in installation planning and facility design regarding future environmental scenarios.** These future scenarios must be scientifically plausible but may have no assigned probabilities, thereby demanding risk-informed decision frameworks that extend beyond the traditional role of infrastructure planners and designers. Using these risk-informed decision frameworks requires deeper involvement from mission owners and resource sponsors to understand the potential effects and help develop effective solutions.

3. **DoD needs to understand how changing extreme weather and climate conditions affect installation or asset exposure, sensitivity, and adaptive capacity in order to form a firm basis for investment decisions on resilient installations.** These factors considered together determine an installation's extreme weather and climate vulnerability. DoD's existing process to assess exposure, sensitivity, and adaptive capacity has become more complicated because the inputs are changing over time.

    - Exposure is the degree to which an installation, due to its location, may be susceptible to a climate or weather phenomenon. (e.g., is the installation located in a flood-prone region?)
    - Sensitivity is the degree to which an installation could be affected by a climate or weather phenomenon. (e.g., are assets located in flood hazard areas? Are assets already elevated above the flood hazard? How much damage could be caused to important assets?)
    - Adaptive capacity is an installation's existing ability to address the potential impacts. (e.g., can important assets be relocated out of the flood hazard area? Do redundant capabilities exist to cover the most important installation functions?)

DoD understands that the responsible approach to understanding and addressing installation vulnerability includes other crucial considerations such as:

- Validating climate-related impacts through additional site-specific analysis;
- Determining potential mission impacts by understanding mission criticality – an installation's or facility's importance to mission accomplishment and a risk tolerance evaluation for that facility's non-availability to accomplish the mission. (e.g., can a Command Center be without power for an extended period of time? Can a maintenance facility tolerate several days or weeks without access due to roadway closure?); and
- Conducting detailed engineering studies to assess which adaptation strategies may be effective to reduce risk. This type of comprehensive analysis is needed to determine where best to apply resources to improve adaptation and resilience to meet mission demands.

Although the Military Departments regularly evaluate exposure, sensitivity, mission criticality and adaptive capacity (e.g., through contingency planning and continuity of operations efforts), the Department has not generally conducted this type of thorough analysis with regard to *future* weather and climate conditions. However, this report describes the progress made thus far to develop the tools, policies, and criteria to address these future hazards with cost-effective solutions. Given the tremendous variety of military installation settings and conditions all over the globe, that one size does not fit all; as the DoD must now adopt a planning and design approach that considers an uncertain future, this is even more so the case.

The Department's approach discussed in this report expands upon the recommendations made by the Government Accountability Office (GAO) in its report from June 2019 titled *DoD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs.* GAO identified the complementary roles of tools, policies, and technical standards toward addressing uncertain future environmental scenarios with more resilient infrastructure, focused on DoD's initial foray into this area with implementation of its database of regional sea level change scenarios. This report builds on that information using the same framework and includes updated progress on implementing the sea level scenario database.

II. Data, Tools, and Processes to Support Better Planning and Design

Over the past four years, the Department has produced new data and tools and refined planning processes, recognizing the need to account for site-specific factors in designing and building structures that are more resilient to the impacts of severe weather and a changing climate. The paragraphs below represent some of the more significant advancements.

DoD Regional Sea Level Scenarios for Coastal Risk Management Report and Database

The Department developed the DoD Regional Sea Level (DRSL) database for use in installation and facilities planning at coastal installations to account for future sea level change. The DRSL database, and its accompanying report, *Regional Scenarios for Coastal Risk Management,* published in 2016, were developed by the DoD-led Interagency Coastal Assessment Regional Scenario Working Group.

The DRSL database, accessible with a DoD-issued Common Access Card, is an online database that provides regionalized sea level and extreme water level scenarios for three future time horizons (2035, 2065 and 2100) for over 1,700 coastal military sites world-wide. The database provides access to site-specific scenario values for each of the three future timeframes, based on five global sea-level rise scenarios that range from 0.2 meters to 2.0 meters rise by 2100. The scenarios should not be considered predictions or most likely futures. Rather, the scenarios provide bounding values to assist decision-makers in managing their risks in the context of plausible future sea levels, allowing installation planners and leadership to make informed decisions about future land use planning. By itself, the database does not provide "an answer" to

improve resilience. Policies and additional guidance on the use of the DRSL database make these data useful. (See Section III.)

Climate Resilience Handbooks

The Naval Facilities Engineering Command (NAVFAC) produced the *Climate Change Installation Adaptation and Resilience Planning Handbook (Handbook)* in January 2017. The primary intent was to provide a systematic process to document the evaluation of possible adaptation strategies for consideration in the master planning process. The process requires a cross-functional team of stakeholders at the installation to compile information about current and potential impacts of severe weather and climate change. The *Handbook* includes references for conducting Cost Benefit Analyses to enable decision-makers to compare design, construction, and maintenance costs over the life of proposed mitigation alternatives. The end product is a portfolio of possible "solutions" to address risks to infrastructure posed by weather and climate factors. The final portfolio does not represent "recommended" solutions but rather a set of possible solutions that have been screened for feasibility and appropriateness. Additional site-specific engineering analyses and more rigorous cost estimations are required before an installation can choose a course of action. Application of the *Handbook* process reinforces the necessity of site-specific analyses to support responsible decision-making.

Using the *NAVFAC Handbook* as a model, the Army and Air Force are in the process of developing their own climate resilience handbooks to reflect terminology and processes specific to their installation planning protocols. The intent of the *Army Climate Resilience Handbook* is to "provide the analytical framework and methodology to help Army installation planners understand how to consider climate change in their installation planning processes, including Real Property Management Plans, Installation Energy and Water Plans, and Installation Natural Resources Management Plans." As mentioned above, the Air Force is in the process of developing an Air Force climate resilience handbook but has not used the existing *NAVFAC Handbook*. However, over the last six months, an enterprise team of Air Force Planners and Air Force Weather Professionals developed a *Severe Weather/Climate Hazard Screening and Risk Assessment Playbook* outlining a process for cross-functional teams at installations to screen for and assess extreme weather risks and climate impacts at each installation. The resulting analysis will help installations assess how best to apply resources to improve adaptation and resiliency. The *Playbook* also offers suggestions for follow-on actions that planners should consider after a specific risk is known. For example, planners should pass on recommendations to be considered during the requirements development, programming and design stage for facility projects (e.g., recommendations for wind modeling). Additionally, the *Playbook* addresses siting strategies for high wind risk areas.

The Air Force *Severe Weather/Climate Hazard Screening and Risk Assessment Playbook* references the *NAVFAC Handbook* as another resource that can be used by installation and facility planners to assess hazards related to severe weather and climate. Additionally, over the

next five to six years, Air Force Installation Development Plans will incorporate the result of severe weather and climate hazards screening and risk assessments.

All of these climate resilience handbooks follow a risk-informed planning process specifically focused on making decisions under uncertainty. And all are intended to provide a consistent, systematic methodology for installations to follow in assessing exposure to severe weather and climate risks.

DoD Climate Assessment Tool

The Office of the Assistant Secretary of Defense (Sustainment) tapped the U.S. Army Corps of Engineers to adapt one of its Army-focused tools to provide a screening level assessment of the exposure to extreme weather and climate effects for selected domestic and foreign locations for each Military Department. The DoD Climate Assessment Tool is a geospatial indicator-based tool that relies on nationally consistent, authoritative data from Federal agencies and other sources. The web-based tool includes indicators (current and future) for many climate factors including coastal total water levels, coastal erosion, riverine flooding, drought, desertification, wildfires, thawing permafrost, and historic extreme weather events. The assessment results will allow the Department to understand relative exposure of the selected locations to the effects of climate and extreme weather, and thus allow informed decision making for possible future assessment at finer scales having more local information, with the goal of planning and implementing resilience measures.

All of the Military Departments are participating in the DoD Climate Assessment Tool development process, providing feedback on outputs, and determining elements that could be integrated into planning and design processes.

Collaboration with Universities and Research Institutions

DoD funds universities and others to perform installation resilience research principally through the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP). A few examples of SERDP research efforts include work at the University of Arizona that evaluated how warm season extreme weather events may change in the Southwest United States and how these changes may affect DoD facilities within the region over time; the development of a fiber-optic geophysical sensing package capable of providing real-time information on building failure in permafrost environments, an effort led by Lawrence Berkeley National Laboratory; and a recently completed examination of the impacts of a changing climate on installations in the Pacific by Woods Hole Oceanographic Institute.

With regard to ESTCP, which is a demonstration and validation program, two recently initiated projects are particularly noteworthy. The first is the University of Alaska Fairbanks's development of the Arctic Environmental and Engineering Data and Design Support System that will transform outdated hardcopy information into a best-available data, curated online hub for engineering designs of buildings, roads, bridges, runways, harbors, communications, and power

systems in the strategically important Arctic region. The second is a Lawrence Berkeley National Laboratory-led initiative, the Weather Effects on the Lifecycle of DoD Equipment Replacement (WELDER) project, to develop an Application Programming Interface plug-in for BUILDER, the current DoD Sustainment Management System module for vertical assets. This plugin will allow users to prioritize infrastructure maintenance schedules and costs according to the likelihood and severity of foreseeable future weather and climate scenarios.

In addition to SERDP and ESTCP, other DoD entities support relevant activities, including the DoD Office of Economic Adjustment (OEA). The OEA's Military Installation Sustainability program funds communities near installations to investigate resilience measures for the benefit of both the community and the installation. This program is designed to help communities make informed decisions by enabling both States and communities to partner with local commands to respond to, address, and mitigate activities that are either impairing or likely to impair the use of the installation. The program addresses several factors, including tidal flooding and storm surge, storm water and floodwater management, extreme weather events including wildfire and drought, and unanticipated changes in environmental conditions, among others. For example, a new OEA project with the University of Rhode Island will investigate specific climate impacts to the State and provide beneficial information for the U.S. Naval Complex in Newport.

Each of the Military Departments sponsors research into programs intended to improve installation resilience. Some Air Force examples include:

- The Air Force's Tyndall AFB Program Management Office (PMO) established an Innovation Working Group that coordinates input from across the Air Force enterprise. Working with AFWERX, a team of innovators who encourage and facilitate connections across industry, academia, and the military to foster innovation, by leveraging relationships with the Small Business Innovation Research (SBIR) program. In addition, the PMO and AFWERX launched a series of Challenges to industry that are identifying technologies that will help shape and inform infrastructure resilience for the Tyndall rebuild; small businesses, large businesses, and academia are involved and encouraged to respond.
- The Air Force is collaborating with the Colorado State University Center for Environmental Management of Military Lands on several projects. The first will improve floodplain delineation for approximately 35 installations this calendar year and prioritize the next set of Air Force installations for floodplain mapping updates based on availability of LiDAR/elevation data, environmental requirements, and vulnerability to coastal and riverine flooding. The second project explores the potential sea level rise, storm surge, and temperature and precipitation pattern change effects on over 60 Air Force sites around the world. The intent is identification of potential vulnerabilities and possible adaptation strategies to feed into Air Force installation Integrated Natural Resource Management Plans. The USAF anticipates completing the remaining installations during the next several fiscal years.

- The Air Force is working with the University of Alaska–Anchorage to pursue more accurate Alaska shoreline erosion prediction models that take into account warming water near the shore, increasing air temperatures, longer periods when sea ice is gone, increasing spatial extent of open water, increasing wind speeds, storm surges, wave height, and thawing of permafrost.

Finally, the Air Force and Army rely on the U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory expertise for its work on construction techniques in permafrost regions.

III. Policies and Criteria to Strengthen Installation Resilience

To effect change in the way Military Construction (MilCon) projects are designed and constructed, policies and specific criteria must be revised to reflect new required processes and standards. This section describes DoD's advancements in infrastructure policies and criteria relating to severe weather and climate change.

Policies

Implementing the DRSL Database

The Under Secretary of Defense for Acquisition and Sustainment issued a February 24, 2020, memorandum requiring Military Departments to implement use of the DRSL database into installation planning and facility design at coastal locations to account for future sea level rise. The memorandum also directs revision of associated Unified Facilities Criteria (UFC) to incorporate the use of the DRSL database (see details below). This is an important step in providing consistency throughout the Department in its technical approach to assessing exposure, determining vulnerability, and planning for resilience. Even with the UFC modifications, the Military Departments need to establish policies for selection and application of the appropriate future scenario or scenarios for installation planning and facility design.

Use of NAVFAC Handbook or Equivalent Document

Consistent with Section 2805(c)(2) of the FY 2020 National Defense Authorization Act, UFC 2-100-01 *Installation Master Planning* is being updated to require the use of the NAVFAC Handbook or Service-specific equivalent. As described above, the *NAVFAC Handbook* provides a process for installation-specific assessment of extreme weather and climate impacts and development of adaptation options as input to the master planning process. Equivalent Army and Air Force documents in preparation will provide similar information.

Unified Facilities Criteria

Unified Facilities Criteria represent the DoD building code, providing a set of minimum standards for all DoD facilities worldwide. DoD Components may choose to go beyond UFC standards when warranted (for example, an increased wind-resistance standard for Tyndall

AFB). The Department regularly updates the UFCs whenever new consensus standards are published by organizations such as the American Society of Civil Engineers (ASCE) and the International Code Council (ICC), which is responsible for the International Building Code (IBC). These codes and standards – particularly those of ASCE – reflect lessons learned around the world to improve resilience against extreme environmental events such as hurricanes, earthquakes, snow, and floods. As these standards are updated, DoD incorporates them on a regular basis into UFCs for use in new construction and major renovations.

In addition to the use of consensus standards, DoD (or individual DoD Components) have often exceeded these standards when DoD-unique requirements are warranted. Examples of this include the following:

- Increasing the risk category (per ASCE design standards) of aircraft maintenance hangars, often used to protect high value aircraft during extreme storms, from level II to level III. This serves the purpose of significantly raising the resiliency of the structure against environmental loading.
- Creating a new risk category level V (exceeding the highest ASCE level IV) specifically intended for facilities critical to national strategic defense. These standards increase nearly all environmental design loads and material redundancy by a significant margin, with the intent to preserve fully functional facilities during extreme events.
- Expanding the geographical regions of windborne debris beyond the model building codes (2018 IBC and ASCE 7-16) to provide increased protection to DoD installations from destructive windborne debris associated with hurricane prone areas.
- Prohibiting vertical lift fabric doors (VLFD) within DoD windborne debris regions due to catastrophic failures at Tyndall Air Force Base during Hurricane Michael. The VLFD industry has responded by proposing to upgrade their product to conform to Miami – Dade County provisions for wind driven missile impact protection testing. DoD is currently re-evaluating future consideration of VLFDs in windborne debris regions.
- Increasing the required stiffness of facilities with long-span roof structures (e.g. aircraft hangars) beyond that required by the national model building codes (2018 IBC and ASCE 7-16) to mitigate potential collapse during an earthquake.

The following UFCs have been or are being revised to required consideration of severe weather and climate impacts.

UFC 2-100-01, Installation Master Planning (Oct 2019)

This UFC is currently undergoing revision to incorporate FY 2020 National Defense Authorization Act (NDAA) language and currently requires each installation to "identify and assess the risks to the installation from the effects of extreme weather and climate change, and develop plans to address those risks as appropriate." Installations are to address changes in climatic conditions, such as temperature, rainfall patterns, storm frequency and intensity

and water levels and use climate projections from reliable sources. More specifically, the revision is promulgating requirements for the incorporation of the DRSL database and its options for regional sea-level change scenarios into comprehensive installation planning, as well as direction on the use of the *NAVFAC Handbook* or equivalent document for developing and comparing alternative courses of action.

UFC 3-201-01, Civil Engineering (Jul 2019)

This UFC is currently undergoing revision to incorporate FY 2020 NDAA language and currently outlines disclosure requirements and includes sections on minimum design flood elevation and flood mitigation requirements, flood resistant design options, and flood protection systems. The revision will establish a technical approach for incorporating the DRSL database at coastal installations to determine future inundated areas, future floodplains, and design flood elevations.

UFC 3-301-01, Structural Engineering (Oct 2019)

This UFC was revised in October 2019 to be current with industry codes and standards relating to seismic and wind standards. Specifically, the revised UFC provides additional design load combinations for designing structural components that are sensitive to vertical earthquake ground motion. In addition, site-specific structural load data tables for wind were updated to the basic wind speed values from the 2018 IBC and ASCE/SEI 7-16.

UFC 3-201-02, Landscape Architecture (Apr 2020)

This UFC was revised to incorporate consideration of specific factors relating to climate resilience and natural hazards. Section 2-6.1 Sustainable and Resilient Planting Design directs that selection of plantings should take into account shifts in the United States Department of Agriculture (USDA) plant hardiness zones; the USDA has provided a map with projected changes in the zones through 2040. In addition, plantings should be resilient to extreme weather events and able to withstand flooding and saltwater intrusion from storm surge in coastal areas. Additionally, plants in coastal areas should have a high tolerance for winds. An Appendix provides additional best practices. Landscape architects should consider the following potential climate change effects: shifts in USDA plant hardiness zone designation; stresses on specific species; changes in disease and pest vector distribution; and changes in regional precipitation patterns. The use of landscaping design to buffer winds, vegetated dunes to reduce wave impacts, and low impact development designs to promote infiltration of precipitation on site can increase military installation resilience.

UFC 1-200-02, High Performance and Sustainable Building Requirements (Oct 2019)

This UFC requires that new building design solutions are "responsive to any Government-provided projections of climate change and determination of acceptable risk." The goal for existing buildings is to improve climate resiliency of facilities and operations.

Policy and Criteria Implementation Examples

Recent design work conducted for Tyndall AFB—seriously impacted by Hurricane Michael in 2018—provides a prototype for revising design criteria to reflect site-specific extreme weather and changing environmental conditions. Given the extensive level of damage, the Air Force made a policy decision to design beyond the minimum criteria for civil and structural engineering. Specifically, the Air Force used DRSL database sea level rise scenarios to inform development of a Design Flood Elevation for reconstruction at Tyndall AFB. Using DRSL data, Air Force personnel generated spreadsheets and visualizations for several planning scenarios for future sea-level change, in combination with the 100-year floodplain elevation for Tyndall AFB. The site-specific Design Flood Elevation will ensure new facilities are built at an elevation above mean sea level that balances long-term risk aversion with minimal cost implications.

In addition, the Air Force adopted portions of the Florida Building Code (FBC) at Tyndall that exceed Unified Facilities Criteria (UFC) standards and require new construction projects to withstand higher wind speeds than previously experienced in the Florida panhandle. These standards include enhanced roof-to-wall/foundation connections and ensure building envelopes meet Florida High Velocity Hurricane Zone material certifications. Furthermore, Tyndall AFB is exploring coastal resiliency pilot projects to help enhance the coastline's natural ability to absorb the impact of storms and related storm surge. These nature-based solutions will supplement the structural infrastructure-based solutions.

In another application of DRSL data, the Navy developed a Washington Navy Yard Flood Risk Management Plan (2017) which addresses current flooding conditions and future flood risk based on projections in the database. This plan includes strategies and cost estimates for addressing flood risks, with follow-on MilCon and Sustainment, Restoration, and Modernization projects in development to mitigate those risks.

DoD recognizes that in some cases, more sophisticated flood modeling and mapping may be necessary to determine and visualize future flood hazard areas. These challenges were described in the report to Congress titled *Feasibility of Transitioning from Using 100-Year Floodplain Data to a Forward-Looking Predictive Model that Takes into Account the Impacts of Sea Level Rise*, dated January 2020.

The approaches executed by the Air Force and Navy are representative of what the Department is striving to implement Department-wide; installation teams consider lessons learned and future climate projections in order to apply a consistent, systematic approach to assess current and future vulnerabilities, and follow the appropriate UFCs or establish more protective standards in designing for resilience.

Service-Specific Policy

Army: The Army is updating its regulatory guidance, Army Regulation 210-20, *Real Property Master Planning for Army Installations*, to reflect the updated UFC 2-100-01 (October 2019). In addition, a new Department of Army Pamphlet addressing the real property master planning

process that aligns with the policy outlined in AR 210-20 is under development. As noted earlier in this report, the master planning UFC is undergoing updates to include NDAA 2020 language. Depending on timing of those revisions, the updated AR 210-20 currently under review may be revised further to incorporate the newest UFC updates.

Navy: The Navy revised the Encroachment Management Program guidance that addresses Military Installation Resilience –OPNAVINST 11010.40A *Encroachment Management Program.* This is Navy's program guidance for working with local, state, tribal governments, other federal agencies, as well as non-governmental organizations to protect military operations at Installations and Ranges through compatible use space (land, sea, air) and includes addressing natural hazards. The Marine Corps Order (MCO) 11000.12, *Real Property Manual, Facilities Planning and Programming* and MCO 11000.5, *Facilities, Sustainment, Restoration and Modernization Program* provide guidance on incorporating environmental resilience from initial master planning to sustainment of existing facilities and infrastructures.

Air Force: Air Force Policy Directive (AFPD) 90-20, *Mission Sustainment,* and Air Force Instruction (AFI) 90-2001, *Mission Sustainment,* were revised in 2019. The AFI includes a process that requires any risk to mission sustainment at an installation, to include severe weather and climate risk, be framed, communicated, and accepted at the appropriate level of authority in accordance with operational risk management concepts. AFI 32-1015, *Integrated Installation Planning* (Jul 2019), requires planners to participate in the AFI 90-2001 *Mission Sustainment* process, outlines climate and severe weather roles, and requires installations to assess and manage climate risk (including severe weather) in planning. AFMAN 32-7003, *Environmental Conservation,* requires those installations to have an Integrated Natural Resources Management Plan, consider historic regional trends in climate, use authoritative region-specific climate science to create projections of future climate change vulnerabilities and risks to natural infrastructure and sensitive species, and employ an adaptive ecosystem-based management approach that will enhance the resiliency of the ecosystem to adapt to changes in climate.

IV. Military Construction Investments in Resilience

Improving the resilience of Defense installations against environmental stressors that are changing over time represents a challenge that extends indefinitely. This stems not only from potentially long-term environmental changes, but from the protracted timeline required to renew the Department's substantial inventory of facilities and infrastructure that is aggravated by historical underinvestment. Moreover, this critical and limited investment is not typically targeted toward improved resilience per se, but toward supporting new mission requirements, modernizing obsolete facilities, and improving overall condition. Improved resilience is largely a byproduct of prioritized investment to construct or substantially modernize facilities using new standards to address these functional and operational needs.

Despite this constraint, exceptions that prove the rule may grow more common over time. For example, lessons learned from analysis of extreme events may generate and inform initiatives to retrofit similar facilities in other locations when supported by cost-benefit analysis; this would represent a unique resilience-targeted investment. Likewise, the Department's ongoing development of tools to assess environmental vulnerabilities should allow pre-emptive analysis of risk and opportunity to identify potential projects to mitigate that risk before events occur. This may lead to proposed projects to mitigate flooding or its impacts, reinforce specific buildings against extreme wind loads, or the like. These types of projects would represent a small fraction of the total demand for investment dollars, but would nonetheless provide specific benefits to the resilience of the installation and its mission. The recent natural disasters provide specific examples of this dynamic.

Somewhat paradoxically, natural disasters themselves provide the most impactful opportunities for improving installation resilience on a scale not otherwise possible. The investment of hundreds of millions of dollars into recovery projects in response to the 2019 California Ridgecrest earthquake impacting Naval Air Weapons Station China Lake and the 2018 Hurricane Florence impacting eastern North Carolina at Marine Corps Base Camp Lejeune, Marine Corps Air Station New River and Marine Corps Air Station Cherry Point will replace the most vulnerable facilities with fully modern facilities built to current standards to resist extreme environmental events. The Department greatly appreciates the responsiveness of Congress and the American people in providing the supplemental resources necessary to renew its installations and greatly improve their resilience against future events.

Although nearly all construction and modernization projects improve resilience to some degree, the additional FY 2020 Planning and Design (P&D) funding for military installation resilience provides a unique opportunity for the Department to identify and plan projects specifically targeted to this purpose. A summary of the spending plan for each Military Department follows.

- The Army is working on an expenditure plan focused on projects that address environmental or climate-related threats to installations, such as sea level rise, flooding, drought, desertification, wildfire, permafrost thaw, or extreme weather events. Projects will be implemented at locations deemed to be the most climate exposed as determined by the Army Climate Assessment Tool, a USACE precursor to the DoD Climate Assessment Tool.
- The Navy spend plan for installation resilience invests P&D funding in: (1) studies and analyses necessary to update UFCs, Unified Facilities Guide Specifications, and supporting technical documents and tools; (2) developing resiliency design expertise to address multiple resilience issues across projects; (3) compilation, sensitivity analysis, and translation of environmental resilience data sets into mapping layers for Department of Navy geo-spatial information system (GIS) data to inform facility designs, to include the results from DoD Sea Level Change-Extreme Water Level and OSD Climate Vulnerability assessments at sixty Navy and USMC installations, and ongoing seismic

and tsunami studies; and (4) design of five highest-priority Navy and Marine Corps resilience projects based on the most significant resilience issues.

- The Air Force has applied resilience P&D funds to projects to increase resiliency and mission effectiveness during extreme weather events. Design funding for FY 2022 is planned for projects in South Carolina, Nebraska, Florida, North Dakota and Japan. Moving facilities outside a tsunami zone, replacing facilities that flood during heavy rain events, and supporting backup power generation all contribute to increased mission resiliency.

Because plans for additional resilience-focused projects are still in development, this report does not include a timeline for such projects appearing in the Future Years Defense Plan as requested by the committee.

V. Conclusion

As always, DoD mission priorities will continue to drive investment decisions on installations, including the extent to which new or existing facilities must be resilient against extreme weather and changing environmental conditions. At the same time, the Department's commitment to maintaining and often exceeding current industry standards, to developing new data and assessment tools, and to refining planning and design practices, will ensure that each dollar invested in new or modernized facilities will continue to materially increase military installation resilience. The Department appreciates the support of Congress in providing the resources necessary to sustain and improve the infrastructure critical to national defense.