

# BUILDING RESILIENCE TOGETHER: COMMUNITY-MILITARY COLLABORATION IN WASHINGTON, D.C.

Final Report of the COG Military Installation Resilience  
Review

April 2023



Metropolitan Washington  
**Council of Governments**





## **BUILDING RESILIENCE TOGETHER: COMMUNITY-MILITARY COLLABORATION ON RESILIENCE IN WASHINGTON, D.C.**

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### **CREDITS**

**COG:** Steven Bieber, Jeffrey King, Katherine Dyer, Ata Adeel

**ICF:** Peter Schultz, Cassandra Bhat, Samantha Heitsch, Claire Phillips, Sonia Aronson

**Nspiregreen:** Jordan Exantus, Allysha Lorber, Hung Truong, Leila Bahrami, Elisabetta DiStefano, Aysha Cohen, Mercy Iyere

### **COVER PHOTO CREDIT**

**Photographer:** Kit Leong; Shutter Stock

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### PROJECT STEERING COMMITTEE

**Mark Scott**, D.C. Homeland Security and Emergency Management Agency  
**Melissa Deas**, D.C. Homeland Security and Emergency Management Agency  
**Jennifer Hirsch**, OLDCC  
**Scott Spencer**, OLDCC  
**Gail Kenson**, Naval District Washington  
**Samuel Mattern**, Washington Navy Yard  
**Charles (Luke) Armstrong**, Washington Navy Yard  
**Samantha Prog**, Joint Base Anacostia-Bolling, formerly Washington Navy Yard  
**Mark Berger**, Joint Base Anacostia-Bolling  
**Thomas Minter**, Joint Base Anacostia-Bolling  
**Kelly Whitton**, Fort McNair  
**Matthew Fortunato**, Fort McNair  
**Stephen Tkacik**, U.S. Naval Research Laboratory  
**Gregory Lipscomb**, Marine Corps  
**Eric Santure**, Joint Task Force—National Capitol Region

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## ACRONYMS

<b>AEG</b>	Advanced Energy Group
<b>AILS</b>	Anacostia Initial Line Segment
<b>ANC</b>	Advisory Neighborhood Commissions
<b>APTA</b>	American Public Transportation Association
<b>ART</b>	Anacostia Riverwalk Trail
<b>ATE</b>	Automated Traffic Enforcement
<b>AWTP</b>	Advanced Wastewater Treatment Plant
<b>BGI</b>	Blue/Green Infrastructure
<b>BID</b>	Business Improvement District
<b>BIL</b>	Bipartisan Infrastructure Law
<b>BMP</b>	Best Management Practices
<b>BRIC</b>	FEMA Building Resilient Infrastructure and Communities Grant
<b>BRT</b>	Bus Rapid Transit
<b>C&amp;CB</b>	Capability and Capacity Building
<b>CARES Act</b>	Coronavirus Aid, Relief, and Economic Security Act
<b>CDBG</b>	HUD Community Development Block Grant
<b>CHP</b>	Combined Heat and Power
<b>CISA</b>	U.S. Cybersecurity and Infrastructure Security Agency
<b>CO</b>	Central Office
<b>COG</b>	Metropolitan Washington Council of Governments
<b>CPO</b>	NOAA Climate Program Office
<b>CSO</b>	Combined Sewer Overflow
<b>DCAT</b>	Defense Climate Assessment Tool
<b>D.C. DHCD</b>	D.C. Department of Housing and Community Development
<b>D.C. DOEE</b>	D.C. Department of Energy and Environment
<b>D.C. DOES</b>	D.C. Department of Employment Services
<b>D.C. HSEMA</b>	D.C. Homeland Security and Emergency Management Agency
<b>DDOT</b>	D.C. Department of Transportation
<b>DCIA</b>	D.C. Infrastructure Academy
<b>DCIP</b>	DoD OLDCC Defense Community Infrastructure Pilot Program

## ACRONYMS

<b>DCOP</b>	D.C. Office of Planning
<b>DCPSC</b>	Public Service Commission of the District of Columbia
<b>DHS</b>	U.S. Department of Homeland Security
<b>DMPED</b>	D.C. Deputy Mayor for Planning and Economic Development
<b>DoD</b>	U.S. Department of Defense
<b>DOE</b>	U.S. Department of Energy
<b>D.C. DPW</b>	D.C. Department of Public Works
<b>EDA</b>	U.S. Economic Development Agency
<b>EEA</b>	Equity Emphasis Areas
<b>EHP</b>	Environmental and Historic Preservation
<b>EIS</b>	Environmental Impact statement
<b>EPA</b>	U.S. Environmental Protection Agency
<b>ERCIP</b>	DoD Energy Resilience and Conservation Investment Program
<b>EV</b>	Electric Vehicle
<b>FCC</b>	Federal Communications Commission
<b>FEMA</b>	Federal Emergency Management Agency
<b>FHWA</b>	Federal Highway Administration
<b>FMA</b>	FEMA Flood Mitigation Assistance
<b>FTA</b>	Federal Transit Administration
<b>GETS</b>	Government Emergency Telecommunications Service
<b>GI</b>	Green Infrastructure
<b>GSA</b>	U.S. General Services Administration
<b>GWRCCC</b>	Greater Washington Region Clean Cities Coalition
<b>HAPP</b>	COG Housing Affordability Planning Program
<b>HCT</b>	High-Capacity Transit Station Area
<b>HMGP</b>	FEMA Hazard Mitigation Grant Program
<b>HPTF</b>	DHCD Housing Production Trust Fund
<b>HSGP</b>	FEMA Homeland Security Grant Program
<b>HUD</b>	U.S. Department of Housing and Urban Development

## ACRONYMS

<b>ICPRB</b>	Interstate Commission on the Potomac River Basin
<b>IDF</b>	Intensity-Duration-Frequency
<b>IC RPWG</b>	Interoperable Communications Regional Programmatic Working Group
<b>JBAB</b>	Joint Base Anacostia-Bolling
<b>JBM-HH</b>	Joint Base Myer-Henderson Hall
<b>MFI</b>	Median Family Income
<b>MGD</b>	Million Gallons Per Day
<b>MIRR</b>	Military Installation Resilience Review
<b>MOU</b>	Memorandum of Understanding
<b>MPD</b>	D.C. Metropolitan Police Department
<b>MW</b>	Megawatt
<b>NASF</b>	National Association of State Foresters
<b>NCPC</b>	National Capital Planning Commission
<b>NCR</b>	National Capital Region
<b>NEP</b>	National Estuary Program
<b>NEVI</b>	FHWA National Electric Vehicle Infrastructure
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NPS</b>	National Park Service
<b>NRL</b>	Naval Research Laboratory
<b>NVRC</b>	Northern Virginia Regional Commission
<b>NWS</b>	National Weather Service
<b>O&amp;M</b>	Operations and Maintenance
<b>OJT</b>	On-the-Job Training
<b>OLDCC</b>	DoD Office of Local Defense Community Cooperation
<b>OPSG</b>	Operation Stonegarden
<b>PAC</b>	Policy Advisory Committee
<b>PDM</b>	Pre-Disaster Mitigation
<b>PJM</b>	Pennsylvania-New Jersey-Maryland Interconnection
<b>PROTECT</b>	U.S. DOT Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation
<b>PSGP</b>	FEMA Port Security Grant Program



## ACRONYMS

<b>PTI</b>	Planning Time Index
<b>PV</b>	Photovoltaic
<b>RAC</b>	Regional Activity Centers
<b>RAISE</b>	U.S. DOT Rebuilding American Infrastructure with Sustainability and Equity
<b>REPI</b>	DoD Readiness and Environmental Protection Integration
<b>RFA</b>	Resilient Focus Areas
<b>RFP</b>	Request for Proposal
<b>RISA</b>	Regional Integrated Science and Assessments
<b>RRAP</b>	CISA Regional Resiliency Assessment Program
<b>SHSP</b>	FEMA State Homeland Security Program
<b>SRC</b>	Stormwater Retention Credit
<b>SRF</b>	State Revolving Fund
<b>SSO</b>	Sanitary Sewer Overflow
<b>STIP</b>	State Transportation Improvement Program
<b>SUFR</b>	USDA State Urban Forest Resilience
<b>SWPS</b>	Stormwater Pumping Stations
<b>TAC</b>	Technical Advisory Committee
<b>TDM</b>	Transportation Demand Management
<b>UASI</b>	FEMA Urban Area Security Initiative
<b>UHI</b>	Urban Heat Island
<b>USACE</b>	U.S. Army Corps of Engineers
<b>USDA</b>	U.S. Department of Agriculture
<b>U.S. DOT</b>	U.S. Department of Transportation
<b>VRE</b>	Virginia Railway Express
<b>WIC</b>	Workforce Investment Council
<b>WIFIA</b>	EPA Water Infrastructure Finance and Innovation Act
<b>WMATA</b>	Washington Metropolitan Area Transit Authority
<b>WNY</b>	Washington Navy Yard
<b>WPS</b>	Wireless Priority Service
<b>WSSC</b>	Washington Suburban Sanitary Commission



# EXECUTIVE SUMMARY

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The Military Installation Resilience Review (MIRR) program was designed by the Department of Defense (DoD) Office of Local Defense Community Cooperation (OLDCC) to identify the hazards and vulnerabilities of concern “outside the fence line” as they relate to ability of the military to carry out its missions on base. This information is then used to identify actions that could be taken to mitigate the vulnerabilities through investments and solutions in the community.

## WASHINGTON, D.C. MIRR

The Washington, D.C. MIRR study assesses four DoD installations within the District of Columbia: **Joint Base Anacostia-Bolling (JBAB)**, **the Naval Research Laboratory (NRL)**, **the Washington Navy Yard (WNY)**, and **Fort Lesley J. McNair (Fort McNair)**. The study evaluates the community resources and services—such as transportation, energy, a trained workforce,

and affordable workforce housing—that are critical to installations’ capacity to carry out their missions.

This study involved extensive stakeholder engagement and collaboration. Stakeholder engagement was conducted through close collaboration with the four installations, a Policy Advisory Committee (PAC), and a Technical Advisory Committee (TAC). The committees included membership from federal agencies, local agencies and organizations, and utilities. This engagement informed the identification of priority installation activities and the community resources and systems upon which they depend, as well as priority hazards—both of which focused the scope of the vulnerability assessment. Stakeholders helped to review and add context to the findings of the assessment, and prioritize the resilience measures that the study developed to address the identified vulnerabilities.

## MILITARY INSTALLATION RESILIENCE

Military installation resilience is defined by the U.S. Federal Code as “the 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.”<sup>1</sup>



Figure 1: COG MIRR At-A-Glance



## Findings: Vulnerabilities and Resilience Measures

The vulnerability assessment focuses on priority infrastructure sectors and key hazards and stressors that affect them. The priority sectors, hazards, and stressors were determined based on the four installations' reported level of dependence on specific infrastructure services\*, stakeholder input, and a literature review. This prioritization led to a focus on **transportation and transit, energy, telecommunications, and water and wastewater** as the key sectors for analysis, and how they are affected by the following hazards and stressors: **flooding; extreme heat; ice storms; extreme winds; population growth; and land use change, development, and encroachment.**

As a result, the vulnerability assessment identifies the following **top vulnerabilities**:

- » **Electricity distribution** vulnerabilities to all hazards, including extreme heat, ice storms, high winds, and wildlife.
- » **Critical telecommunications assets** (e.g., transmission towers; aboveground fiber optic and coaxial cables and associated facilities) vulnerabilities to hazards including ice storms and high winds, as well as loss of power.
- » **Specific areas and critical assets that are vulnerable to flooding**, including low-lying roads/emergency walkout routes, wastewater treatment plants, a (CHP) plant, substations, D.C. Department of Public Works (DPW) fuel sites, emergency power generators and fuel tanks, and several water supply and sewer system assets.

- » **Strain to regional water supply**, driven by drought and increased population growth and water demand.
- » Overall increased **stress on the region's transportation** system from aging infrastructure, climate impacts, and population growth.
- » **Limited safe, reliable, and efficient mobility choices** serving the installations.
- » Supply chain disruptions to **regional petroleum fuel supply** from multiple hazards.
- » **Encroachment** and vulnerabilities related to public trespassing.
- » Limited local **affordable housing** availability for installation workforce.
- » Limited local **workforce availability and retention.**

Additionally, the study identifies the need for increased **communication and coordination** around routine planning activities, as well as cross-cutting emergency response efforts.

The study used these top vulnerabilities as a launch point for identifying opportunities to strengthen resilience of the installations and the region. After thorough desk research and stakeholder consultation, the study identified **14 priority resilience measures to advance for implementation, four of which received the strongest support from installations.**

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\* To prioritize sectors, the study distributed a survey to installations regarding their activities, the extent to which the activities are affected by natural hazards, and dependence of those activities on sectors.

## Top Four Resilience Measures

**1**

Retrofit stormwater pumping stations

**2**

Assess and address key climate risks to telecommunications systems

**3**

Support Blue Plains floodwall construction

**4**

Ensure Lower Anacostia Waterfront redevelopment is resilient

**The other ten top priority measures that should be undertaken in proximity to the installations are:**

1. Provide financial support for Blue Plains microgrid
2. Advance fuel resilience opportunities identified in Regional Resiliency Assessment Program (RRAP) study to benefit installations and communities
3. Construct community electric vehicle (EV) charging stations
4. Expand connectivity with High-Capacity Transit (HCT) Station Areas
5. Create installation viewshed security plan
6. Implement congestion relief and traffic-control measures
7. Increase shade cover and green infrastructure (GI)
8. Invest in workforce development for in-demand skills
9. Develop suspicious activity and trespassing prevention plan
10. Invest in affordable housing

Each of these measures is described in further detail in the report, with information to help advance implementation, including a description of the measure and its benefits, key partners and stakeholders who should collaborate on implementation, potential costs and funding opportunities, and next steps.

## Moving Forward with Building Resilience

This study describes four pillars of an overarching resilience strategy to build holistic resilience for installations and the surrounding communities, involving multiple sectors, stakeholders, and partners.

- 1. Continue and expand coordination.** This pillar reflects stakeholders' emphasis of the need to continue and build upon the increased communication and coordination with one another that this MIRR study helped foster. They voiced that continued collaboration beyond this study will be vital to the success of regional resilience efforts.
- 2. Advance implementation of physical and policy measures to address vulnerabilities.** This includes the 14 priority physical and policy resilience measures listed above, which address the vulnerabilities identified in the study. These measures are meant to be implemented in the communities outside the installations to build resilience inside and outside the fence.
- 3. Continue to advance military installation resilience through measures inside the fence.** While this study focuses on identifying vulnerabilities and measures off-base, it is important that the installations also review on-base vulnerabilities and identify on-base actions that can complement the findings of this study.
- 4. Create an enabling environment for resilience.** This pillar would involve diminishing any existing barriers and identifying or creating new opportunities to implement resilience measures.

## Four Resilience Pillars

- 1** Continue and expand coordination
- 2** Advance implementation of physical and policy measures to address vulnerabilities
- 3** Continue to advance military installation resilience through measures inside the fence
- 4** Create an enabling environment for resilience

The next steps for carrying the results of this study forward involve implementing the recommendations under each of these pillars, with the installations taking the lead and coordinating with the other partners and stakeholders as described. Implementation should involve establishing a monitoring plan to track progress and effectiveness of the measures, which can then inform the evolution of next steps. **Investing time and resources into building resilience now should allow the installations and communities to reap the benefits of a stronger, safer, and thriving region well into the future.**

This report is designed to be a tool for decision-makers to foster collaborative work that moves installations and surrounding communities toward improved resilience. The work of implementing these measures should establish processes by which installations continue to monitor their progress and should be periodically revisited and updated. **This MIRR study should be seen as a foundational effort that launches collaborative work on community and installation resilience activities: a beginning, rather than a conclusion.**



# 1 | INTRODUCTION

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## 1.1 PURPOSE OF THE MILITARY INSTALLATION RESILIENCE REVIEW

Military installations are inherently connected to the communities and infrastructure that surround and support them. The communities surrounding military installations contain a network of services and infrastructure that are essential for the installations to ensure their readiness and operational success. For example, the resources upon which the installations depend (e.g., water, power, transportation, and telecommunications systems) serve both the installations and the surrounding communities. Additionally, service members and their families that live in the broader community rely on these systems. Both installations and communities benefit from measures to increase resilience, enhancing their abilities to recover from unforeseen events while supporting military operations and national security. These types of actions are consistent with numerous directives including Executive Order 13990 (“Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis”) and the DoD Climate Adaptation Plan (DoD 2021).<sup>2</sup>

This MIRR study focuses on four installations within Washington, D.C.: Fort McNair, WNY, JBAB, and NRL.

**The goal of this study is to identify measures that could be conducted off-base to increase the resilience of both the installations and the surrounding communities to a range of potential hazards and stressors.\*** The changing frequency and intensity of natural hazards due to climate change has further amplified the need for installations and communities to understand and manage potential vulnerabilities.

This report documents the findings of this study, including the top priority resilience measures for further implementation.

Other outcomes of this study include:

- » Identification of overlapping threats to community and installation resilience. These include specific natural and climate hazards as well as stressors related to land use, development, and encroachment.
- » Prioritization of vulnerabilities from threats to be addressed through targeted resilience measures.
- » Heightened awareness of vulnerabilities among key partners and stakeholders in the community and installations.
- » Consolidation of findings into a clear strategic implementation plan that describes resilience measures, including details on how to implement and sources of funding.
- » Increased collaboration among partners within the metropolitan Washington region for resilience.

This study helps establish a shared understanding across a wide range of stakeholders regarding vulnerabilities and corresponding potential resilience measures. Completing this work required bringing together many different organizations that emphasized the need to continue and build upon the collaborative work that the MIRR study fostered. Stakeholders acknowledged that in order for regional resilience efforts to be successful, continued coordination beyond this study will be critical.

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\* Throughout this report, “off-base” or “outside the fence” refers to areas and infrastructure that are not physically on the installations. The vulnerability assessment and the resulting resilience strategy focus on “outside the fence” impacts and activities that affect the installations and solutions that can build resilience in both the communities surrounding the installations and the installations themselves.



## 1.2 SCOPE OF THE STUDY

This report provides a roadmap to improve the resiliency of four riverfront installations in Washington, D.C. (see Figure 2).

- » **Fort McNair** is a US Army base that along with two bases in Arlington, Virginia comprises Joint Base Myer-Henderson Hall. A key activity on base includes safeguarding the National Capital Region. Fort McNair also hosts the National Defense University and Inter-American Defense College that focus on graduate studies for senior military members.
- » The **WNY** is the oldest Navy installation in the U.S. It was formerly a shipyard and weapons manufacturing plant.
- » **JBAB** is an installation merging Naval Support Facility Anacostia and Bolling Air Force Base, supporting Air Force, Navy, Marine Corps, Coast Guard activities, and other agencies which support a variety of missions. It includes housing and community facilities for military members and their families.
- » **NRL** is the headquarters for US Navy research into fields such as artificial intelligence, communications technology, energy, materials science, and other disciplines.

### WHAT DOES IT MEAN TO BE RESILIENT?

#### MILITARY INSTALLATION RESILIENCE:

The 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.\*

#### COMMUNITY RESILIENCE:

Community resilience is the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions.†

\* US Code. 2022. "101.e.8.Military Installation Resilience." 10 USC 101: Definitions. [uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title10-section101&num=0&edition=prelim#sourcecredit](https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title10-section101&num=0&edition=prelim#sourcecredit)

† FEMA. "Community Resilience." National Risk Index. [hazards.fema.gov/nri/community-resilience](https://hazards.fema.gov/nri/community-resilience)

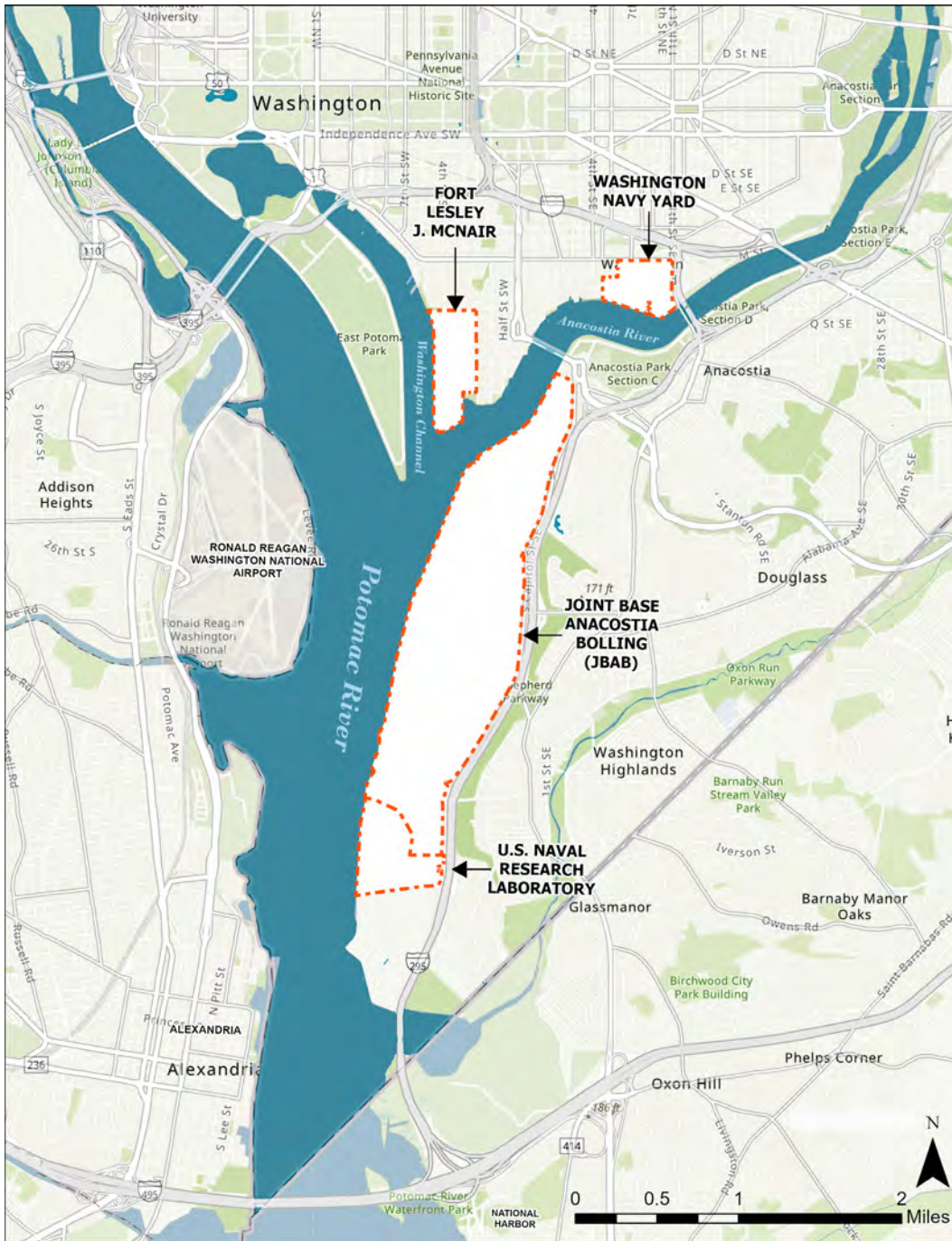


Figure 2: Installation Locations

The study provides insight into “outside-the-fence” vulnerabilities that could potentially affect the installations, and identifies resilience measures to be implemented off-base to address those vulnerabilities.

To identify the “outside-the-fence” vulnerabilities, the study focuses on priority infrastructure service sectors and hazards or stressors. The priority sectors were determined based on the four installations’ reported level of dependence on specific infrastructure services\*, stakeholder input, and literature review. This prioritization led to a focus on **transportation and transit, energy, telecommunications, and water and wastewater** as the key sectors for analysis.

The priority hazards and stressors were selected from an array of both natural and man-made issues based on level of historical impact to key installation activities; potential for future impacts to sectors and installations; and level of a priority sector’s sensitivity and exposure to the hazard. Hazards and stressors were prioritized and sorted into three tiers based on these selection criteria, consultation with stakeholders, and desk-based research. The process led to the following priority hazard and stressors: **flooding, extreme heat, ice storms, extreme winds, changes in resource needs associated with population growth, and land-use change, development, and encroachment.**

Section 2 further describes these focus areas, hazards, and stressors and how they were identified.

The resilience strategy portion of this study builds on the findings of the vulnerability assessment to recommend potential actions that COG, the installations, and partners (e.g., D.C. government, utilities, non-governmental organizations and nonprofits) may take. Due to the nature of the MIRR process, the **resilience strategy is focused on ways to implement actions off-base to build the resilience of both the installations and the surrounding community.** Section 3 provides more details on this resilience strategy.

The purpose of the study is not to be prescriptive, a complete vulnerability assessment of the installations themselves, or a comprehensive resilience strategy for measures to be taken inside the fence. Rather, this **study should be seen as part of an ongoing, multi-stakeholder effort to build resilience for the installations and the metropolitan Washington region.**

## 1.3 STUDY PROCESS

The study was divided into three phases and took place over 18 months from Spring 2021 to Fall 2022 (Figure 3).

Throughout all three phases, **stakeholder engagement** was a critical component of the process. The study team formed a TAC and PAC to provide input throughout the entire MIRR process, made up of members from the installations, local utilities and other infrastructure service providers, federal agencies, District of Columbia government agencies, and regional planning agencies made up the advisory committees (see [Appendix D](#) for further information on the makeup of the committees). These committees met regularly over the course of the project and guided the identification of major threats and vulnerabilities, and were instrumental in developing actionable resilience measures. In addition, a guiding principle of the study was that the overarching strategy should advance equity in metropolitan Washington, and the study took several steps to advance equity in the resilience planning process, summarized in the text box on page 12.

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\* To prioritize sectors, the study team distributed a survey to installations regarding their activities, the extent to which the activities are affected by natural hazards, and dependence of those activities on sectors.

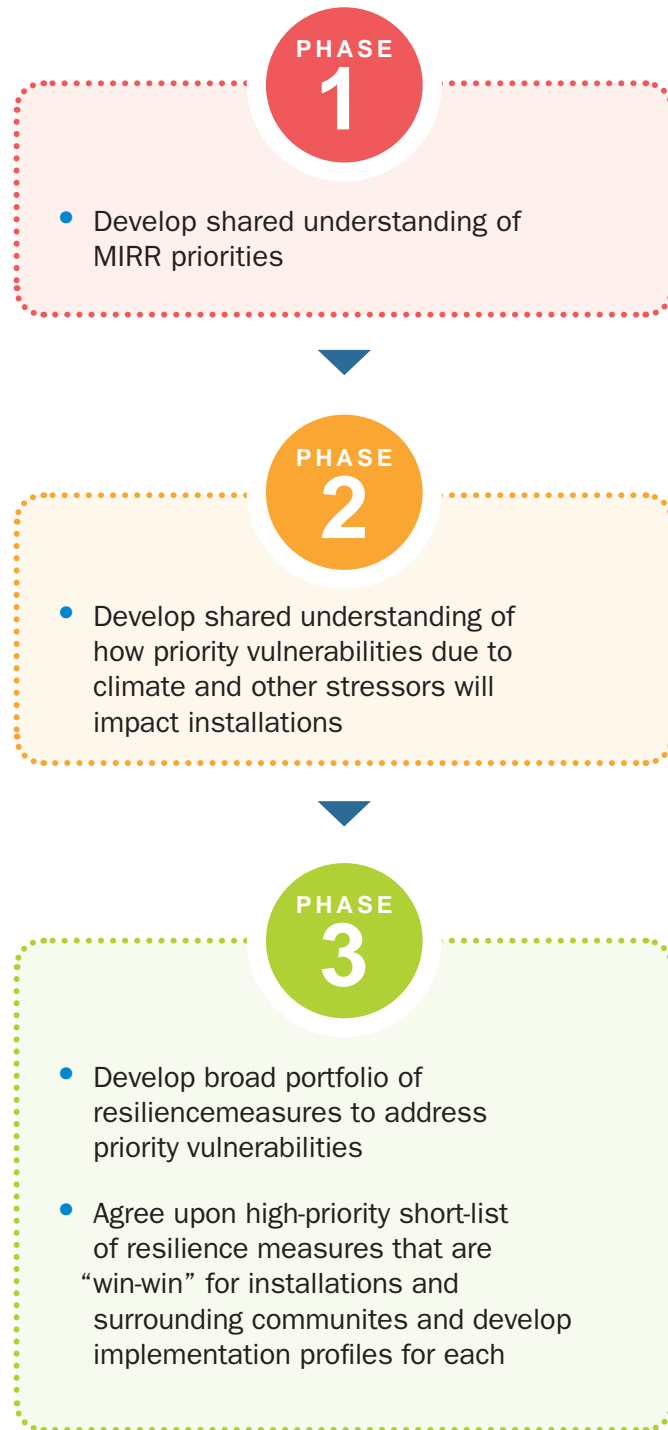


Figure 3: MIRR Study Phases

**Phase 1: Identify Priorities.** The study team created a baseline understanding of key sectors upon which the installations and communities depend as well as natural hazards and other stressors that affect the Washington, D.C. region. These priorities were established based on input from the advisory committees and prior studies in the area. Flooding, extreme heat, ice storms, high winds, population growth, and land use and development were selected as priority hazards.

**Phase 2: Assess Vulnerabilities.** The second phase involved conducting a vulnerability assessment to understand the potential impact of the priority hazards on installations under different climate change scenarios. Priority vulnerabilities were selected based on the potential effects of each hazard or stressor on critical installation assets or services. For example, roads and wastewater treatment plants in the floodplain are vulnerable to flooding, and electric assets are vulnerable to high winds and extreme storms.

**Phase 3: Develop Resilience Strategy.** The third phase involved identifying a lengthy list of measures to address priority vulnerabilities. That initial list of approximately 75 measures was refined through extensive stakeholder meetings. A shorter list of measures was selected using screening criteria focused on potential benefits, resource requirements, and feasibility, with attention given to enhancing equity. From there, stakeholder consultation was used to winnow the list down to the top 14 measures. This included input from the installations and the TAC and PAC. A plan for implementation was developed for each of these top 14 measures, including steps for the near- and long-term. The measures feed into a holistic strategy that promotes collaboration among participants on resilience issues beyond the conclusion of the MIRR study.

## PROCESSES USED TO ADVANCE EQUITY IN THIS MIRR INCLUDED:

- » Considered socioeconomic vulnerabilities in the Vulnerability Assessment
- » Identified gaps for equitable solutions in developing extensive list of resilience measures
- » Vetted resilience measures with a “do-no-harm” screening criterion (i.e., removing any non-equitable measures)
- » Included potential equity impacts as a criterion in evaluating and prioritizing resilience measures
- » Provided recommendations and considerations to ensure equity is a key component of the implementation process for each high-priority resilience measure (e.g., conduct community engagement)



## 1.4 GUIDE TO THE FINAL REPORT

This report documents the methods and findings of the MIRR study, including the identification of priority vulnerabilities and a strategy for enhancing military and community resilience.

**Section 2** describes the vulnerability assessment, including the identification of natural hazards and stressors and the identification of priority vulnerabilities to climate change, land use, development, and encroachment.

**Section 3** describes a recommended strategy to address the identified vulnerabilities and increase resilience of the installations and community. The strategy is organized into four pillars and includes 14 top priority physical and policy measures identified for implementation.

**Section 4** synthesizes the findings of this report and provides an overview of immediate next steps for the installations and community key partners and stakeholders.

**Section 5** contains appendices for this report:

- » **Appendix A: Vulnerability Assessment Methodology** describes the methodology for conducting the vulnerability assessment in Section 2.
- » **Appendix B: Resilience Measure Prioritization Process** provides the framework used to prioritize the resilience measures.
- » **Appendix C: Resilience Measures Considered** lists the set of resilience measures that were considered as part of the prioritization process, but ultimately were not recommended for implementation as part of this study.
- » **Appendix D: Technical and Policy Advisory Committees** lists the members of the two committees.
- » **Appendix E: Funding Opportunities** provides information on possible funding sources for implementing resilience measures, including who and what activities are eligible, the funding amount, and requirements such as cost-sharing.



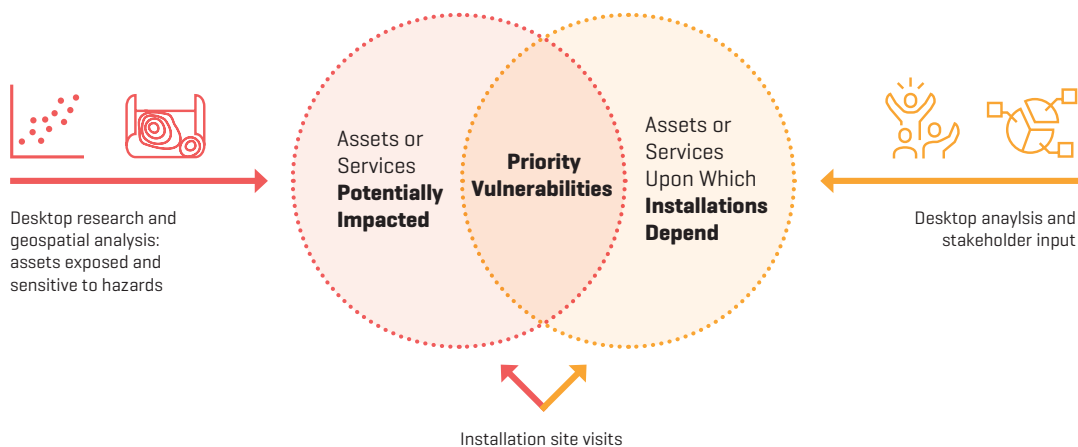
## **2 | IDENTIFICATION OF PRIORITY VULNERABILITIES**

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## 2.1 PRIORITY VULNERABILITIES

To develop the resilience strategy and identify priority resilience measures, the study conducted a vulnerability assessment to identify how priority climate hazards (flooding, extreme heat, ice storms, and extreme winds) and stressors (population growth and land use change, development, and encroachment) might impact infrastructure upon which installations depend in-order to continue carrying out their missions.

Priority vulnerabilities are where assets or services that the installations depend on may be potentially impacted by the hazards and stressors considered, as illustrated in Figure 4. The study gathered information for the assessment through desktop research, consultation with subject area experts, stakeholder engagement, and site visits with installation staff.



**Figure 4: Overview of Vulnerability Assessment Approach: Priority vulnerabilities are from assets that installations depend upon that are potentially impacted by hazards or stressors, as assessed based on a range of data and stakeholder input**

The assessment identified the following priority vulnerabilities. Some priority vulnerabilities relate to specific individual assets and hazards, while others represent general asset classes or geographic areas that represent a vulnerability.

Priority vulnerabilities identified:

- » **Electricity distribution** vulnerabilities to all hazards, including extreme heat, ice storms, high winds, and wildlife.
- » **Critical telecommunications assets** (e.g., transmission towers; aboveground fiber optic and coaxial cables and associated facilities), vulnerabilities to hazards including ice storms and high winds as well as loss of power.
- » **Specific areas and critical assets that are vulnerable to flooding**, including low-lying roads/emergency walkout routes, wastewater treatment plants, a CHP plant, substations, D.C. DPW fuel sites, emergency power generators and fuel tanks, and several storm drains, treated water pumping stations, fire hydrants, sanitary sewer pumping stations, combined sewer overflow (CSO) outfalls, municipal separate storm sewer systems (MS4) outfalls, and sanitary sewer overflow (SSO).

- » **Strain to regional water supply**, driven by drought and increased population growth and water demand.
- » Overall increased **stress on the region's transportation** system from aging infrastructure, climate impacts, and population growth.
- » **Limited safe, reliable, and efficient mobility choices** serving the installations.
- » Supply chain disruptions to **regional petroleum fuel supply** from multiple hazards.
- » **Encroachment** and vulnerabilities related to public trespassing.
- » Limited local **affordable housing** availability for installation workforce.
- » Limited local **workforce availability and retention**.

Additionally, the study identified the need for increased **communication and coordination** around routine planning activities, as well as cross-cutting emergency response efforts.

The remainder of this section contains additional detail on the assessment methodology and findings.

## 2.2 SCOPE OF THE VULNERABILITY ASSESSMENT

The vulnerability assessment focuses on **priority infrastructure service sectors** and **hazards and stressors**, including how land use and socioeconomic forces could affect the installations' ability to carry out their missions. **The priority sectors were determined based on the criteria described below, stakeholder input, and a literature review.** To define the criteria, the study team pulled on their knowledge of best practices for vulnerability assessments and distilled findings from discussions with the TAC focused on installation and stakeholder priorities and vision for success of the study. This was an iterative process, with TAC members providing feedback on potential criteria and their application, and the study team refining the scope of the vulnerability assessment in response.

This collaborative prioritization led to a focus on **transportation and transit, energy, telecommunications, and water and wastewater** as the key infrastructure sectors analyzed, and how they are affected by the following hazards and stressors: **flooding, extreme heat, ice storms, extreme winds, changes in resource needs associated with population growth, and land use, development, and encroachment.**

The study used the following criteria to select the key sectors:

- » **Level of installation dependency on sector.\*** The extent to which installation activities depend on specific sectors, determined in part by:
  - **Level of historical impact to key installation activities.** The severity and extent of historical impacts from hazards and drivers on sectors and installation activities.
  - **Potential for future impacts to key installation activities.** The potential for future impacts from changing hazards and drivers on installation activities.
- » **Salience across installations.** The extent to which multiple installations depend upon the same sector, to account for the breadth of footprint across the four installations.
- » **Interdependencies among sectors.** The extent to which disruption of one sector results in disruptions of other sectors (i.e., cascading impact).

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\* To prioritize sectors, the study distributed a survey to installations regarding their activities, the extent to which the activities are affected by natural hazards, and dependence of those activities on sectors.

- » **Impacts initiate outside of installations.** Focuses on sectors outside the fence that support resilience of installations.
- » **Potential to mitigate service disruption.** If there is little that can be done to prepare for or mitigate impacts of the disruption, it was deprioritized.

Hazards and stressors were selected based on level of historical impact to key installation activities; potential for future impacts to sectors and installations; and level of a priority sector's sensitivity and exposure to the hazard. Hazards were prioritized and sorted into three tiers based on these selection criteria, consultation with stakeholders, and desk-based research:

- » **Tier 1** includes flooding, as this hazard has materially impacted a range of sectors and installations, has historically occurred several times over a 10-year period, and is projected to become more frequent and/or consequential under climate change.
- » **Tier 2** includes hazards and stressors that were deemed impactful to priority sectors and installation activities, and have been observed historically with moderate frequency over a 10-year period or are expected to occur by mid-century: extreme heat; ice storms;\* extreme winds; changes in resource needs associated with population growth; and land use, development, and encroachment.
- » **Tier 3** includes hazards and stressors that are less impactful to the installations, unlikely to occur in a typical 10-year period, or are expected to become less frequent under climate change: drought, snow storms, extreme cold, noise and vibration, hazardous materials, earthquakes, ecosystem change, and other (e.g., electromagnetic storms). Tier 3 hazards and stressors were considered qualitatively in the vulnerability assessment.

For each hazard or stressor in tiers 1 and 2, the study examined vulnerabilities in each of the infrastructure service sectors to recent conditions and future conditions through the middle of the century (2040s-2060s).† However, to reflect the long-lived nature of infrastructure and the long-term changes in climate, the assessment also discusses the direction of future change further into the century beyond the 2050s.

The assessment used two scenarios of climate change, driven by different trajectories of greenhouse gas emissions over time (i.e., the Representative Concentration Pathway, RCP). A high level of climate change is represented by the RCP 8.5 scenario, which corresponds to a “business-as-usual” pathway of greenhouse gas emissions, with negligible reduction in emissions intensity. A more moderate, intermediate scenario is represented by the RCP 4.5 scenario, which corresponds to a modest reduction in emissions beginning around 2045.

The study assessed vulnerability by identifying which assets would be exposed to flooding and extreme heat using geospatial information‡ and assessing asset sensitivity to each hazard or stressor by asset type based on desk-based research and expert knowledge. The results presented in the vulnerability assessment are supplemented with information from site visits to the installations and discussions with stakeholders. A more detailed description of the methodology can be found in Appendix A.

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\* Ice storms are considered a tier 2 hazard, while snow storms are considered a tier 3 hazard. The study team made this distinction due to the differential impacts these events can cause, with ice storms leading to greater consequences.

† This time frame was chosen to help prioritize the timing of resilience actions (e.g., actions needed in the near-term that would also have flexibility to adjust to further change beyond the middle of the century, versus resilience actions that could be implemented later into the century) and to align with standard non-climate planning time frames (e.g., population forecasts extend to 2045).

‡ Ice storms and extreme winds are assumed to impact all areas of Washington, D.C. equally and therefore did not warrant a geospatial exposure analysis.



## 2.3 EXISTING AND PROJECTED CONDITIONS

The study conducted a desk review and collected data to understand existing and projected conditions for the priority hazards and stressors (described above), focusing on the middle of the century (2050) for projected conditions but also considering changes further into the century beyond 2050.

### FLOODING

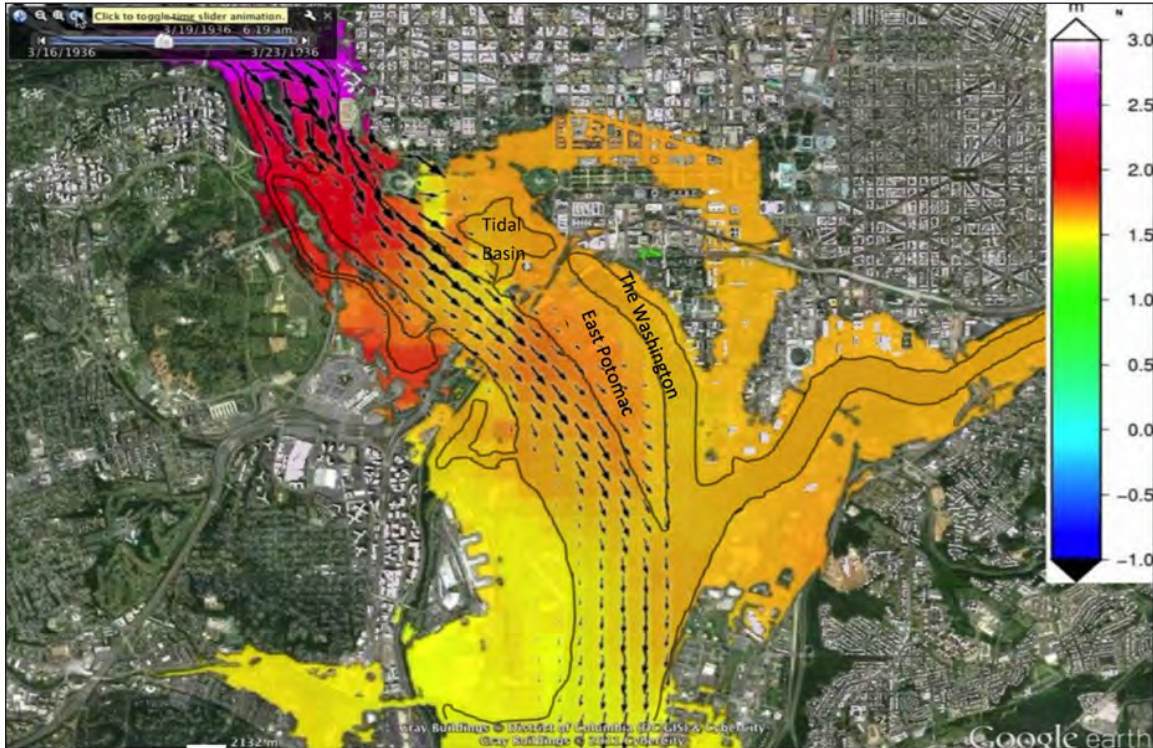


Figure 5: Visualization of the Water Level (background color) and Velocity Vectors (arrows) from a Simulation of the 1936 Potomac River Great Flood. Source: Wang, Loftis, Forrest, Smith, and Stamey, 2015

Washington, D.C. is influenced by three primary types of flooding:

1. **Riverine flooding** from heavy precipitation associated with the passage of hurricanes as well as rain-on-snow events can cause major flooding downstream. The last major flood on the Potomac River occurred in 1996 (two occurrences that year). Major flooding in the past century occurred in 1985, 1972, 1955, 1952, 1942, 1937 (two floods), 1936 (two floods), and 1932.<sup>3</sup> Figure 5 shows a reconstruction of one of the 1936 floods, which is the largest on record.<sup>4</sup> That 1936 flood was due to a major rain event over tributaries of the Potomac, with 5+ inches of rain falling on already-elevated streams in Virginia and Maryland after a rainy two weeks. Washington, D.C. itself saw less than an inch of rain; the flooding was due to the rain upstream that turned into runoff and flowed into the Potomac.<sup>5</sup>

The 1-in-50-year 24-hour precipitation event in Washington, D.C. is currently 7.0" and expected to increase by the middle of the century to 7.4" under both the RCP 4.5 scenario and to 7.8" under the RCP 8.5 scenario.<sup>6</sup> The 1-in-100-year 24-hour precipitation event is currently 8.2" and expected to increase by the middle of the century to 8.6" and 9.3" under the RCP 4.5 and 8.5 scenarios, respectively. **As major storms are projected to become more frequent and more intense, so will riverine flooding.**

2. **Interior flooding** (i.e., pluvial flooding) caused by intense rainfall events together with inadequate drainage capacity or development over the historic floodplain not being able to carry water away. This has historically been an issue for the District. For example, a June 2006 storm dropped six inches of rain in six hours, resulting in flooding that was largely concentrated in the Federal Triangle area and caused \$10 million in damages.<sup>7</sup> The 1-in-2-year 24-hour precipitation event in Washington, D.C. is currently 3.1” and expected to increase to 3.3” by the middle of the century under both the RCP 4.5 and 8.5 scenarios. The 1-in-10-year 24-hour precipitation event is currently 4.8” and expected to increase by the middle of the century to 5.0 and 5.1” under the RCP 4.5 and 8.5 scenarios, respectively. **This will increase the likelihood of interior flooding.**
3. **Marine flooding** caused by extreme high tides, storm surges, and sea level rise, which interact with water levels in the rivers. Sea level rise has already begun to impact the area: Water levels for the Potomac and Anacostia Rivers have increased 11 inches over the past 90 years as a result of sea level rise and subsidence, leading to an increase in nuisance flooding along the Washington, D.C. riverfront.<sup>8</sup> Projections for future sea level rise in Washington, D.C. range from 1.1-3.6 feet by 2050 to 2.6-6.3 feet by 2080.<sup>9</sup> Flooding associated with high tides has been increasing in frequency as sea level rise pushes tides higher and further inland. Washington, D.C. currently experiences about 50 tidal flooding events per year. As sea level rises, Washington, D.C. is projected to experience more than 150 tidal floods per year by 2030 and by 2045 is projected to experience upward of 400 tidal floods per year—meaning that **days without tidal flooding will become the exception rather than the norm.**<sup>10</sup> Further, storm surge driven by Atlantic hurricanes is projected to increase in frequency and magnitude, as there is a **positive correlation between increased global temperatures and increased frequency of hurricanes, especially for stronger storms.**<sup>11</sup> However, the strength of this correlation carries much uncertainty, so it is difficult to pin down specific increases in probability and magnitude of hurricane-driven storm surges at this time.<sup>12</sup>

For the vulnerability assessment, the study analyzed potential impacts under three flooding scenarios:

1. Future (2050) 10% annual chance flood (assuming 2.5 ft. SLR)
2. Future (2050) 1% annual chance flood (assuming 2.5 ft. SLR)
3. Extreme future (2050) 1% annual chance flood (assuming 3.6 ft. SLR) (Figure 6)

These scenarios provide a range of potential flooding over the next few decades, capturing potential areas that would be flooded relatively frequently and under extreme events by the middle of the century. The first two scenarios (with 2.5 feet of SLR) represent the projected sea level rise by 2050 under the National Oceanic and Atmospheric Administration (NOAA) et al. 2017 Intermediate-High scenario at the Washington, D.C. tide gauge (for consistency with the scenario D.C. Department of Energy and Environment (D.C. DOEE) used to develop the proposed Tidal Shoreline Buffer).<sup>13</sup> The third, “extreme” scenario was used as a means to sensitivity-test other potential impacts and measures to ensure they would be robust against higher potential amounts of sea level rise or other changes, or for longer periods of time. This scenario is also approximately the projected sea level change under the Intermediate-High scenario by 2060-2070.

**Additional details on these scenarios are provided in Appendix A.**

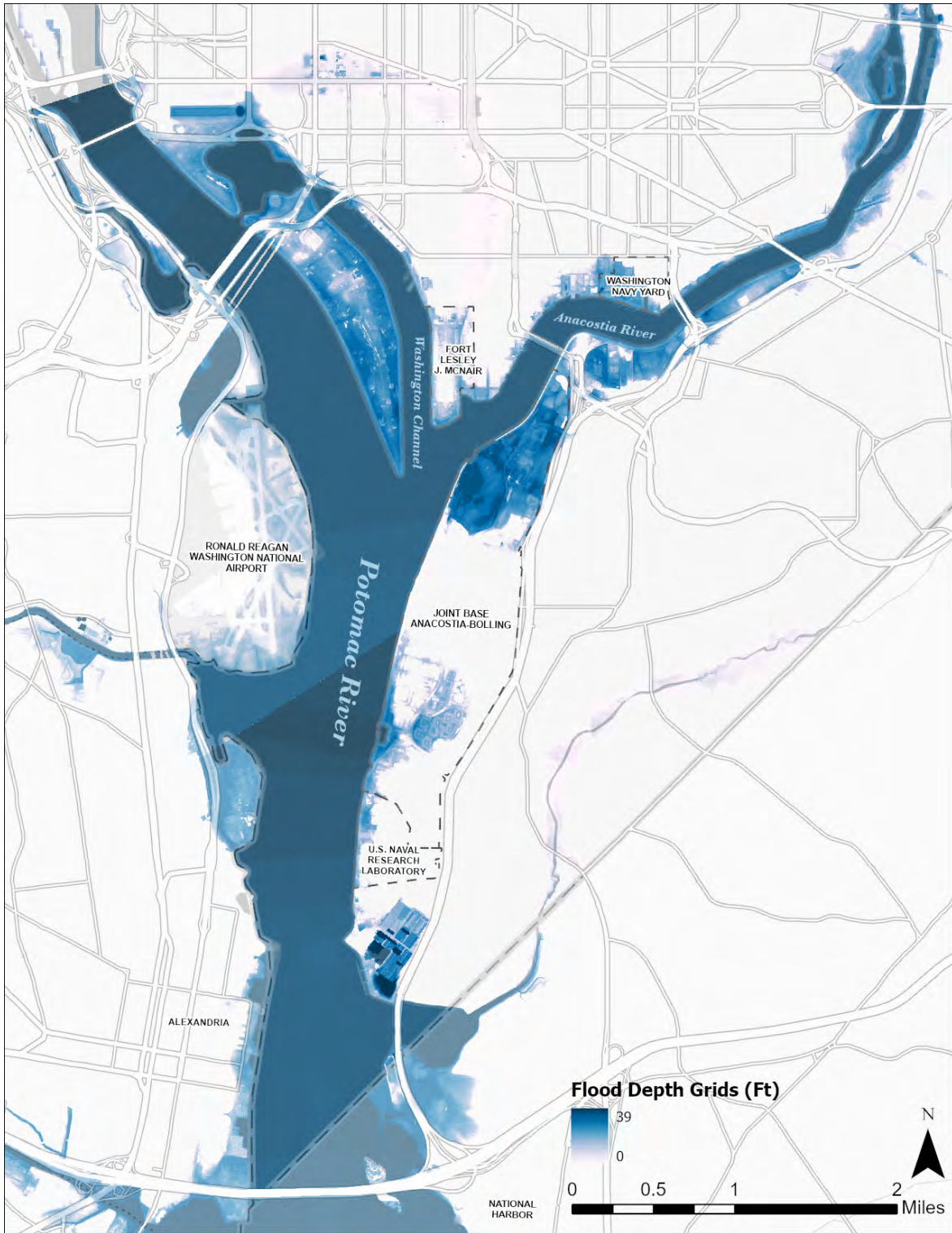


Figure 6: Extreme Future (2050) 1% Annual Chance Flood Scenario (assuming 3.6 ft. SLR) (Flooding Scenario 3)



## EXTREME HEAT

Annual temperatures in Washington, D.C. have risen and are projected to continue to increase due to climate change. Temperature changes will be experienced in a variety of ways, from increasing average and extreme temperatures, as well as heatwave frequency and duration (see Table 1). For example, heatwaves in Washington, D.C. historically lasted about five days. However, in 2012 the area experienced a record-breaking heatwave that lasted 11 days.<sup>14</sup> Changes in climate are expected to make current extreme events standard in the foreseeable future. Increased temperatures and more frequent and intense heat waves pose health risks, increase the amount of energy used to run air conditioning, and increase the rate of wear-and-tear on infrastructure.

**Table 1: Historic and Projected Future Values for Indicators of Extreme Heat in Washington, D.C.15**

Variable	Historic Conditions*	Projected Future Conditions**
Summer average temperatures	87°F (day) 66°F (night)	Increase of 5-7°F by 2050 and 6-10°F by 2080
Summer temperature extremes	11 days/year with max daytime temps above 95°F	30-45 days by 2050 40-70 days by 2080
Summer heat index	30 days/year with heat index above 95°F	70-80 days by 2050 75-105 days by 2080
Summer heatwaves (3+ consecutive days with daily max heat index above 95°F): Frequency	Average of four waves per year	Seven events by 2050 Eight events by 2080
Summer heatwaves: Duration	Average heatwave lasts an average ~5 days	8 to 9.5 days/wave by 2050 9.5 to 12 days/wave by 2080

\*Historical conditions for summer average temperatures represent a baseline time period of 1981-2000. The baseline historic time period for extreme temperatures, heat index, and heatwaves is 1991-2010, as these variables require humidity data, and observations for humidity at Reagan National Airport did not begin until 1990.

\*\* The range of projected future conditions is based on climate scenarios RCP4.5 (lower estimates) and RCP8.5 (higher estimates).

Washington, D.C. experiences an urban heat island (UHI) effect; developed urban areas can be more than 7°F warmer than outlying rural areas. UHI occurs due to a number of factors including the greater absorption of heat by dark surfaces, less evaporative cooling, and heat emissions from vehicles and air conditioning units. Figure 7 below depicts a snapshot of 2018 summer temperatures.<sup>16</sup> The contrast is evident between Fort McNair and WNY. Fort McNair has an abundance of grassy fields, whereas WNY has a relatively higher proportion of asphalt and dark roof surfaces. It is also evident in the temperature contrast between wooded area to the east of JBAB and parts of Ward 8 to the east. Areas of Washington, D.C. with less green space and more development are in greater need of heat adaptation measures to combat the UHI, especially when considering how climate change will lead to higher temperatures.

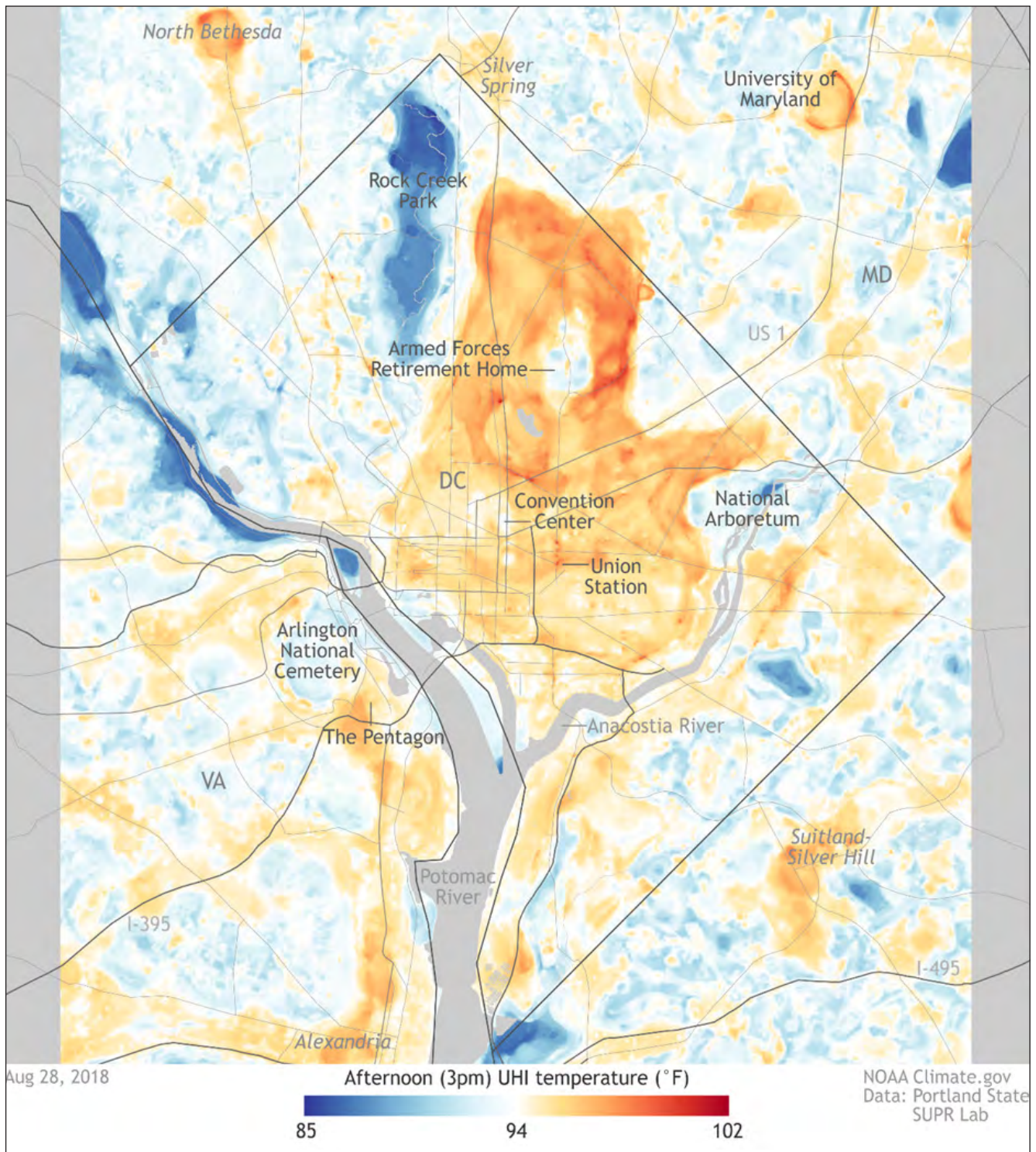


Figure 7: The Urban Heat Island Effect in Washington, D.C.  
Source: Shandas, Voelkel, Williams, and Hoffman, 2019



## ICE STORMS

Ice storms are events that include a combination of rain or sleet together with surface temperatures just below freezing, allowing the accumulation of a layer of ice on the ground, trees, and infrastructure.<sup>17</sup> These types of events can result in structural damage, electric outages, and dangerous transportation conditions, restricting people indoors. While ice storms specifically (as opposed to snow storms) have not been tracked for Washington, D.C., there is information available on winter storms—a category of storms that includes but is not limited to ice storms. There were 22 recorded winter storms in Washington, D.C. between 1900 and 2019, ten of which have occurred since 1990.<sup>18</sup> In January 1994, an ice storm resulted in a presidential major disaster declaration for the District of Columbia. There were five emergency or major disaster declarations for severe winter storms (which can include ice) between 1989 and 2016—accounting for nearly a third of the 19 Presidential Major Disaster or Emergency Declarations under the Stafford Act declared for Washington, D.C. since 1953.<sup>19</sup> While climate change is projected to increase temperatures overall, climate change is also projected to lead to more intense storms, and it is possible that the frequency and intensity of winter storms will increase for the eastern United States.<sup>20</sup>

## EXTREME WINDS

Extreme winds refer to events where winds reach high speeds and may cause damage as a result. For example, the 2012 derecho hit Washington, D.C. with peak gusts of 70 mph, causing widespread outages and several deaths (mostly from falling trees). Derechos typically occur every 2 to 4 years.<sup>21</sup> There are not enough observations of extreme wind events to allow for scientists to determine whether there are long-term trends in frequency or intensity, or how climate change may influence the frequency and intensity of such events.<sup>22</sup> Extreme winds are also experienced during hurricanes, and the number of strong hurricanes (i.e., Category 3+) is projected to increase due to climate change.<sup>23</sup>

## POPULATION GROWTH

The metropolitan Washington region and the District of Columbia have experienced recent population growth and are expected to continue to experience such growth. As of 2020, metropolitan Washington has roughly 5.5 million people, with nearly 700,000 living in the District, a 15% growth from 2010. COG forecasts a 47% increase in the District's population from 2015 to 2045, and a 26% increase for the metropolitan Washington region.<sup>24</sup> However, population growth within the District is not uniformly dispersed. The area of Ward 6, including the area around Fort McNair and WNY, has seen more population growth than the area of Ward 8, which encompasses NRL and JBAB. Ward boundaries change with the U.S. Census every 10 years to represent a roughly balanced number of people for the District Council, and the Ward 8 boundary is expected to expand into areas of Ward 6 in 2022, including the area of WNY. This is due to higher population growth in Ward 6 compared to Ward 8.

The COG Long Range Transportation Plan identifies the Capitol Riverfront, Southwest Waterfront, Poplar Point, and Anacostia areas as Activity Centers, where population and job growth is expected to occur surrounding the military installations. This may impact installations by increasing demand for shared sector services, including transportation, power, and water supply/sanitation—leading to increases in congestion, demand and potential stress to the power grid and water supply, travel times and costs, and likelihood of service disruptions (which will be exacerbated by climate change).

## LAND-USE CHANGE, DEVELOPMENT, AND ENCROACHMENT

The four installations are situated along the waterfront within the District of Columbia. Fort McNair and WNY are located in Washington, D.C.'s Ward 6 on the north side of the Anacostia River. JBAB and NRL are located in Ward 8 south of the Anacostia River, and along the east bank of the Potomac River. The character and context are different between Ward 6 and Ward 8. See Figure 8 below for a map of future land use from the District's Comprehensive Plan, along with Ward boundaries.

## WARD 6 LAND USE

The Fort McNair and WNY installations are both surrounded by high-density commercial, residential, and mixed-use development in Ward 6. The installations are both historic, and the surrounding land use has continued to change over time. During the 19th and early-20th centuries, the Southwest and Southeast neighborhoods surrounding these installations were industrial or working waterfront community, home to working-class families. However, after World War II the area lost much of its historic character due to ambitious postwar urban renewal programs aimed at redeveloping areas in the vicinity. In their place, high-rise apartments and new townhouses were built, along with a new Southwest Freeway. Since this postwar period, industrial uses have been replaced by mixed-use neighborhoods. Buildings and public spaces have been designed in the late modern international style, along with transportation improvements that widened the street network to increase highway and road capacity.<sup>25</sup>

In recent years, the area has experienced significant infill development. Two sports stadiums are located in the vicinity: Audi Park (home of D.C. United soccer club) and Nationals Park (home of Washington Nationals baseball team). There are also public open spaces offering outdoor recreational amenities at Yards Park and the Anacostia Riverwalk Trail (ART). The Riverwalk includes a section that extends between WNY and the riverfront and is planned to extend to Buzzard Point near the Fort McNair boundary. The river is navigable, and the riverfront also includes multiple private marinas.<sup>26</sup>

The District Comprehensive Plan establishes the planned future land use for Washington, D.C. and policies that target locations for new development (see Figure 8 below). The local vicinity surrounding WNY and Fort McNair are planned for medium- and high-density infill development with housing, commercial, and cultural uses as well as new open space. The Comprehensive Plan is encouraging a transition of formerly industrial land uses to a new mixed-use neighborhood, and to break down large contiguous government-owned properties into individual development parcels for private redevelopment.<sup>27</sup> Greenleaf is a public housing community adjacent to Fort McNair where major redevelopment is planned by the D.C. Housing Authority to upgrade the housing stock and provide neighborhood enhancements.<sup>28</sup>

## WARD 8 LAND USE

JBAB and NRL are both within Ward 8 along the Potomac riverfront to the west and bordered by Interstate 295 (I-295) on the east. The Department of Homeland Security (DHS) campus and the U.S. Coast Guard Headquarters are on the opposite side of I-295 adjacent to JBAB, along with the historic Saint Elizabeth's Hospital. Railroads and highways have replaced many historic subdivisions and structures in this portion of Ward 8, including a homestead community of freed slaves on the historic Barry Farm site and a historic streetcar suburb of Uniontown, later renamed Anacostia.<sup>29</sup> East of the highway, the land is mostly low- and medium-density housing with some medium-density, neighborhood-scale commercial land. Blue Plains wastewater treatment plant (WWTP) is located south of NRL. Bridgepoint Hospital and a fire station/police station are located right across the highway from the main entrance of NRL.<sup>30</sup>

These areas fall within the Lower Anacostia Waterfront/Near Southwest Area Element and the Far Southeast/Southwest Area Element of the District Comprehensive Plan. Recent efforts to revitalize the neighborhood of Bellevue and the Anacostia Historic District with the aim of expanding retail, food, and real estate options have already begun. The Congress Heights, Anacostia, and St. Elizabeth neighborhoods are also anticipated to see new commercial, housing, transportation, and infrastructure investments within the decade. Outdoor recreational amenities can be found along the ART, Shepherd's Parkway, the Oxon Run Trail, and Anacostia Park.<sup>31</sup>

Recommendations in the District Comprehensive Plan include a 70-acre waterfront park and more mixed-use infill development centered near the Metro stations in Anacostia, northeast of JBAB. Bellevue and Congress Heights, neighborhoods east of JBAB and NRL, are recommended for neighborhood conservation efforts to improve existing housing stock and community amenities with pockets of higher-density infill housing development.<sup>32</sup> Essential community amenities currently lacking in Ward 8 include, but are not limited to, grocery stores and healthcare facilities. In particular, there is a lack of a full-service community hospital in Ward 8. Good Food Markets, a community grocery store that opened in late 2021, and Cedar Hill Regional Medical Center, a hospital under construction at the St. Elizabeth's East Campus that is expected to open in late 2024, are some recent examples of projects being implemented to fill the gap in community amenities.<sup>33, 34</sup>

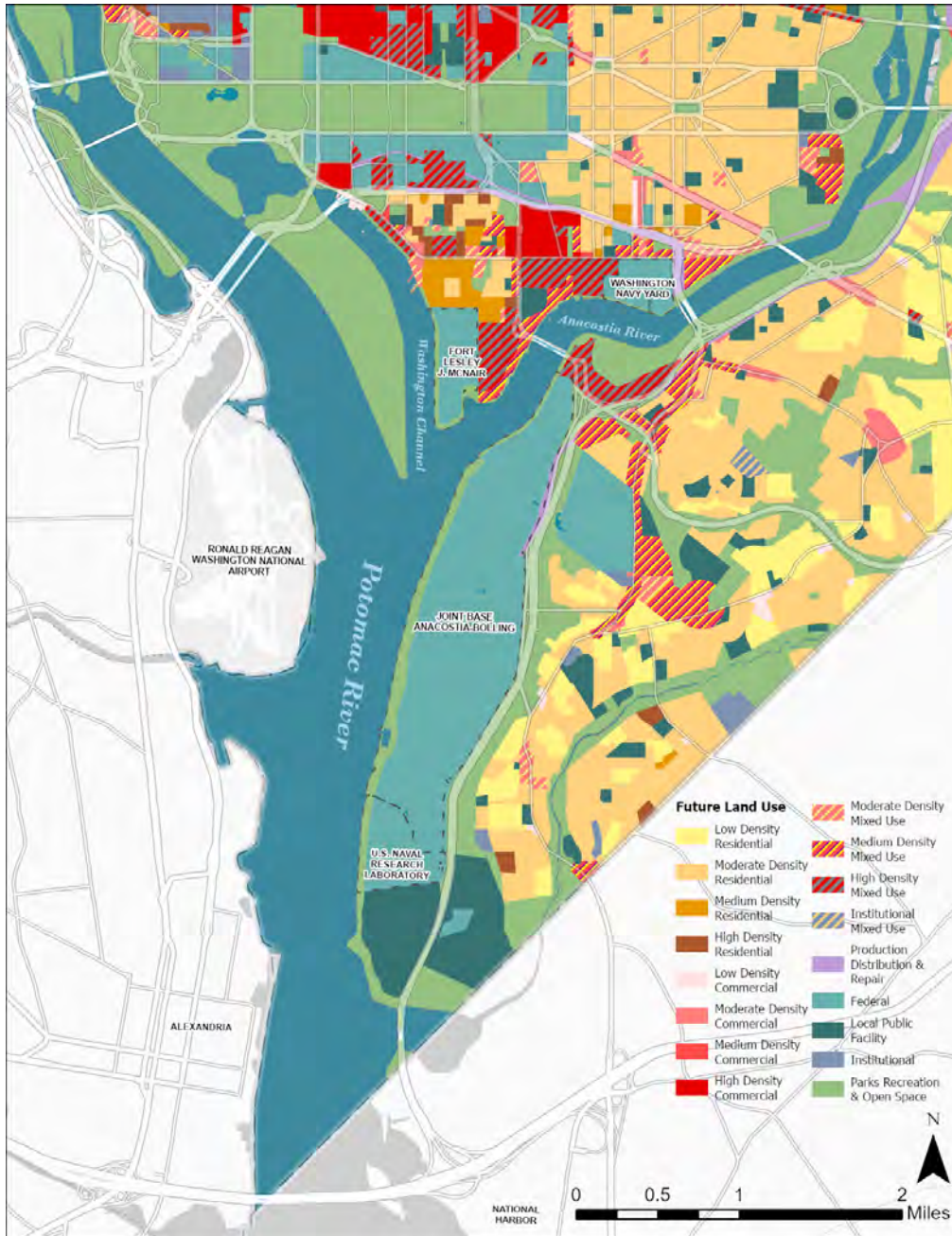


Figure 8: Future Land Use from the District Comprehensive Plan. Source: D.C. Office of Planning, 202135

## TRANSPORTATION CIRCULATION PATTERNS

Washington, D.C. has a multimodal transportation network that includes interstate highways, local arterials, bicycle and pedestrian paths, and a public transit system comprising of the Washington Metropolitan Area Transit Authority (WMATA) Metrorail and Metrobus and D.C. Circulator networks. Figure 9 on the following page shows the transportation network as well as traffic volume (annual average daily traffic, AADT) values from 2019. A DoD-sponsored shuttle bus service linking between the Metro system, the Pentagon, and local installations is available to the installations' workforce. Currently, Washington, D.C. has limited water-based transportation with ferry access to points along the riverfront, but not connected to the military installations. While WNY and Fort McNair are well connected to sidewalks and bike paths, JBAB and NRL lack convenient pedestrian and bike access as of this report. Other transportation projects nearing completion or completed around the area of the installations include the Malcolm X Interchange, Frederick Douglass Memorial Bridge<sup>36</sup>, South Capitol Street Trail<sup>37</sup>, and the 11th Street Bridge. There are no high-capacity transit improvement projects for JBAB and NRL within the State Transportation Improvement Program (STIP) or long range plans.

Commuting patterns and travel times to work vary significantly in Washington, D.C., as shown in Figure 10. The local vicinity and the greater Washington region regularly experience heavy traffic congestion that can cause delays, reducing transportation reliability and efficiency. Areas within dense, mixed-use city blocks and walkable routes tend to have a more diverse variety of commuting options and are more easily within reach of a Metrobus/Circulator stop or Metro station. These areas will more likely exhibit shorter travel times. Residents of areas where single-occupancy vehicles are the predominant mode of commute, with limited access to high-frequency public transportation, often experience the longest travel time to work.

A small portion of installation workforce commute by public transit, carpool, or via active transportation (walking, biking, or other personal mobility devices). The public transit system is not always convenient in terms of last-mile connectivity, defined by the American Public Transportation Association (APTA) as the distance between a traveler's origin/destination to the transit station.<sup>38</sup> The installations and the employment centers on-site require a long walk, a long wait for less frequent shuttle service, or other means to reach a destination from the public transit network. The installation workforce at each site mostly relies on private vehicles to get to work, which can be hampered by traffic congestion or parking availability. Based on internal installation staff surveys from 2017, some installation staff travel more than 50 miles to work, coming from areas in Maryland and Virginia, and even Pennsylvania and West Virginia.<sup>39</sup> While Figure 9, Figure 10, and the vulnerability assessment findings presented in Section 4 focus on the smaller study area surrounding the installations within Washington, D.C., the study acknowledges that there are potential vulnerabilities and transportation chokepoints outside the study area, and the resilience solutions explored as the result of this vulnerability assessment will seek to have a wider impact.

Since the 2020 global COVID-19 pandemic, each installation experienced a greater portion of their workforce transitioning to remote telecommute work. This pattern of telecommute or hybrid work where some workdays are on-site and other days are remote is expected to continue for the foreseeable future. This lessens the impacts of a long commute for some of the installation workforce, but a majority of the DoD workforce are still required to work on-site and are unable to perform job functions by telecommuting.



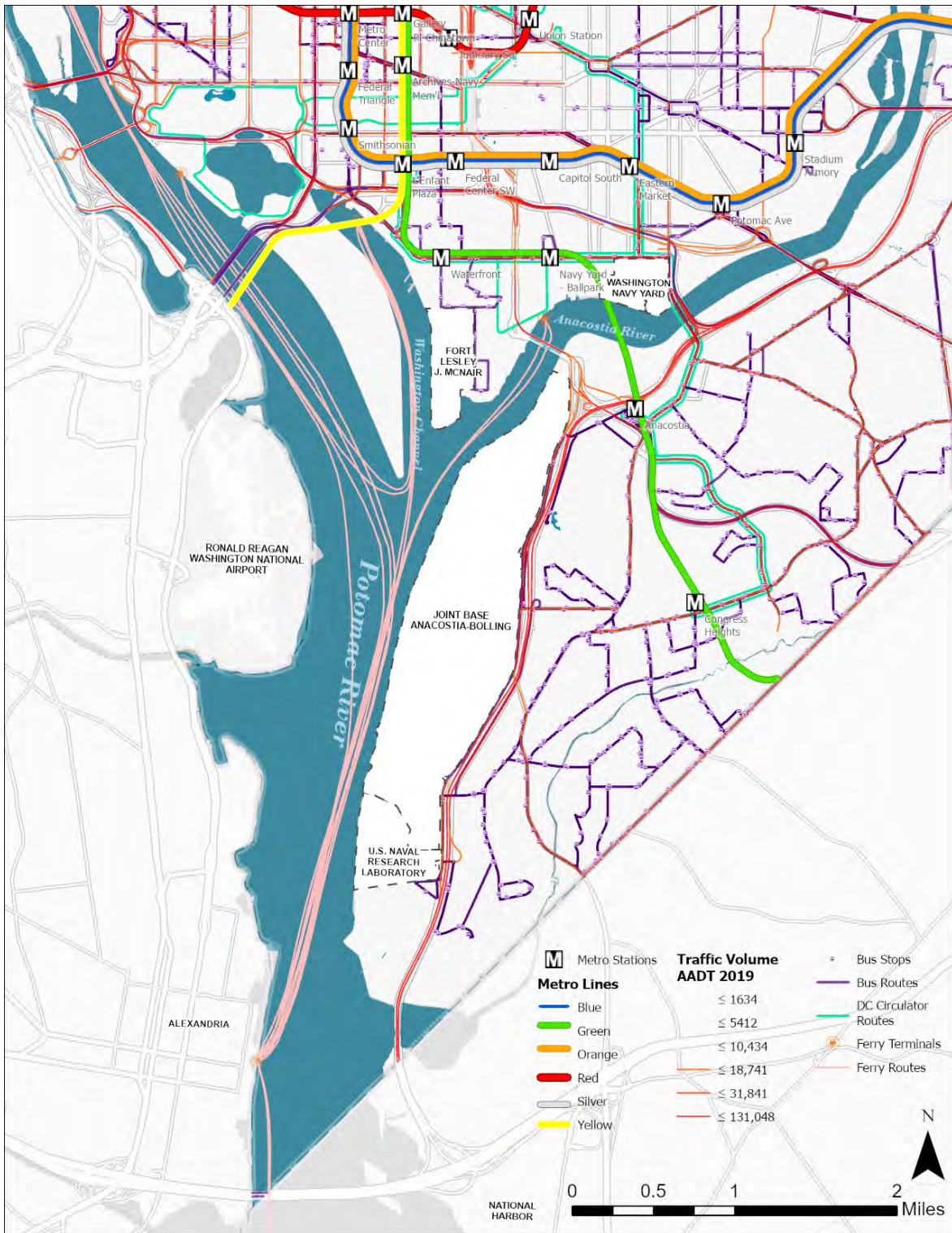


Figure 9: Transportation and Transit Network with AADT 2019 Values.  
 Source: Open Data D.C., 2021



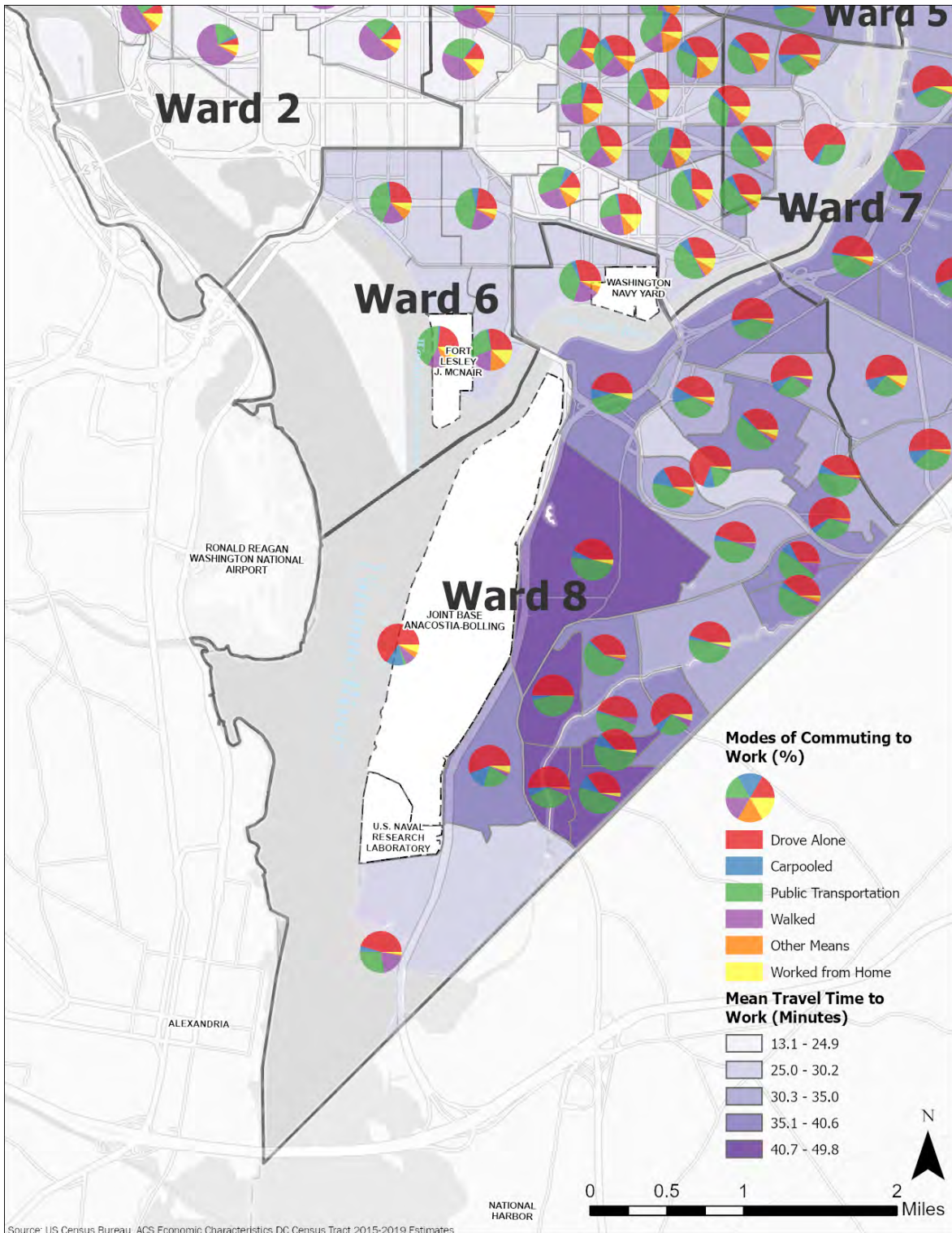


Figure 10: Commuting to Work—Travel Time and Mode; ACS-5-Year Data 2015-2019 Census Tracts. Source: Open Data D.C., 2021

## OTHER HAZARDS AND STRESSORS

As described in the introduction, hazards and stressors were grouped into three tiers based on selection criteria. The vulnerability assessment focused on the top two tiers as the priority hazards and stressors, but did consider all three tiers as part of the assessment. Some of these Tier 3 hazards subsequently emerged as relevant to priority vulnerabilities through the assessment process. Tier 3 hazards and stressors may create vulnerabilities to installations and infrastructure services; however, compared to Tiers 1 and 2, they are deemed less impactful across all sectors and to installations, less frequent (i.e., unlikely to occur in a typical ten-year period), or are expected to become less frequent under changing climate conditions. There are some connections between Tier 3 and Tiers 1 and 2, such as drought being considered in the discussion of changes in precipitation extremes related to flooding, and extreme cold being considered as part of ice storms.

The Tier 3 hazards and stressors include:

- » **Drought:** conditions that reduce the region's water supply. The Potomac River is the region's primary source of water and is augmented by upstream reservoirs during droughts. Climate scenarios modeled by the Interstate Commission on the Potomac River Basin (ICPRB) indicate that the impact of future increases in demand in combination with climate change is projected to threaten available supply, and that both new reservoirs and changes to operational strategies will be needed in order to provide adequate supply.<sup>40</sup>
- » **Snow storms:** a subset of winter storms consisting of extreme cold and heavy snowfall. They can cause secondary hazards including flooding, severe thunderstorms, and high winds.<sup>41</sup>
- » **Extreme cold:** severe temperatures that can cause injury or death. Extreme cold temperatures may coincide with winter storms and can be defined by low air temperatures or a low wind chill.<sup>42</sup>
- » **Noise and vibration:** disturbances related to the urban setting of Washington, D.C. and the four installations, caused by traffic, construction, and other activities. Vibrations can impact the development and testing of sensitive equipment.
- » **Hazardous materials:** a release of hazardous materials may occur from a fixed-use or storage site or during transport. The degree of threat depends on the type and amount of material. This may include radiological materials or oil spills.<sup>43</sup>
- » **Earthquake:** sudden ground movements, shaking, or trembling that can damage both above- and below-ground infrastructure, cause injury or death, and trigger other hazards including landslides, avalanches, flash floods, and fires.<sup>44</sup>
- » **Ecosystem change:** shifts in composition and abundance of local flora and fauna as a result of changes in climate, land-use changes, and ecosystem management. Impacts include habitat degradation, colonization of invasive species, loss of tree canopy or natural ground cover, or loss of sensitive environmental resources.
- » **Other (e.g., electromagnetic storm):** electromagnetic storms are major disturbances to the Earth's magnetosphere that can result from changes in intensities of solar wind. These events can add drag to satellites in low-earth orbit, modify the path of radio signals, create errors in GPS positioning information, disrupt navigation systems, and create harmful currents in power grids and pipelines.<sup>45</sup>

These hazards and stressors were not prioritized for detailed analysis based on the criteria outlined, but nonetheless do create vulnerabilities to the installations and infrastructure services.

## 2.4 VULNERABILITY CONTEXT

### COMMUNITY VULNERABILITY CONTEXT

Washington, D.C. has conducted multiple studies on the District's vulnerability to current and projected climate conditions, including Climate Ready D.C.<sup>46</sup> These efforts have highlighted rising temperatures, rainfall and flooding, and sea level rise and storm surge as the primary climate hazards.<sup>47</sup> Washington, D.C. is already experiencing these hazards, including repetitive flooding along the Potomac and Anacostia Rivers;<sup>48</sup> flooding from Hurricane Isabel in September 2003 that downed trees, caused outages, and created \$125 million in damages (in 2003 dollars);<sup>49</sup> and a severe inland flood in 2006 in the Federal Triangle neighborhood that caused tens of millions of dollars in damages.<sup>50</sup> Particular areas of concern include the downtown and southwest D.C. neighborhoods, which are vulnerable to increased flooding and rising sea levels.

Socioeconomic and demographic factors also contribute to community vulnerability. The degree of vulnerability is higher for minority, disabled, elderly, young, and low-income people because they may face greater barriers when recovering from property damage and interruptions in school or employment, affording repairs or relocation costs, or accessing necessary health or social services after climate events. Further, minority and low-income communities are often more vulnerable to climate-induced events due to a history of discriminatory zoning and housing practices, lack of political influence, and limited financial means to relocate or invest in resilient infrastructure.<sup>51</sup>

Ward 8 (which includes JBAB and NRL) is home to the largest number of residents who are more vulnerable to climate change impacts, particularly increased heat, due to socioeconomic factors (e.g., unemployment, age, education, poverty).<sup>52</sup> Ward 8's population is predominantly Black/African American (92% of Ward 8 residents), has lower levels of educational attainment than the Washington, D.C. average, and has a 16% unemployment rate—about ten points higher than the Washington, D.C. average. Of the families that live in Ward 8, about 24% are living below the poverty line, compared to about 11% for Washington, D.C. as a whole.<sup>53</sup>

Ward 8 has also historically experienced inequitable planning decisions, such as the placement of I-295 cutting off the community's access to the waterfront. Other facets of this inequitable planning history include the scaling back and closure of the only full-service hospital east of the Anacostia River—thereby significantly reducing Ward 8 residents' access to critical healthcare,<sup>54</sup> though the D.C. government is seeking to rectify this with the construction of a new hospital in Ward 8—and the fact that food deserts make up a considerable portion of Ward 8. Indeed, 51% of Washington, D.C.'s food deserts by area are located in Ward 8, and 31% are in Ward 7.<sup>55</sup>

The heightened vulnerability of these populations alongside the history of inequity means that there is a particular need for resilience measures in these communities—and the need to ensure that the resilience planning and decision-making processes involve community input.<sup>56</sup>

As part of the review of community vulnerability, the study assessed the potential vulnerability of emergency response infrastructure (i.e., hospitals, fire stations, emergency transfer locations, local emergency operations centers, and the levee and floodwall system). Generally, emergency response assets are not located in areas that are projected to be exposed to flooding; there is one riverine fire boat station that would be impacted by all flood scenarios, and one local emergency operations center that would be impacted under the most extreme flood scenario. Hospitals may be highly impacted by increases in the frequency and intensity of heat waves. The change in temperature and longevity of heat waves would require them to spend more energy on cooling to protect vulnerable, heat-sensitive patients—and may deal with more patients coming in with heat-related illnesses. Ice storms and extreme wind currently stress transportation systems and place demands on emergency response infrastructure. However, due in part to scientific uncertainty, it is not clear how impacts from ice storms and extreme winds may change in the future.

## LEVEE VULNERABILITY TO FLOODING

To assess the levee's potential vulnerability to the three flood scenarios, the study team identified any areas of the levee that would experience 11+ feet of flood depth. Eleven feet was chosen as the threshold as this is the height of the Anacostia levee. The flood analysis found that small portions of the levee system near JBAB may experience flood depths of 11+ feet by the 2050 1% annual chance flood under both 2.5 and 3.6 ft. of sea level rise.

Source: USACE. (2021, June 26). Anacostia. Retrieved from National Levee Database: <https://levees.sec.usace.army.mil/#/levees/system/2305300001/summary>

Washington, D.C. is actively planning to adapt to climate change. For example, the Continuity of Operations Plans for all D.C. agencies helps to ensure that critical services can be provided following a disaster or disruption; the Floodplain Management Program coordinates Washington, D.C.'s participation in the National Flood Insurance Program; and the All-Hazard Mitigation Plan was updated in 2016 to include climate-related hazards and mitigation actions.<sup>57</sup> In addition, the D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA) is participating in an ongoing resilience assessment of regional petroleum fuel supply.

### INSTALLATIONS VULNERABILITY CONTEXT

The four installations themselves are also vulnerable to the range of existing and projected conditions. For example, major storms such as the 1936 Potomac River flood (see Figure 11) and storm surge from Hurricane Isabel in 2003 resulted in flooding in WNY. All four installations are within the Federal Emergency Management Agency (FEMA) 100- and 500-year floodplains. As part of the response to this key vulnerability, WNY developed a Flood Risk Management Plan. Examples of existing precautions include prohibiting critical equipment on ground-floor locations and maintaining sufficient pumps to minimize impacts on installation activities.<sup>58</sup> JBAB has built a levee system that spans a large portion of its riverfront perimeter. The levee was decertified in 2007, but USACE is currently working on the designs for the levee repair project.

DoD has criteria for installation master planning to guide land use, transportation, environmental protection, historic preservation, and other factors—all inside the fence. The National Capital Planning Commission (NCPC) reviews installation master plans to promote orderly development of the NCR in coordination with the surrounding communities and other federal agencies. The master plan for WNY was completed in 2014, the Master Plan for JBAB was approved in February 2022, and master plans for JBM-HH and NRL are currently being reviewed. Recognizing the importance of planning for climate change within the installations, a 2020 update to the installation master planning criteria directs installations to develop comprehensive installation resilience plans that incorporate climate resilience analysis.





**Figure 11: Flooding at Washington Navy Yard During the 1936 Potomac River Flood.**

**Source: Presentation by Jason Elliott (NWS/NOAA), citing Library of Congress and U.S. Naval History and Heritage Command**

DoD has identified climate change as a critical national security issue and threat multiplier, and the Department's Climate Adaptation Plan (2021) includes a "line of effort" focused on resilient built and natural installation infrastructure.<sup>59</sup> To help facilitate climate resilience planning, the Defense Climate Assessment Tool (DCAT) provides a screening-level assessment of installations to climate hazards. The study reviewed DCAT to screen the four installations in Washington, D.C. and found that the key hazards are riverine and coastal flooding, heat, associated changes in energy demand, extreme weather events, and drought.<sup>60</sup> DoD plans to complete climate exposure assessments, using DCAT, on all major U.S. installations. For the purposes of this MIRR, the study applied higher-resolution and Washington, D.C. specific data relative to the data that underpins DCAT.

Many measures to address installation vulnerabilities will need to be pursued in coordination with organizations outside the fence. For example:

- » Implementation of the Potomac Commuter Fast Ferry between Northern Virginia and Washington, D.C. has the potential to provide an alternative mode and help alleviate congestion.
- » D.C. Water's CSO control tunnels can accommodate increases in stormwater across Washington, D.C. to alleviate the combined water and sewer overflow that can affect the installations and exacerbate flooding on-site. While the tunnels provide capacity for CSOs, only one of the tunnels is designed to mitigate flooding. This tunnel is the Northeast Boundary Tunnel and does not serve the military installations identified in the report.
- » To prepare for future changes in drought, population growth, and the impact on water supply, regional water management agencies will need to coordinate on supply from the Potomac. There is an opportunity for military co-investment in water supply solutions, particularly as the U.S. Army Corps of Engineers (USACE) manages the Washington Aqueduct, which provides drinking water for D.C. Water, Arlington County, and Fairfax Water.



## 2.5 INFRASTRUCTURE SERVICE VULNERABILITY AND RISK ASSESSMENT

The ability of Fort McNair, WNY, JBAB, and NRL to carry out their critical missions is influenced by how vulnerable the installations are to infrastructure service disruptions that occur “outside the fence.” For example, the installations are dependent on reliable transportation access, as well as power and water supplies. The following sections explore each of these vulnerabilities by sector.

To assess vulnerability, the study first calculated impact ratings by analyzing exposure and sensitivity of the assets to each of the priority hazards (flooding, extreme heat, ice storms, and extreme wind). The study combined the impact ratings with information on the level of dependence the installations reported for the assets (recall Figure 4). The study gathered information for these ratings from desktop review, expert opinion and stakeholder input, and site visits and staff discussions with installations. More information on the exposure and sensitivity analyses can be found in Appendix A.

The level of potential impact was determined through a combination of an asset’s sensitivity and its exposure. The box below provides definitions for key terms such as sensitivity, exposure, impact, and vulnerability. Assets that are potentially impacted, and those the installations are dependent on, were flagged as priority vulnerabilities using the framework illustrated in Figure 12. The determinations of vulnerability are on a scale ranging from “low” to “highest” based on level of impact and level of dependence. The highest vulnerabilities are those assets that would experience high impacts (i.e., asset may have significant damages, service disruptions for an extended period, and/or be subject to significant costs of restoration) and those with a reported high dependency.

Level of Dependence of Installations	High	Medium vulnerability	Medium-high vulnerability	Highest vulnerability
	Moderate-High	Medium vulnerability	Medium-high vulnerability	High vulnerability
	Moderate	Low vulnerability	Medium vulnerability	Medium-high vulnerability
	Low	Low vulnerability	Low vulnerability	Medium vulnerability
		Low	Moderate	High
		Level of Impact to Infrastructure		

Figure 12: Vulnerability Matrix Based on Level of Installation Dependence and Impact Rating

## KEY TERMS

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This vulnerability assessment describes how climate affects infrastructure and services with the following terms:

**Exposed:** The asset type (or specific asset) is located in an area that is projected to experience the hazard (e.g., within a flooded area or the urban heat island).

**Sensitive:** The asset or asset type would experience some degree of damage if exposed.\*

**Impacted:** Based on the study team's geospatial analysis, the asset is both exposed and sensitive.

**Vulnerable:** The asset is impacted by the hazard, and the installations reported some degree of dependence on the asset type. Level of vulnerability depends on both the level of impact and dependence.

\* Sensitivity to flooding is defined by flood-depth thresholds specific to each asset type that were determined via desk research and consultation with sector experts (e.g., roads are sensitive to a foot or more of flooding), while sensitivity to other hazards was defined qualitatively based on degree of damage expected from exposure to the hazard:

**Low sensitivity:** Asset may experience no damage or minor damage, and no material disruption to services.

**Medium sensitivity:** Asset may suffer damages that can be repaired with moderate cost and ease, and/or experience short-term, temporary disruption to services.

**High sensitivity:** Asset may be severely damaged, be out of service for an extended period, and/or be subject to significant costs of restoration.

The impact rating scale aligns with the sensitivity scale above, assuming the asset is exposed.

## LAND USE AND SOCIOECONOMIC VULNERABILITIES

The assessment of land-use encroachment and socioeconomic vulnerability considers a number of factors related to community development, compatible land uses, and social and economic concerns for areas on-site and adjacent to the military installations. Land use and socioeconomic vulnerabilities are primarily driven by changes in population and land-use policies. This portion of the analysis does not assess vulnerabilities at an asset level; rather, it assesses the potential for impacts associated with land-use encroachment and workforce development across the region. As noted by the DoD Office of Diversity, Equity, and Inclusion,<sup>61</sup> the department is working to ensure:

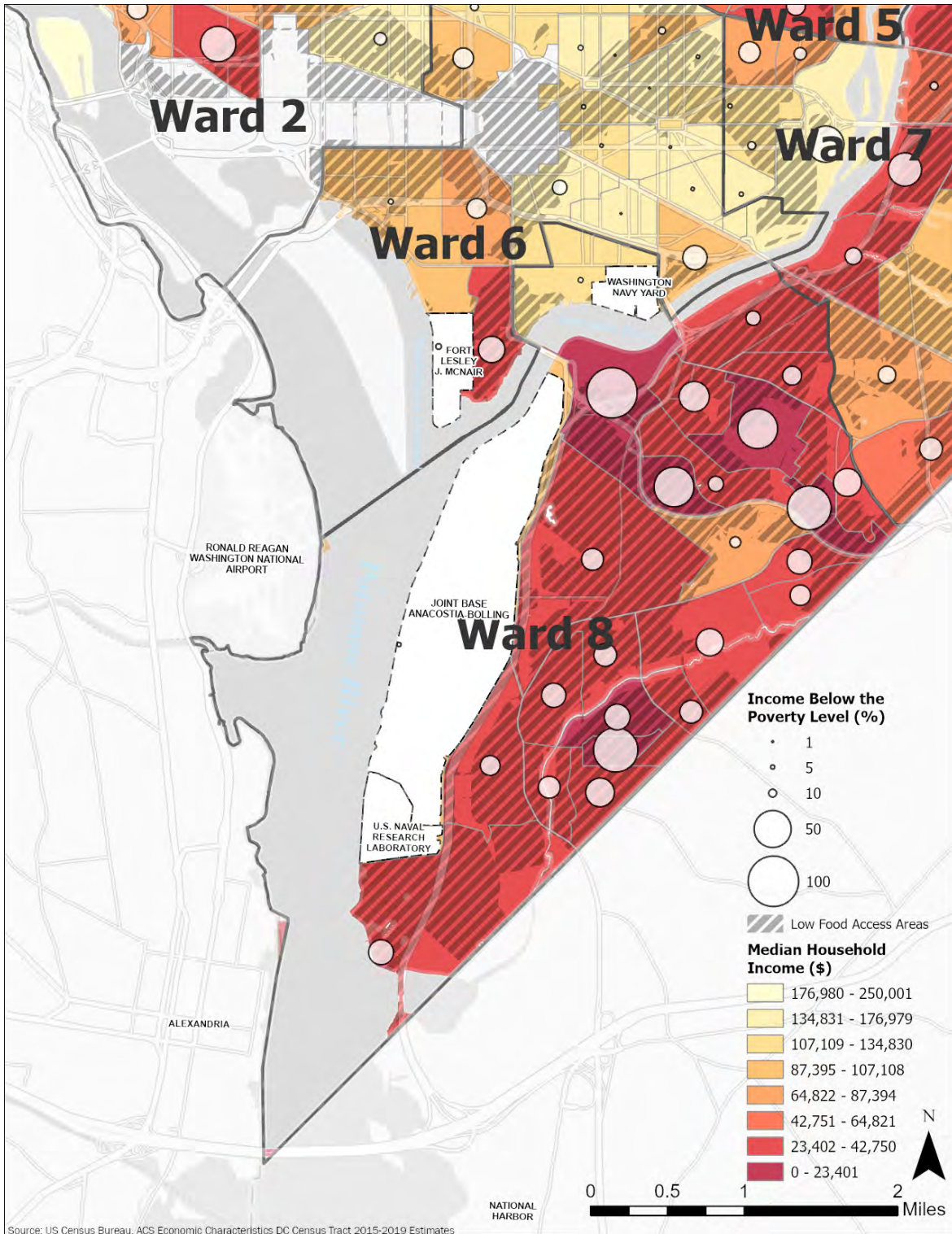
- » The DoD systematically develops a demographically diverse leadership that reflects the public it serves and the forces it leads.
- » The DoD pursues a broader approach to diversity that includes the range of backgrounds, skill sets, and personal attributes that are necessary to enhancing military performance.

To provide opportunities for military diversity, equity and inclusion, the consideration of potential land use and socioeconomic vulnerabilities that may inhibit the installations' ability to undertake their key activities on-base is essential.

Figure 13 provides an overview of social equity factors including areas with low food access, median household income and percentage of income in the past 12 months below the poverty level for the area.<sup>62</sup>

## INSTALLATION VULNERABILITIES, EQUITY, AND COMMUNITY RESILIENCE

Resilient DC defines equity as “just and fair inclusion into a society in which all can participate, prosper, and reach their full potential.” The military installations, including through this study, play a crucial role in the prosperity of their neighboring communities. Resilience measures that emerge from this study to boost installation's resilience will carefully consider the equity implications of those measures on the surrounding communities, as well as the ability of the military to meet its vision related to Diversity, Equity, and Inclusion.



**Figure 13: Income, Poverty, and Food Access. Median Household Income, Income (Past 12 Months) Below the Poverty Level, and Low-Access Food Areas ACS-5-Year Data 2015-2019 Census Tracts.**  
 Source: Open Data D.C., 2021

**Key land-use encroachment and socioeconomic vulnerabilities applicable to all installations include:**

**Public Trespassing:** Military installations that are situated in an urban setting or are adjacent to property with public access are subject to issues related to potential civilian incursions into secure areas and other areas with safety hazards related to military operations. Public trespassing can have adverse impacts on military operations and security. Installations have potential for public trespassing along the installation perimeters directly adjacent to public rights-of-way and navigable waterways. People and personal automobiles regularly pass by roadways and walkways in close proximity to installation perimeters, and boaters can pass by the installations' waterfront and unintentionally attempt to dock at installation piers or marinas.<sup>63</sup>

**Transportation Capacity:** Transportation capacity refers to the ability of existing roads, pedestrian infrastructure, public transit, parking, and other transportation systems to provide adequate access and mobility for people and cargo between military installations and their surrounding communities. While some installations closer to the urban core are adequately served by Metrorail systems, Metrobus or Circulator route lines, and bike lane networks, others further out in the periphery of the city rely predominantly on highways to convey their workforce and supplies. Ongoing roadway congestion near these installations hinders mobility for the installation workforce, delays emergency response and freight deliveries, and reduces overall roadway safety. Impacts to road capacity can also create issues such as delays at installation entrances/exits affecting installation operations and efficiency and increase commute times. Traffic congestion along with limited public transit last-mile connectivity (see Transportation Circulation Patterns section) limits safe, efficient, and reliable mobility options. In the case of congestion, there are a lack of effective alternative routes to access the installations.

All four installations experience issues related to traffic congestion. Fort McNair and NRL have ample parking available; JBAB and NRL have limited options for alternative transportation, such as transit or biking. These installations are auto-dependent and experience daily traffic congestion that causes delays. WNY has limited parking, but more options for alternative transportation with good access to local public transit and a multi-modal roadway network. WNY is within walking distance (0.6 miles) from the Navy Yard-Ballpark Metro Station. Nearby traffic congestion still affects mobility and the ability to receive freight supplies at the base. Additionally, limited parking on-site at WNY affects the ability of its workforce to drive independently and park near the work site.

**Local Housing Availability:** Affordable housing refers to quality accommodations at a cost that is up to 30% of household income, regardless of income level, as defined by COG and the Washington Area Housing Partnership. The military provides limited housing to some military personnel, and a small amount of housing is available on-site at Fort McNair, WNY, and JBAB. However, on-site housing tends to have long waitlists and is reserved for senior leadership or long-term career professionals. A 2014 report by the Urban Institute in partnership with COG notes that affordable housing is in short supply in the D.C. Metro area for low- and middle-income households.<sup>64</sup>

The remaining housing demand for the installation workforce relies on adjacent communities to meet the needs of military and civilian personnel. Given the high cost of housing in the D.C. Metro area, it can be difficult for military and civilian personnel to find good quality and affordable housing near the installations. Less-expensive housing is available in some areas of Washington, D.C., but it often tends to be older housing stock of lower quality, which would require higher costs for maintenance and renovation.

Public housing assistance is also available but is only reserved for households that meet the income threshold and can also have a long waitlist and a cumbersome application process. Dedicated affordable housing, as defined in a 2019 Housing Equity Report by the D.C. Department of Housing and Community Development (D.C. DHCD), is subsidized housing for households earning less than 30% median family income (MFI) up to households earning less than 80% MFI.



A majority of the neighborhoods in Ward 8 are designated as areas with low food access by the D.C. Office of Planning (DCOP) (as shown on Figure 13), meaning there are limited opportunities to purchase healthy food within a community. In addition to low food and public health access, these communities also have lower rates of access to a personal automobile, lower access to quality educational institutions, experience less efficient and frequent access to public transportation options, poorer environmental quality, and may have fewer community amenities overall. This places an added burden and cost when considering housing choices in communities where lower-cost housing may be available.

Limited availability of good quality, affordable housing in the vicinity can push the installation workforce to choose more affordable and higher-quality housing further away, thereby requiring longer commutes. The installation workforce may have to travel long distances from their homes dispersed across the metro region and beyond and rely on an already congested transportation network. This places additional burdens on the installation workforce, including the ability to be at work during extreme weather events that affect transportation routes.

**Local Workforce Availability:** Availability of skilled workforce to fulfill installation needs from both civilian and military personnel can affect the installations' ability to operate efficiently and effectively. Attracting and retaining a workforce requires competitive wages and benefits, available and affordable childcare, and adequate training for skilled job readiness. The issues of reliable transportation and good quality, affordable housing also affect the ability to attract and retain a workforce. Participants of the TAC and PAC meetings and installation personnel have repeatedly stressed that increased competition from both private and public sectors and a reduced labor pool have made it difficult to attract and retain skilled workers, especially for high-demand, blue-collar, skilled-trade jobs needed for installation operations.

**Additional stressors that may disproportionately affect installation operations and security include:**

**Air Quality (Dust/Smoke/Steam/Odor/Emissions):** Military operations or training activities can produce dust, resulting in impacts to local air quality. In local communities, dust created by grading or agriculture, and smoke, steam, or other airborne emissions from industrial facilities can reduce visibility or introduce odors and thereby potentially impact military operations. This is a higher-level concern at NRL and JBAB as they are situated adjacent to the Blue Plains WWTP where odors are released. Operations at NRL are sensitive to air quality, and additional air-filtering systems are used.

**Vibration:** Vibration generated from military aircraft, experiments, ordinances, and ground-training exercises impacts buildings and other structures within adjacent communities. In addition, vibration from adjacent construction activity, traffic, or industrial land uses may impact the development and testing of sensitive equipment. Operations at NRL can be sensitive to vibrations, and additional vibration reduction systems are in place to minimize vulnerability.

**Vertical Obstructions:** The height of nearby buildings and other structures (such as construction cranes) may inhibit sight lines and encroach into the navigable airspace used by military operations (airfield surfaces, Small Unmanned Aircraft [SUAs], radar operations, etc.), presenting a safety hazard to both the public and military personnel and potentially impacting military readiness.

**Land/Airspace Competition:** The military manages or uses land- and airspace for testing, training, and operational activities. These resources must be available and of a sufficient size, cohesiveness, and quality to accommodate effective training and testing. Military and civilian air operations can compete for limited airspace, especially when the airfields are in close proximity to each other. Use of this shared resource can impact future growth in operations for all users.

Helicopters fly in and out of JBAB regularly and Fort McNair occasionally. Several other nearby land uses also require airspace such as Reagan National Airport, the U.S. Coast Guard, and potentially other locally operated or privately operated airfields. Access to airspace is essential for key activities at JBAB, and changes in access due to air traffic control or increasing heights of nearby development may affect air travel patterns.

**Additional land-use encroachment considerations that may affect installations, but are lower vulnerability, include:**

**Stormwater Management:** Impervious surfaces are pavement, buildings, compacted soils, or standing water that do not allow rainfall to infiltrate into the ground. Rainfall will run off these surfaces, and during storm events can cause flash flooding. Urban areas will have more impervious surfaces, causing more stormwater runoff. Runoff from areas outside the installation can flow onto the installation and cause flash flooding, erosion, or increase flow into the drainage systems on-site. Stormwater management facilities can capture and retain runoff, helping to slow the release and reduce flood vulnerability. Areas with development that predates modern stormwater management regulations (circa 2005 when Washington, D.C. established new local stormwater management rules) often do not have stormwater management to fully capture and treat runoff.

Each installation is experiencing drainage issues, and further research may be needed to determine the amount of excessive runoff originating from areas outside the installations. Increasing development may increase the prevalence of impervious surfaces, but modern stormwater management regulations require that runoff from new development be managed on-site. Redeveloping already impervious areas can often reduce runoff since upgraded stormwater management facilities will be incorporated.

**Sensitive Land Uses:** Sensitive land uses on military installations may include areas in need of privacy for national security, areas where sensitive experiments or training operations occur, and on-site residences. Sensitive land uses outside of military installations may include residential housing, schools, nursing homes, retirement communities, healthcare facilities, and others. The most common sensitivity concerns are noise, light and glare, security, and public safety in the vicinity of installations.

**Hazardous Materials Containment:** Hazardous and contaminated materials may be stored on installations, on areas off installations, or may be carried along transportation networks in close proximity to sensitive areas on or off installations. Contamination spills may occur and disrupt military operations, impact sensitive habitats, and endanger public health, safety, and welfare. Vehicles carrying hazardous materials on nearby freight routes may crash and spill contaminants into areas on installation properties.

## TRANSPORTATION AND TRANSIT VULNERABILITIES

### KEY FINDINGS

**Overall, increased stress on the transportation system**, whether from increased demand or increased wear-and-tear from hazards in combination with aging infrastructure, **can increase congestion and strain the overall reliability and resilience of the regional transportation network**. This includes the transit system as well as the roadway network. Priority transportation vulnerabilities—that is, potential impacts to transportation infrastructure and services outside the fence that could affect the installations—are as follows:

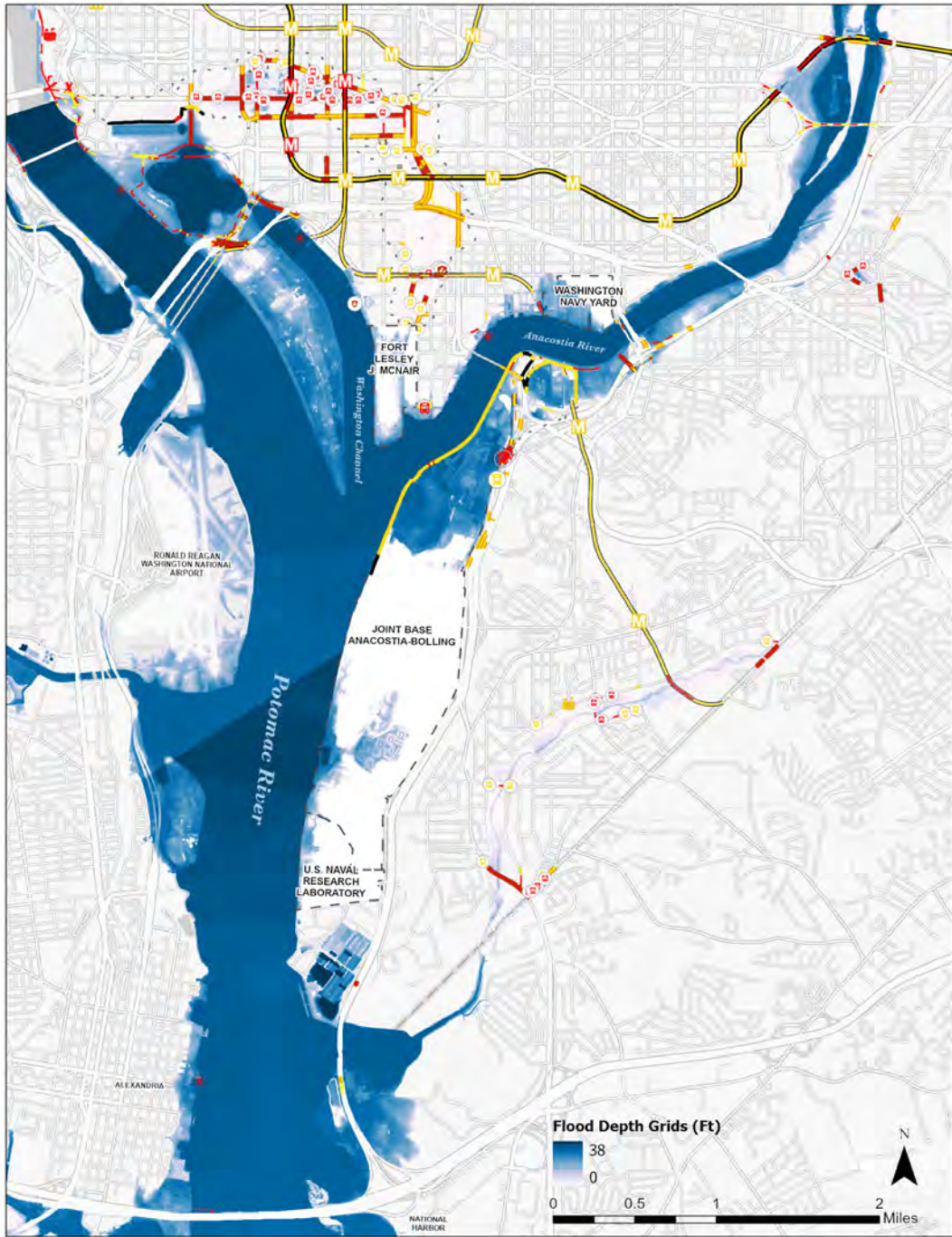
- » **Flooding from the three scenarios** impacts low points in the roadway network, including the **11th Street Bridge near WNY and major routes (Route 1 and I-395) crossing through East Potomac Park**. These routes represent a main connection between Washington, D.C. and the Pentagon and Reagan National Airport. These roadways are also designated truck and bus through routes, and vehicle evacuation routes. The intersection of **S Capitol St SW and Defense Blvd SW at JBAB** is also highly impacted by flooding. Inland flooding impacts the 3rd street tunnel and bus and truck through routes.
- » **Transit infrastructure is impacted by inland flooding**, including Metrorail stations and lines as well as Metrobus and Circulator stops and routes.
- » Extreme heat can impact public transit and affect the ability of Metrorail lines and Metrobus and Circulator vehicles to operate reliably. Specifically, heat waves can lead to rail buckling on Metro lines.
- » Potential impacts to **emergency walkout routes\*** from flooding, ice storms, and other hazards.
- » Impacts to transportation assets that result in delays or disruptions could limit the installations' ability to **obtain necessary supplies** such as fuel during emergencies and for staff to **commute on and off** the installations.

Metro has been taking steps to mitigate flood vulnerabilities for the past 20 years, such as raising ventilation shafts, upgrading the draining system within the rail system, adding additional discharge lines, and building in redundancy in Metro's pumping stations. Metro's newly adopted sustainability principles include a commitment to further improve resilience, and Metro has begun to develop a climate resilience implementation strategy. The goal of the strategy is to identify vulnerabilities and develop a plan of action to prepare for and prioritize investments in infrastructure that will improve resilience. In addition, Metro relies on power delivered by regional energy utilities and supports efforts to build a resilient energy grid, while also following industry best practices that include having redundant energy systems and backup power supplies at facilities.

Details on potential impacts to transportation assets and services outside the fence identified in this study and their relation to the installations are described below.

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\* Emergency walkout routes are designated routes used to evacuate D.C. residents out of the city and into Maryland or Virginia by foot. These may be used by the installations as a replacement or addition to vehicular evacuation routes during emergencies.



Transportation		DC Circulator Routes	Emergency Services	Emergency Walkout Routes	Snow Emergency Roads	Levee System
Metro Stations	Metro Lines	DC Circulator Routes	Emergency Services	Emergency Walkout Routes	Snow Emergency Roads	Levee System
M High	High	High	Emergency Transfer Locations	High	High	High
M No	Low	Low	Transfer Locations	Low	Low	Low
Bus Stops	Truck and Bus Through Route	Tunnel Entrances	Fire Stations	Regional Evacuation Routes	Hurricane Evacuation Routes	No Impact
High	High	High	High	High	High	Levee Protected Area
Low	Low	Low	Low	Low	Low	
Ferry Terminals	Metro Bus Lines					
High	High					
	Low					

Layer Credits: DC Open Data, Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data, USACE Geospatial Open Data, NOAA NWS Flood Depth Grid Data, FEMA 100-Year Flood Depth Grid Data

Figure 14: Potential Impacts of Flooding on Transportation, Scenario 2 (Future 1% Annual Chance)



## SUPPORTING INFORMATION

### POTENTIAL IMPACTS

The following sections discuss how each priority hazard and stressor poses potential impacts to transportation infrastructure and services, focusing on assets outside the fence.

#### Flooding

As shown in Figure 14, primary transportation vulnerabilities include road connections between communities in the metropolitan Washington region, the installations, the Pentagon, and other key hubs such as Reagan National Airport. These roadways are also designated truck and bus through routes, and vehicle evacuation routes. The areas of emergency walkout routes that are highly vulnerable differ somewhat from the roads that are highly vulnerable, as these are pedestrian routes.

**While the length of roads, evacuation routes, and walkout routes that are highly vulnerable to flooding are short, they represent key crossings across both the Potomac and Anacostia Rivers that could hinder movement during an evacuation scenario.**

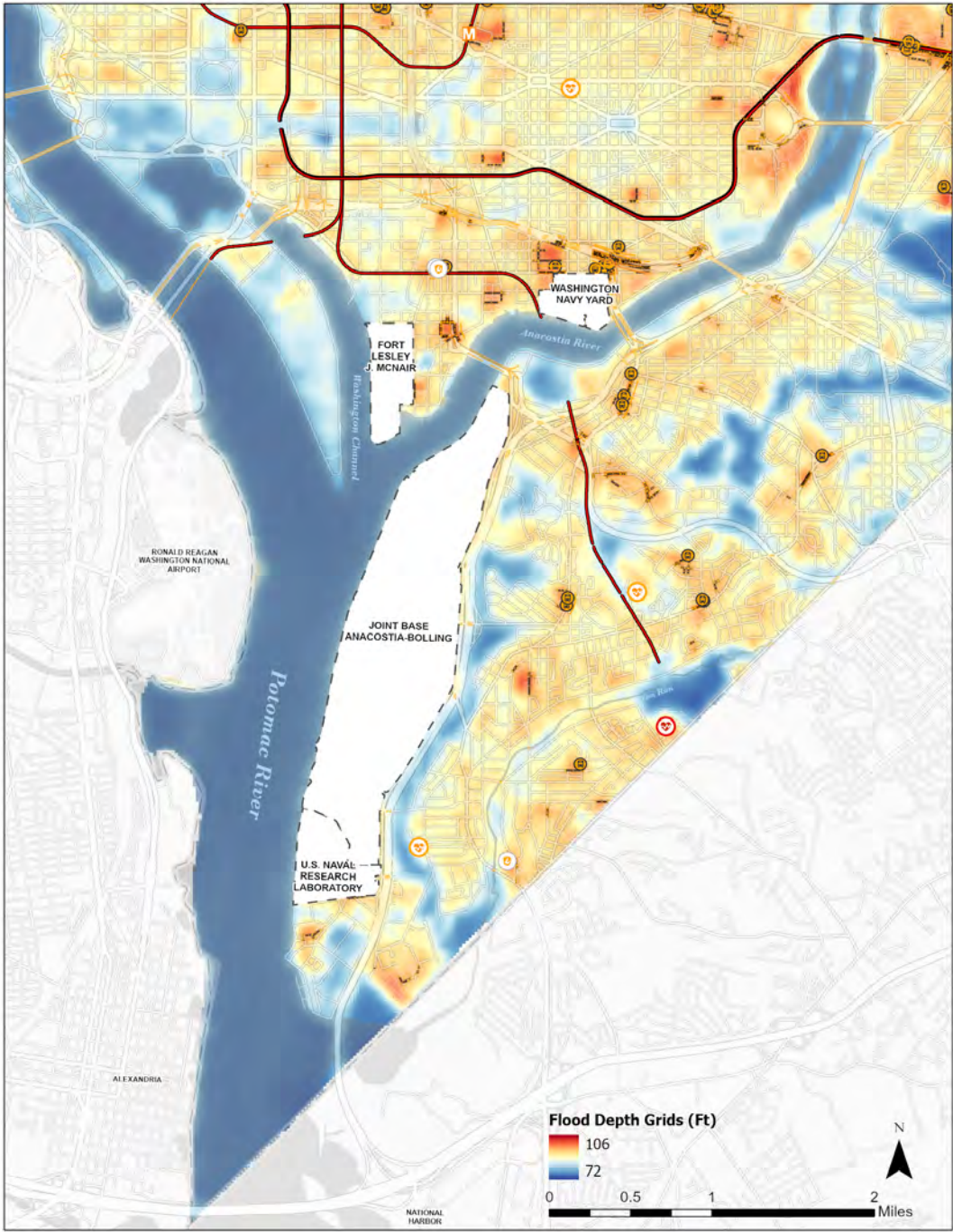
In addition, several designated emergency walkout routes represent a high vulnerability from all climate hazards (flooding, ice storms, and extreme winds) except extreme heat. The analysis did not identify specific locations that are highly vulnerable to ice storms or extreme winds, as the study assumed that these hazards would affect the entire District of Columbia.

The study found that Metrobus and Circulator stops and routes could be highly impacted by flooding under all three flood scenarios as well as inland flooding. Metro train stations and lines face varying degrees of impacts to inland flooding. If flooding were to impact the Metro system, installations and the community would face delays and potential shutdowns, which would greatly affect commuters' ability to travel on and off the installations.

#### Extreme heat

**The largest potential impacts to transportation services from extreme heat relate to public transit and affect the ability of Metrorail lines as well as the Metrobus and Circulator to operate reliably.** The analysis found that Metro lines are expected to be highly impacted, as heat waves can lead to rail buckling. This may prevent passage, and under extreme situations, creates the potential for dangerous derailment. To mitigate this vulnerability, Metro implements speed restrictions during heat events. In 2016, Metro limited trains on above-ground tracks to 35 mph, resulting in delays.<sup>65</sup> These impacts could in turn affect the more transit-dependent installations like WNY and Fort McNair.

Other impacts of heat on transportation infrastructure include pavement softening (which increases rutting, shoving, and accelerates pavement deterioration) and impacts to bridge joints. Extreme heat can expand bridge joints and stress the bridge structure,<sup>66</sup> which can over time increase the need for repair. There are six bridge segments where there may be high impacts based on their location in the area's UHI. However, these pavement and bridge impacts are likely to increase repair costs for D.C. Department of Transportation (DDOT) but not likely to affect usability of the structures from the installation perspective. That said, an increased need for road repairs could divert resources away from other needs and overall strain the reliability and resilience of the regional transportation network. In addition, extreme heat poses health risks and discomfort to pedestrians, bikers, and other transportation system users such as people waiting at Metrobus and Circulator stops. It is important to ensure that both the infrastructure itself is resilient and users are protected from the impacts of extreme heat.



Layer Credits: DC Open Data, Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data, USACE Geospatial Open Data, NOAA NWS Flood Depth Grid Data, FEMA 100-Year Flood Depth Grid Data

Figure 15: Potential Impacts of Extreme Heat on Transportation

## Ice storms

**Emergency walkout routes are the only transportation asset type found to be highly vulnerable to ice storms.**

Because these are pedestrian-specific routes, users are particularly exposed to the elements, and ice on the routes would make them potentially too dangerous or difficult to walk on. The installations also have a high level of dependence on emergency walkout routes, as they are required for safe evacuations.

Installations also have a high level of dependence on roads, including snow emergency roads, truck and bus through routes, regional and hurricane evacuation routes, and bridge and tunnel entrances. However, these have only a medium-high vulnerability to ice storms, as such an event would not necessarily lead to the same level of danger or difficulty for use as the walkout routes.

## Extreme winds

The two transportation asset types that are highly vulnerable to extreme winds are **bridge and tunnel entrances and emergency walkout** routes. Debris from the high winds (e.g., downed tree branches) may block bridges, underpasses, and tunnel entrances, and some bridges may be un-usable in high winds. For emergency walkout routes, high winds can pose a danger to pedestrians and can make the route harder to traverse (both from debris and buffeting, especially for younger, disabled, or elderly people trying to use the route). Extreme winds present a danger for both people in vehicles and pedestrians—for example, nearly all of the deaths that occurred during the 2012 derecho were due to falling trees, including trees falling directly onto people and onto their vehicles.<sup>67</sup> Access to and use of bridges, tunnels, and emergency walkout routes could be limited during high-wind events, though personnel would likely be safest sheltering in place and therefore should limit use of these assets.

## Population growth

The region's projected increase in population will likely expand the number of commuters competing for the limited capacity on roads and in parking facilities, leading to increased congestion. The installations noted that congestion is an issue, particularly for staff who commute and park at the installation. If Washington, D.C. chooses to widen roads or build new transportation infrastructure, expanding right-of-way may impact installations' boundaries. Residents and installation workforce who rely on public transit may also face issues from congestion. For example, Metrobus and D.C. Circulator buses may not run on time because of interference from traffic congestion, and transit systems may need to increase capacity with more frequent service to accommodate a growing population. To reduce congestion and enhance livability, the region is evaluating alternative transportation mode options ranging from a commuter ferry to enhanced access for pedestrians and bikes.

## ADAPTIVE CAPACITY OF INSTALLATIONS

The installations have high adaptive capacity for short-term transportation service disruptions (events ranging from hours to even 1-2 days). Congestion and delays on the order of a few hours are inconvenient but manageable, and all installations maintain stockpiles of important supplies such as backup fuel in case of extreme events.

However, the installations have low adaptive capacity for extended transportation service disruptions of more than a few days. These types of scenarios include supply chain issues, such as a disruption in transportation concurrent with an extended power outage and the installations requiring resupplies of fuel to run backup generators. In addition, there may be subsets of mission-critical individuals who cannot be away from the installation for extended periods of time. Air transportation such as helicopters may be available as backup for transporting staff if roadways are impassable, but this is not a practical long-term solution for routine transport of large numbers of staff. Similarly, the current water-based transportation system has limited ability to provide redundant capacity and resilience to the land-based transportation system.

The ability of the regional transportation system to recover quickly from disruptions and maintain surface transportation access to the installations is directly linked to the installations' resilience. This includes the transportation system connecting the installations to the wider metropolitan Washington area, as well as interstate commerce.

## ENERGY VULNERABILITIES

### KEY FINDINGS

All of the installations rely on energy infrastructure services including electricity, natural gas, and fuel. Disruptions to supply chains with limited redundancy may cause fuel delivery delays (including natural gas used for operational energy, and diesel fuel used for emergency energy); petroleum supply chain disruptions from hurricanes Irene and Sandy<sup>68</sup> in the Northeast provide recent examples of similar delays occurring. Supply chain vulnerabilities apply to transportation modes involved in global supply chains, such as freight rail, ports where tankers and barges dock, shipping, and air freight. The RRAP study already underway, focused on vulnerabilities in the petroleum fuel supply chain, may also include detailed examination of local vulnerabilities within these broad systems.

Priority potential impacts to energy infrastructure and services outside the fence that could affect the installations are as follows:

- » **Specific energy and fuel assets** with potential impacts from flooding.
- » **Above-ground electric distribution lines and transformers** could experience potential impacts from extreme heat, ice storms, high winds, wildlife, and other hazards.
- » **Potential overall grid stress from extreme heat**, including impacts to assets located in UHIs.
- » **Supply chain disruptions**, including to natural gas for operational energy and diesel fuel supply (for emergency energy).

Details on potential impacts to energy assets and services outside the fence, and their relation to the installations, are described below.

### SUPPORTING INFORMATION

#### POTENTIAL IMPACTS

The following sections discuss how each priority hazard and stressor poses potential impacts to energy infrastructure and services, focusing on assets outside the fence.

#### Flooding

Several assets may see high potential flood impacts under the scenarios evaluated (see Figure 16).

- » **A CHP plant** may see high potential impacts from flooding scenarios 1, 2, and 3 (scenarios 1 and 2 represent 2050 10% and 1% annual chance flood assuming 2.5 ft. SLR, respectively, and scenario 3 represents the 2050 1% annual chance flood assuming 3.6 ft. SLR).
- » **Several substations** may see high potential impacts from flooding.
  - Substations must be functional for customers to receive power, and flooding can cause impacts ranging from moderate damage to asset failure. Damages from a severe flooding event may require significant time and costs to repair\*, and damages incurred overtime from periodic flooding (e.g., corrosion, in areas with brackish water) may as well. The Climate Ready D.C. report notes that loss of a single substation could leave many businesses and residents without power; notably, asset-protection measures such as elevation and floodproofing can reduce vulnerabilities.<sup>69</sup>



- Most substations have several sources of built-in resilience and redundancy (e.g., designed to FEMA Base Flood Elevation, have multiple supply sources) and Pepco is evaluating potential impacts of extreme flooding to inform additional resilience measures.
- » **D.C. DPW Fuel Sites†** may experience high potential flooding impacts under scenarios 1, 2, and 3.
- » **Emergency power generators and fuel tanks** may be affected by future flooding: It may impede their operation.
- » **Utility poles** have relatively low potential impacts from flooding. Additionally, gas distribution assets serving the installations have relatively low sensitivity to flooding.

### Extreme heat

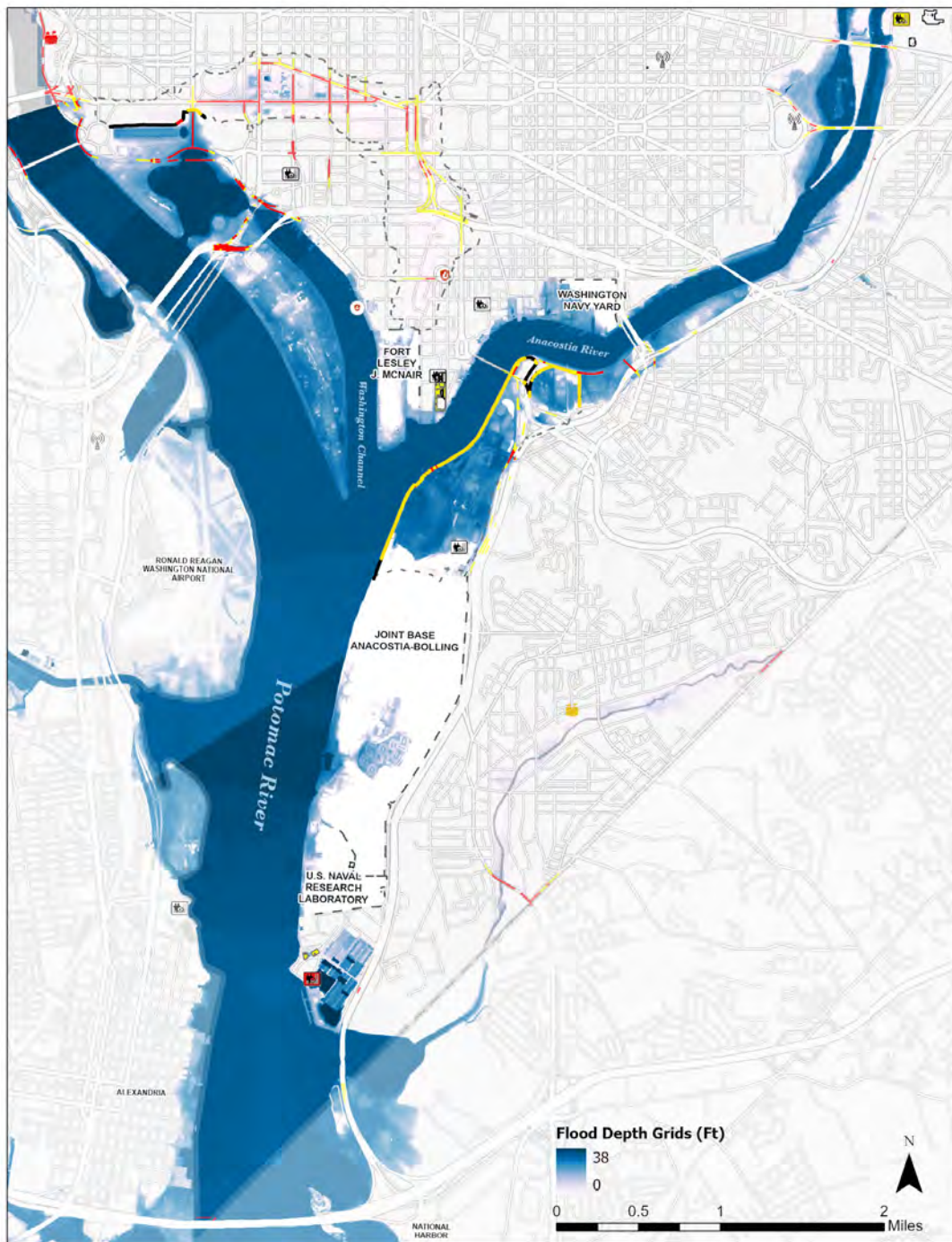
The grid may experience increases in stresses from extreme heat. Electric substations, electric power facilities, and above-ground electric distribution lines may see high potential impacts from extreme heat (see Figure 17).

- » **Substations** may see high impacts from extreme heat.
  - High temperatures may cause substation potential impacts ranging from thermal wear to decreased load capacity from derating to component overloading and failure; in severe heat, these impacts may trigger substation circuit breakers to trip in an effort to prevent equipment damage, leading to customer outages.<sup>70</sup> Additionally, if substations have to repeatedly run briefly at emergency ratings in extreme heat events, their lifetime and durability generally decrease.<sup>71</sup> Hotter extreme heat events can also increase peak cooling demand.<sup>72</sup>
- » **Electric power facilities:** An electric power facility‡ has the potential to be highly impacted by extreme heat (determined by high exposure and a medium sensitivity of these asset types to extreme heat conditions).
- » **Above-ground distribution lines:** Above-ground electric distribution lines in the Washington, D.C. area have the potential to experience high impacts from extreme heat. In hotter conditions, above-ground lines may see decreased ampacity (i.e., can handle less load) and be at increased vulnerability to line sag, which may increase costs or lead to power failure.<sup>73</sup>

The natural gas system has low sensitivity to extreme heat events, as most assets are underground.

### Ice storms

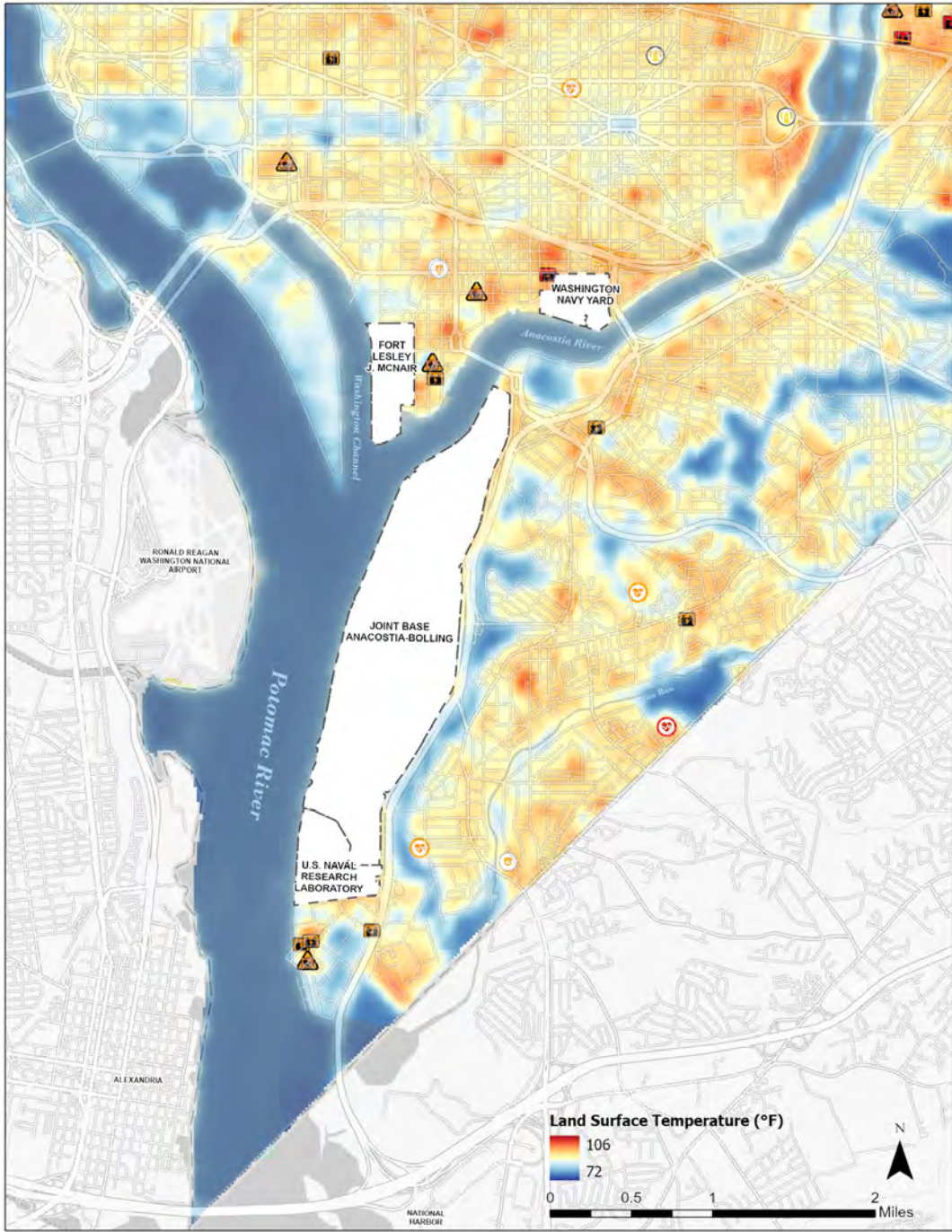
In the electric system, above-ground electric distribution lines that traverse the broader Washington metropolitan area have high potential impacts associated with ice storms. Ice storms can cause ice to build up on power lines, resulting in the lines experiencing higher stress and potentially breaking if exposed to winds. Potential for impacts may differ by asset due to construction standards. More right-of-way clearance can reduce impacts of falling vegetation in ice storms. In a February 2021 storm in Virginia, thousands of customers experienced power outages partially due to ice buildup on tree limbs, leading them to fall on power lines, causing outages.<sup>74</sup> Additionally, the consequences of ice storms for the assets may differ, with ice storm impacts on transmission assets often having greater consequences than ice storm impacts on distribution assets. The natural gas system is designed to withstand the coldest conditions it has experienced (known as the cold “design day,” with an average daily temperature of 5°F), and thus has low sensitivity to extreme cold conditions. The natural gas system experiences very cold temperatures (e.g., average daily temperature <20°F) every few years, with the most recent very cold event in 2018.



Layer Credits: DC Open Data, Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data, USACE Geospatial Open Data, NOAA NWS Flood Depth Grid Data, FEMA 100-Year Flood Depth Grid Data

Figure 16: Potential Impacts of Flooding on Energy and Telecommunications, Flooding Scenario 2 (Future 1% Annual Chance)





Layer Credits: DC Open Data, Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data, USACE Geospatial Open Data, NOAA NWS Flood Depth Grid Data, FEMA 100-Year Flood Depth Grid Data

Figure 17: Potential Impacts of Extreme Heat on Energy and Telecommunications Infrastructure

## Extreme winds

Several energy asset types, including electric substations, above-ground electric distribution lines, utility poles, and electric power facilities, have high potential impacts from extreme winds. Each installation is located near several such electric assets. High winds can carry debris and knock down trees, utility poles, and power lines across the region. Substations, above-ground distribution lines, CHP plants, and other facilities may experience these impacts (e.g., heavy branches downed by wind can break distribution lines and knock out power for customers, including the installations). The 2012 derecho downed hundreds of trees and left approximately 68,000 Washington, D.C. customers without power.<sup>75</sup> Strong winds can also take out solar-powered telemeters that monitor pressure on natural gas transmission and distribution systems, but the system has built-in redundancy measures for service continuity.

## Population growth

An increase in population typically furthers demand on the energy systems that are shared by the installations. However, utilities and transmission operators and planners (e.g., Pennsylvania-New Jersey-Maryland Interconnection [PJM]) conduct required and strictly regulated long-term planning, and have reserve margins. Population growth and associated energy demand should continue to be considered alongside other changes in demand (from changing temperatures, trends in transportation electrification, etc.) in energy system planning. A population-driven change in electricity demand would exacerbate a temperature-driven summertime increase in demand.

## ADAPTIVE CAPACITY OF INSTALLATIONS

The installations all have moderately high adaptive capacity for short-term power disruptions to their critical loads through backup generators and on-site fuel storage as long as the outages are not coincident with significant river flooding. They have low tolerance, however, for extended electrical power outages (exceeding a few days) or fuel supply shortages. They also lack increased power redundancy (e.g., N+2, or a backup to a backup) that can come from networked solutions like microgrids.

Installations' adaptive capacity is also tied to supply chain reliability for fuel delivery, including natural gas for routine operational use, and diesel fuel for emergency use during electrical outages. There are limited supply chain redundancies, and diesel fuel supplies have historically been largely unavailable during national emergencies (e.g., as seen in hurricanes Katrina in 2005 and Sandy in 2012).

Some installations have or are in the process of constructing or exploring on-site generation projects that could increase their adaptive capacity for long-term disruptions. For example, NRL is in the process of constructing a 4.5-megawatt (MW) cogeneration plant that would meet significant portions of the installation's (i) electricity consumption, and (ii) thermal (natural gas) energy consumption, allowing use of fewer natural gas boilers and thereby increasing thermal energy redundancy, especially during summer months.

Multiple installations (e.g., NRL and JBAB) have upcoming master planning processes that will clarify the extent to which their critical power needs may change in the future and define future, on-installation resilience investments.



## TELECOMMUNICATIONS VULNERABILITIES

### KEY FINDINGS

The greatest potential telecommunications vulnerabilities are direct damages to critical assets from ice storms and extreme winds, and potential loss of critical energy supplies.

**Ice storms and extreme winds may cause damages to critical assets such as transmission towers and fiber optic and coaxial cables.** These hazards may compound each other to create particularly severe impacts (e.g., wind loading on top of ice loading may increase the risk of structural damage to an asset).

Telecommunications assets and services depend on electric power as well as liquid fuel supply in emergencies or when commercial electricity is not available; **they may be affected by the various impacts to the energy services discussed above.** Several stakeholders also noted an opportunity for increased information-sharing among service providers and asset owner-operators about climate-related vulnerabilities of telecommunications services, to facilitate a greater understanding of resilience needs.

High-impact, low-frequency electromagnetic storms also create vulnerabilities to telecommunications assets; impacts of previous electromagnetic events range from shutting down electrical grids to disrupting radio communications.<sup>76</sup> Human-caused electromagnetic pulses (EMPs) can also cause these impacts to large geographic regions; agencies such as DHS are working with operators to make critical infrastructure in the communications and energy sectors in particular resilient to these events.<sup>77</sup>

Installations could be affected by telecommunications disruptions directly affecting the installation, as well as if staff experience telecommunications disruptions in their home working environments, limiting the ability of personnel to work remotely.

Details on potential impacts to telecommunications assets and services outside the fence, and their relation to the installations, are described below.

### SUPPORTING INFORMATION

#### POTENTIAL IMPACTS

The following sections discuss how each priority hazard and stressor poses potential impacts to telecommunications infrastructure and services, focusing on assets outside the fence.

##### Flooding

Transmission and cellular towers have relatively low sensitivity to and low potential impacts from flooding. Fiber optic assets do as well but may be impacted by other damages resulting from extreme flood events. If severe flooding displaces underground conduit containing fiber cables (e.g., if roads or railways wash out, or a bridge collapses), that can damage the fiber inside. If a severe flood event does expose fiber optic cable (either aerial or underground conduit), the cable often stays functional but is then more exposed to other hazards, such as being accidentally driven over or damaged in post-flood-event debris removal operations. In extreme cases, underground conduit that is fully flooded has the potential to channel some of that water into otherwise non-flooded central offices (COs) or similar facilities; carriers seal conduits for this reason, and regularly check to ensure conduits entering a CO or similar facility are properly sealed.

Additionally, telecommunications facilities (COs and Internet Exchange Points [IXPs]) may be in areas facing increasing vulnerability to flooding under future climate conditions.

### Extreme heat

Transmission and cellular towers and fiber-optic assets have relatively low sensitivity to and low potential impacts from extreme heat.

### Ice storms

Transmission and cellular towers have high potential impacts from ice storms. These towers—tall structures with antennas—are often elevated, and thus very exposed to the elements, and very sensitive to impacts from ice storms. Impacts of ice buildup and loading include interfering with signals, causing structural fatigue or damage, or leading to an antenna or section of the tower collapsing.<sup>78</sup>

Above-ground fiber-optic and coaxial cables also have high potential impacts from ice storms. These components typically run alongside or from the same utility poles as overhead electric distribution lines, and have similar vulnerabilities to those described in the section above on energy vulnerabilities (e.g., ice can build up on lines, causing them to experience higher stress and potentially break if exposed to winds).

### Extreme winds

Transmission and cellular towers also have high potential impacts from high winds. The same elevation and exposure to the elements that increase the potential for these towers to be impacted by ice storms also makes them sensitive to impacts from high winds. Severe winds may lead to strong wind loading on towers, and this load may cause impacts ranging from structural stress on towers<sup>79</sup> (and the lines between them)<sup>80</sup> to severe structural damage (e.g., bending or breaking).<sup>81</sup>

Above-ground fiber-optic and coaxial cables also have high potential impacts from high winds. These components typically run alongside or from the same utility poles as overhead electric distribution lines and have similar vulnerabilities to those noted in the section above on energy vulnerabilities (e.g., high winds can carry debris and knock down telecommunications lines across the region).

Telecommunications assets may experience indirect impacts of hazards as well<sup>82</sup> (e.g., in the 2012 derecho event, both power outages and transportation facility disruptions led to cell site outages).<sup>83</sup>

### Population growth

Telecommunication assets have low vulnerability to population growth. However, an increase in population may increase demand, and higher demand may require increased costs to expand capacity for telecommunication infrastructure that are shared with the installations. Short-term large public events near installations (e.g., large gatherings in nearby sports stadiums) also risk crowding out public bandwidth.

### ADAPTIVE CAPACITY OF INSTALLATIONS

The installations have relatively high adaptive capacity to outside-the-fence telecommunications disruptions. All have alternate internal communications mechanisms that provide some degree of backup capability. Many stakeholders noted an opportunity to increase cellular service to enhance telecommunications redundancy and resilience.

## WATER AND WASTEWATER VULNERABILITIES

### KEY FINDINGS

**Impacts to water and wastewater assets can disrupt or reduce reliable water supplies and potentially lead to flow backing up into communities.** In addition, drought and water supply availability are concerns for continued access to water. Potential impacts to water and wastewater infrastructure and services outside the fence that could affect the installations are as follows:

- » **Flooding is the climate hazard that presents the greatest threat to water and wastewater infrastructure and service provision.** Flooding has historically been a concern for D.C.'s combined stormwater and water infrastructure and related service provision. In September 2020, Washington, D.C. experienced three inches of rainfall in one-and-a-half hours, overwhelming D.C. Water's 124 million gallons of built tunnel storage in just over half an hour. This resulted in CSO into the Anacostia River and backing up into homes.<sup>84</sup> However, the installations have their own water, sanitary sewer, and separate storm sewer systems apart from D.C. Water, and so impacts to D.C. Water infrastructure are more directly related to the surrounding communities than to the installations themselves.
  - All local stormwater conveyances eventually discharge into the Potomac River. As the height of the river water level increases due to factors such as sea level rise, it **becomes difficult to quickly drain stormwater.**
  - The most vulnerable water and wastewater assets to future flooding (i.e., they would be exposed to flood depths that would cause damage, and the installations reported a high level of dependence upon these asset types) include **wastewater treatment plants, storm drains, pumping stations, and fire hydrants.**
  - Assets that would also be exposed to a damaging flood depth include **sanitary sewer pumping stations, CSO outfalls, municipal separate storm sewer systems (MS4) outfalls, and SSO.** However, the installations reported only a moderate to high level of dependence for these assets, giving them a slightly lower vulnerability rating than the assets listed above.
- » **Future available water supply is a concern in the D.C. area—both from drought and demand increases.** Implementation of both operational and infrastructural changes will be necessary to meet regional needs for water supply.<sup>85, 86</sup>

### SUPPORTING INFORMATION

#### POTENTIAL IMPACTS

The following sections discuss how each priority hazard and stressor poses potential impacts to water and wastewater infrastructure and services, focusing on assets outside the fence.

#### Flooding

Blue Plains WWTP is exposed to flooding.<sup>87</sup> Further, Blue Plains WWTP was built at the lowest elevation in the city to reduce the amount of energy needed to pump waste to the facility by allowing gravity to work in favor of the system—but this low elevation means that the facility is potentially vulnerable to sea level rise and flooding. To mitigate this vulnerability, D.C. Water is constructing a 17-ft. sea wall around the facility to protect the site from a 500-year flood.<sup>88</sup>

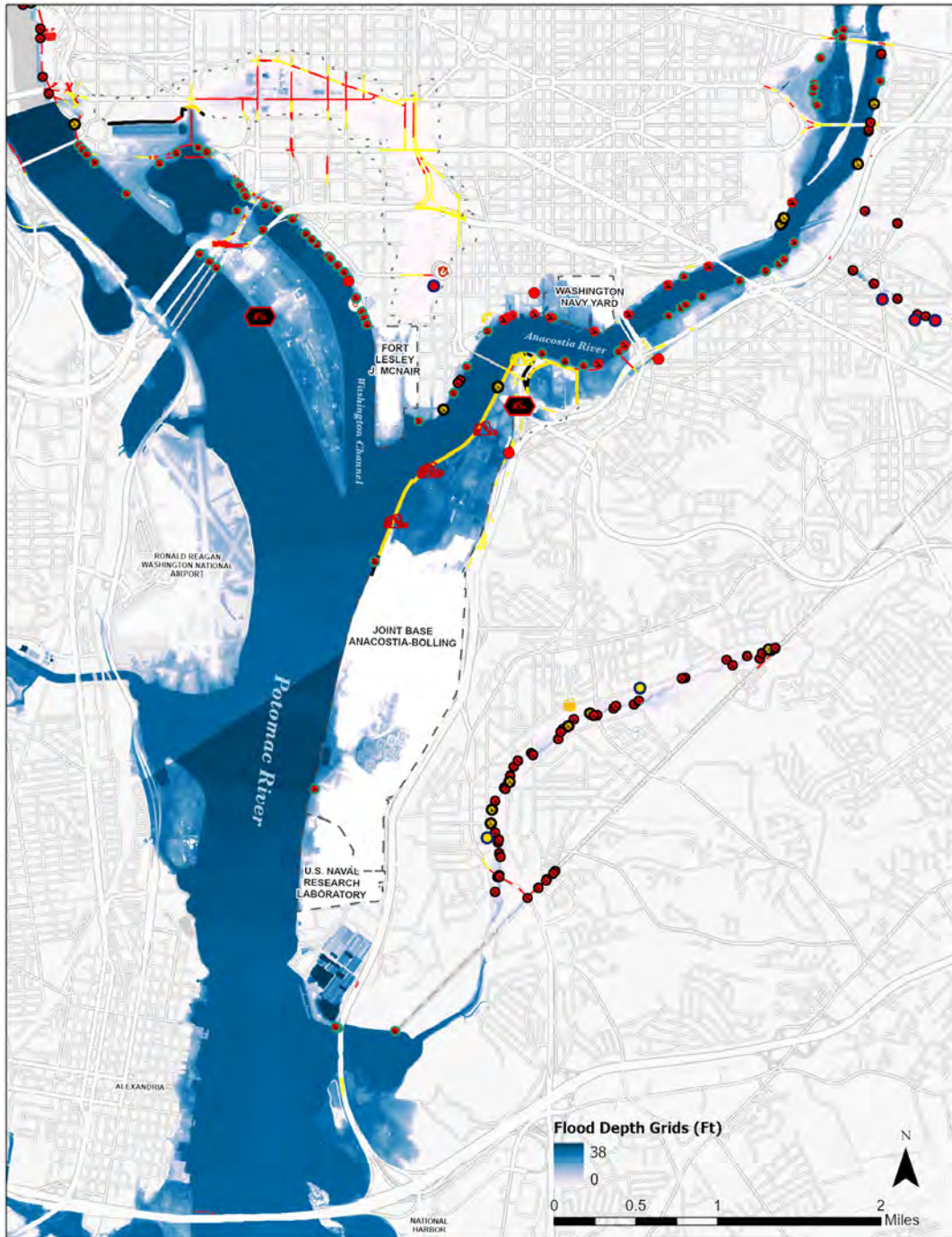
Storm drains, pumping stations, and fire hydrants are the assets in this sector with the highest vulnerability to flooding, as they have the potential to be highly impacted by the modeled flood scenarios, and the installations are highly dependent on these assets (see Figure 18). Specific vulnerable assets include:

- » **Storm drains:** While none are exposed under scenario 1 (which represents the 2050 10% annual chance flood assuming 2.5 ft. SLR), there is one location that would be highly impacted under scenario 2 (which represents the 2050 1% annual chance food assuming 2.5 ft. SLR) and two more storm drains that are highly impacted under scenario 3, which represents the worst-case scenario flood (2050 1% annual chance flood assuming 3.6 ft. SLR).
  - Washington, D.C.'s stormwater collection system is designed based on historic rainfall events and is expected to be strained by future flood events. This may result in localized flooding and increased stormwater runoff.<sup>89</sup>
- » **Pumping stations:** There are six treated water pumping stations included in the study. Under scenario 1, four face high impacts and one faces low impacts based on flood depth. Under scenario 2 and 3, five pumping stations face high impacts, and one faces low impacts.
  - For this analysis, high impacts to pumping stations indicates a flood depth of at least 4 ft., the critical threshold established by Hazus (FEMA's tool for calculating flood damages).<sup>90</sup> Flooding of pumping stations could ruin the electrical equipment at the station, block access to the station, and otherwise take the station offline. This could disrupt treated water distribution to areas serviced by those pumping stations until repairs are completed.
- » **Fire hydrants:** All four installations have nearby fire hydrants that face high impacts from flooding.
  - Fire hydrants could become damaged or inaccessible due to flood waters or debris from flooding. A damaged hydrant can release water, and a damaged or inaccessible hydrant could make it difficult for emergency responders to respond to a fire.
  - Additionally, if pumping stations were to be impacted by floods, it could cause loss of pressure in their service zones. This would render hydrants in those zones inoperative, even if the hydrants themselves were not impacted by the floods.

Sanitary sewer pumping stations, CSO outfalls, MS4 outfalls, and SSO overflows are also highly vulnerable, as they could experience high impacts from flooding, and the installations have a moderate to high dependence on these asset types.

- » **Sanitary sewer pumping stations:** The study included eight total sanitary sewer pumping stations. None of these are highly impacted under scenario 1; two are highly impacted under the scenario 2 flood and the scenario 3 flood.
  - If a sewage pumping station were to become inundated, its electrical components and dry well could be submerged, causing damage to the pumping station and potentially taking it offline until repairs could be performed.<sup>91</sup>
- » **CSO outfalls:** There are 15 CSO outfalls, and all are located along the Anacostia River. Because of their proximity to the river, most are impacted by flooding: 12 face high impacts under scenario 1, and 14 face high impacts under both scenarios 2 and 3.





- |                               |                                     |                                    |                              |                                   |                                    |                        |
|-------------------------------|-------------------------------------|------------------------------------|------------------------------|-----------------------------------|------------------------------------|------------------------|
| <b>Water &amp; Sewer</b>      | <b>MS4 Storm Sewer Outfalls</b>     | <b>Sanitary Sewer Pump Station</b> | <b>Emergency Services</b>    | <b>Emergency Walkout Routes</b>   | <b>Snow Emergency Roads</b>        | <b>Levee System</b>    |
| Sanitary Sewer Overflow (SSO) | ● High                              | ■ High                             | Emergency Transfer Locations | — High                            | — High                             | — High                 |
| ● Low                         | ● Low                               |                                    | ■ High                       | — Low                             | — Low                              | — Low                  |
| ● Low                         | <b>Anacostia River Pump Station</b> |                                    | ■ Low                        | <b>Regional Evacuation Routes</b> | <b>Hurricane Evacuation Routes</b> | — No Impact            |
| ● High                        | ■ High                              |                                    | ■ High                       | — High                            | — High                             | — Levee Protected Area |
|                               | ■ Low                               |                                    | ■ Low                        | — Low                             | — Low                              |                        |

Layer Credits: DC Open Data, Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data, USACE Geospatial Open Data, NOAA NWS Flood Depth Grid Data, FEMA 100-Year Flood Depth Grid Data

Figure 18: Potential Impacts of Flooding on Water and Wastewater, Flooding Scenario 2 (Future 1% Annual Chance)

- Heavy precipitation events can overwhelm a combined sewer system; outfalls allow for the release of excess flow to prevent flooding in buildings and streets connected to the system.<sup>92</sup> If CSO outfalls are under floodwaters, they may not be able to release this excess flow, leading to further flooding and combined sewer water backing up into homes and other buildings.
  - Even if CSO outfalls are not underwater and are able to function as intended, excess flow being discharged into rivers is detrimental to the river—and therefore public health. The D.C. Clean Rivers Project has work underway such as bioretention in planter strips and permeable pavement that is projected to reduce CSO volume by 96% in an average year.<sup>93</sup>
- » **MS4 outfalls:** These assets discharge water from the MS4 system. There are 573 outfalls located along the Anacostia and Potomac rivers as well as Rock Creek and its tributaries. Most of the outfalls along the Anacostia River and the southeastern portion of the Potomac River are exposed and highly impacted by flooding due to their proximity to these bodies of water.
- If MS4 outfalls were to be submerged under floodwaters, they may not be able to properly discharge stormwater, leading to localized flooding (e.g., around connected storm drains).
- » **SSOs:** Very few SSOs are highly impacted by flooding. Of the 254 SSOs included in the study, four are highly impacted under scenario 1, six are highly impacted under scenario 2, and nine are highly impacted under scenario 3.
- Outfalls and overflows may be compromised by flooding, leading to backed-up systems. For the sanitary sewer system, this could present a health hazard as wastewater is backed up into buildings.

While water and wastewater pipes were not identified as highly impacted to flooding due to their underground placement, it is important to routinely inspect these assets for leakages, which can lead to sinkholes.

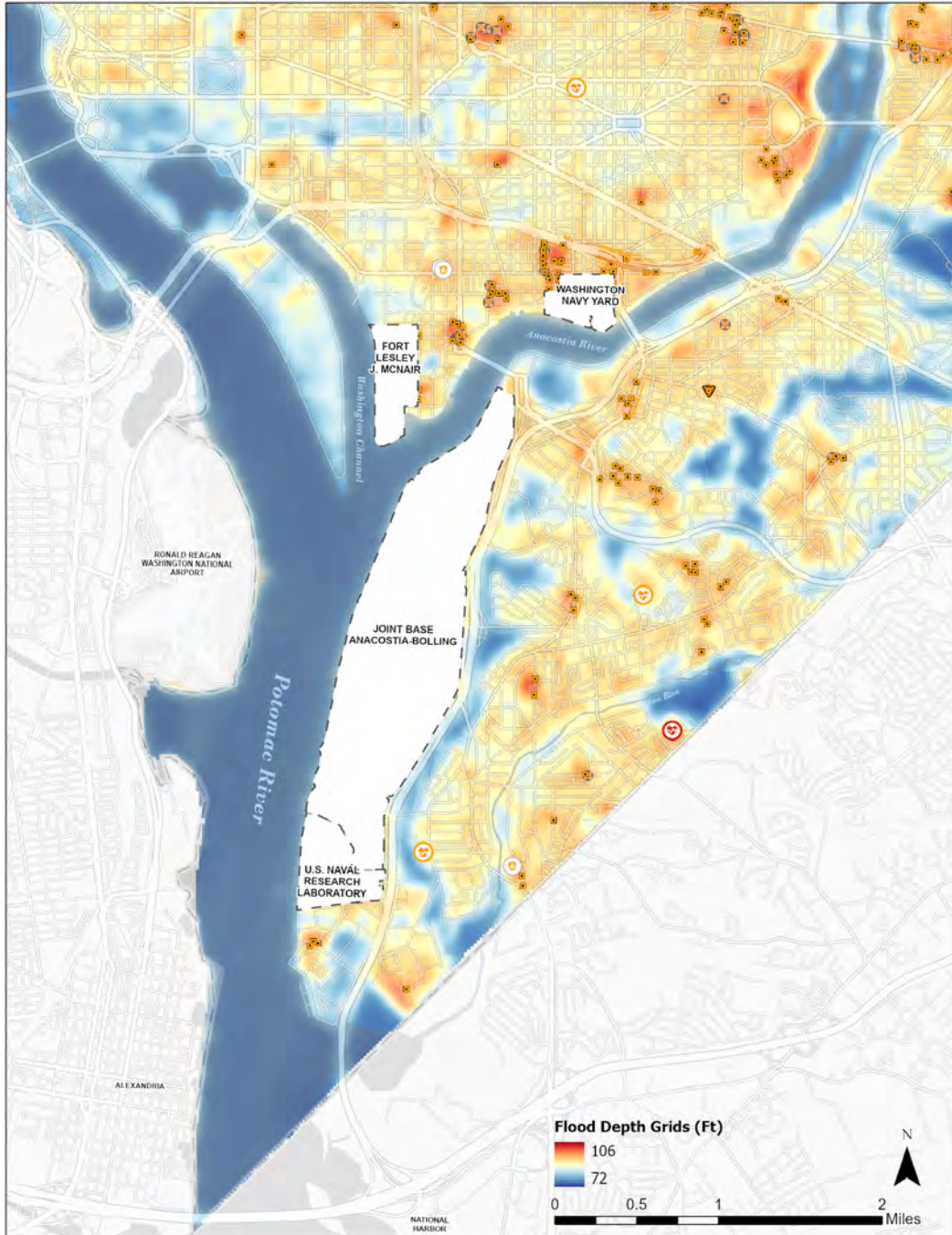
### Extreme heat

**Water and wastewater infrastructure and services are not highly sensitive and therefore not vulnerable to extreme heat** (see Figure 19). However, there are still ways that heat impacts to other sectors and systems could impact the water and wastewater sector. These cascading impacts include drought events, high temperatures degrading drinking water quality through eutrophication and algal growth, changes to user behavior in response to temperatures, and extreme temperatures leading to blackouts or brownouts in the electric grid and thereby taking pumping stations offline. D.C. Water is beginning a process that may lead to establishment of a Blue Plains WWTP microgrid with an upcoming solicitation for the feasibility studies, concept designs, owner's representative during projects implementation, FEMA or other grants application assistance and as-needed engineering services. Enhanced power monitoring capabilities and control of relevant portions of the power distribution system will enable the establishment of a microgrid at Blue Plains WWTP. The roadmap will identify a portfolio of projects to be implemented over time. A microgrid will ensure the continued service of this key facility.

### Ice storms

**Water and wastewater infrastructure and services are not highly sensitive and therefore not vulnerable to ice storms.** This is largely because the placement of water, stormwater, and sewer lines underground affords them protection against direct impacts of ice storms. The main impacts to storm drains or outfalls/overflow would be if ice or debris blocked passage of water through these assets. The issues for above-ground infrastructure such as pumps would be secondary impacts resulting from primary impacts to the energy grid.





- |                              |                                         |                                      |                                       |                                                  |
|------------------------------|-----------------------------------------|--------------------------------------|---------------------------------------|--------------------------------------------------|
| <b>Emergency Services</b>    | Fire Stations<br>○ Med                  | Snow Emergency Roads<br>— Med        | <b>Water &amp; Sewer</b>              | Sanitary Sewer Overflow (SSO) Incidents<br>▽ Med |
| Hospitals<br>⊕ High<br>⊕ Med | Emergency Walkout Routes<br>— Med       | Hurricane Evacuation Routes<br>⋯ Med | Fire Hydrants<br>■ Med                | Storm Drains<br>● Med                            |
|                              | Regional Evacuation Routes<br>- - - Med |                                      | Sanitary Sewer Pump Stations<br>⊠ Med |                                                  |

Layer Credits: DC Open Data, Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data, USACE Geospatial Open Data, NOAA NWS Flood Depth Grid Data, FEMA 100-Year Flood Depth Grid Data

Figure 19: Potential Impacts of Extreme Heat on Water and Wastewater Infrastructure

However, some impacts are possible given the extreme cold temperatures associated with ice storms. Extreme winter weather can lead to water main breaks and leaks, which can disrupt water supply or result in boil water notices as drops in pressure in the system allow for potential contamination of the water.<sup>94</sup> Smaller pipes on properties can also break during extreme cold temperatures, leading to disruptions in individual supply even if issues with the broader infrastructure such as broken water mains are resolved.<sup>95</sup> These impacts were observed when Winter Storm Uri hit Texas in February 2021.

### Extreme winds

**Extreme winds are not expected to cause high impacts to water or wastewater infrastructure**, so these assets are not highly vulnerable. Potential impacts could include increased blockages or breaks during storms, especially due to debris or falling trees/branches.<sup>96</sup> Further, outages in the electric sector would impact water and wastewater pumping stations, which could create disruptions in service. This occurred during the 2012 derecho, when D.C. Water urged residents to conserve water, as pumps were offline and not able to refill reservoirs.<sup>97</sup> Backup power at pumping stations could mitigate this potential impact.

### Drought

Beyond potential impacts to specific water infrastructure and services, the study also reviewed existing research on the resilience of overall water supply for the District of Columbia. The Potomac River is the District's main source of drinking water. The ICPRB recommends that flows above 100 million gallons per day (MGD) occurs at Little Falls dam and above 300 MGD between Great Falls and Little Falls dam. Metropolitan Washington has experienced several episodes of drought. In 2002, only 78 MGD was measured at Little Falls.<sup>98</sup> Water demand is estimated at 453 MGD for the 2014-2018 period. This demand is expected to rise to 528 MGD by 2050.<sup>99</sup> This increase in demand will stress the water supply, potentially exacerbated by drought. Climate scenarios modeled by the ICPRB indicate that the impact of future climate changes in precipitation and temperature on stream flow for the Potomac River and other water sources in metropolitan Washington is uncertain at this time (with future stream flow decreasing under most scenarios but increasing slightly under others), but the combined impact of climate and increased demand will require investment in new infrastructure (i.e., reservoirs) and changes to operational strategies to continue to provide adequate water supply.<sup>100</sup> If the region is not able to meet demand for water, there could be drastic consequences for human health, and it would be more difficult for the installations to successfully carry out their missions.

### Population growth

An increasing population means increasing demand on the water and wastewater system. Increased demand on the water supply could result in drawing water from regional sources faster than it can be replenished, and an increase in wastewater could overwhelm wastewater treatment facilities and cause potential sewage spills. Water demand in the metropolitan Washington area is estimated at 453 MGD for the 2014-2018 period and is expected to rise to 528 MGD by 2050, presenting a further constraint on ensuring adequate supply.<sup>101</sup>

### ADAPTIVE CAPACITY OF INSTALLATIONS

All installations have very low adaptive capacity to water supply disruptions and would rely on externally provided water due to minimal on-site water storage. All also have low tolerance for disruptions to regional wastewater treatment and most have relatively moderate capacity to manage stormwater on-site. The resilience of the region's water supply as well as the wastewater treatment capabilities at the Blue Plains WWTP are fundamental to the installations' resilience to extreme events and other stresses.





### **3 | STRATEGY FOR ENHANCING MILITARY AND COMMUNITY RESILIENCE**

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## 3.1 INTRODUCTION TO THE STRATEGY

To continue to build resilience in metropolitan Washington, collaboration between the military installations, multiple levels of governments, communities, and private entities is necessary to develop and implement actions that address risks to the installations and the surrounding communities. The development and implementation of a resilience strategy should provide the ability to adapt and mitigate against damages and disturbances caused by current and future climate impacts and other stressors and vulnerabilities. A resilience strategy should reduce the risk to human life, improve community and ecosystem health, and ensures military installations are able to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions from unanticipated and anticipated changes in the environment.

### KEY PILLARS

The recommended strategy for enhancing military and community resilience in Washington, D.C. includes **four key pillars** (see Figure 20). The four pillars are described below:

- 1. Continue collaboration and expand coordination.** The study increased collaboration among stakeholders in metropolitan Washington who share an interest in increasing resilience of the installations and the communities around them. Continuing coordination, sharing of activities and best practices, leveraging expertise, and integrating planning efforts will further assist in prioritizing resilience efforts within the region. The strategy identified several specific coordination measures beyond the completion of the study.
- 2. Advance implementation of priority physical and policy measures to address vulnerabilities.** This study identifies 14 priority measures that could address the vulnerabilities identified in the vulnerability assessment. This chapter (under Pillar 2) provides details on these top priority measures to help the installations and key partners and stakeholders move forward with applying for funding and implementation.
- 3. Continue to advance military installation resilience through inside-the-fence measures.** The scope of the study focuses on resilience measures outside the fence that would benefit the four installations and surrounding communities. Measures taken on the installations may also be necessary, and in some cases, be more effective at addressing identified vulnerabilities. Further work is needed to identify the specific on-base vulnerabilities and appropriate resilience measures, and paths for successful implementation of such measures.
- 4. Foster an environment that prioritizes resilience.** The study identifies barriers that may hinder military and community resilience efforts. The strategy highlights ways to overcome barriers to building resilience and increase collaboration to help achieve desired outcomes.

## Pillars of resilience

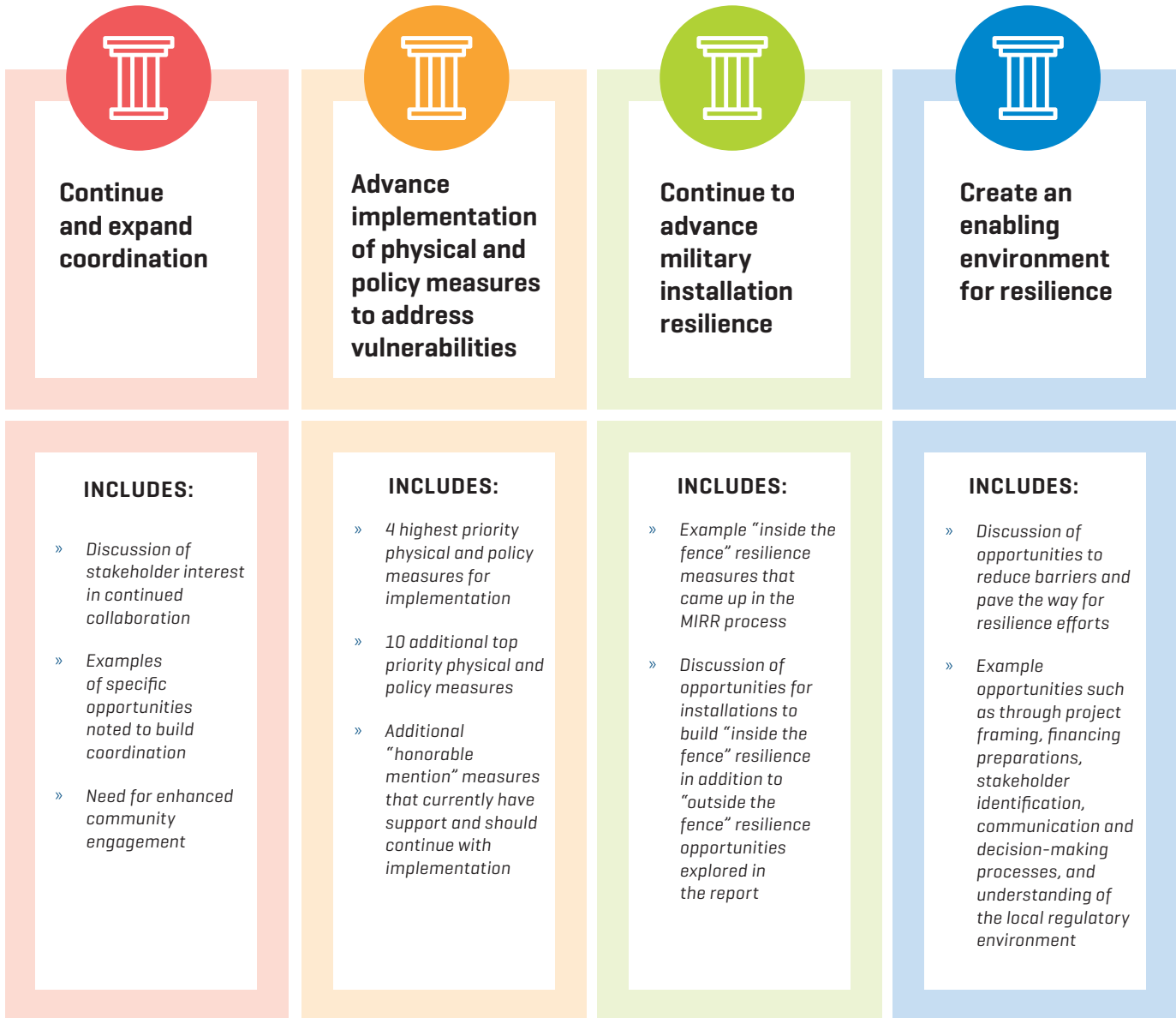


Figure 20: Overview of the Strategy for Enhancing Military and Community Resilience in Washington, D.C

## OVERARCHING PRINCIPLES FOR IMPLEMENTING THE RESILIENCE STRATEGY

To implement a resilience strategy, a set of overarching principles will assist in promoting long-term success, including:

**Think and act holistically.** The approach to installation resilience should be holistic; each installation does not operate in isolation from their surrounding communities or fellow installations. The implementation measures identified in this report should be executed with input and support from key stakeholders that are vital to the success of each measure and any that may be affected by the measures' outcomes. A holistic approach not only avoids potential unintended consequences in resilience efforts, but also helps to generate buy-in among key stakeholders and those affected, which can help drive the long-term success of resilience efforts. Further, intentional community involvement that incorporates equity can assist in mitigating historic injustices and build stronger, more resilient communities, as disadvantaged communities are also those that face greater vulnerabilities to climate hazards and other threats.

**Consider multiple time frames.** The resilience strategy should identify measures across multiple time frames. The strategy should weave short-term, achievable targets with long-term measures that require greater time and resources but have greater potential to be transformative. Plans should be organized around short-, medium-, and long-term time horizons to consider threats that must be addressed immediately and identify threats that may become more prevalent with time.

**Embrace flexible pathways.** Flexibility is paramount to a successful long-term effort. Multiple variables can change over time, including but not limited to military missions, infrastructure at the installations, the community organizational structure, the community infrastructure, the environment, and the nature of the threats and vulnerabilities. A community- and installation-wide approach to monitoring and evaluating vulnerabilities as well as implementation of the resilience strategy is essential. Key stakeholders can assist in analyzing the successes of the resilience strategy, what needs modification, and what should be abandoned due to failures or significant changes identified by the vulnerability monitoring and evaluation system.

**Emphasize equity.** Integrating an equity lens into the development and implementation of resilience strategy and specific measures is critical to addressing the needs of surrounding communities, particularly those living in underserved areas. Historically disadvantaged, vulnerable, and/or marginalized communities including people of color, low-income, elderly, and others have been disproportionately impacted by environmental threats, and are often the most vulnerable in the event of an emergency. It is imperative that the needs of people in these groups are prioritized and that their communities are consulted in the development and implementation of resilience solutions. The vulnerability assessment and development and prioritization of resilience strategies were conducted with equity in mind.

**Prioritize resilience.** Having decision-makers who understand the importance of prioritizing resilience is often a key factor in the successful funding and implementation of resilience measures. When presenting a potential measure to those in charge of implementation and funding decisions, partners should describe all the factors that make a particular initiative valuable—how it was prioritized, what vulnerability(ies) it addresses, why it would be cost-effective, and any co-benefits that it provides besides resilience. Each of the top-14 resilience measures presented in this report in Pillar #2 below provide key details to help describe and make the case for the measure, including key partners and stakeholders who should collaborate on implementation, costs, and potential options for funding, and the benefits of the measure.

## 3.2 PILLAR #1—CONTINUE AND EXPAND COORDINATION

The study brought together military installations, government agencies, utilities, and other key stakeholders with a vested interest in increasing the resilience of the installations and the communities around them.

These stakeholders assisted to refine a short list of physical and policy measures to address priority climate vulnerabilities identified through the vulnerability assessment.

Additionally, stakeholders emphasized the need to continue and build upon the increased communication and coordination with one another that the MIRR study helped foster. **They voiced that continued collaboration beyond this study will be vital to the success of regional resilience efforts.**

Common themes that emerged include increased collaboration and information-sharing for both routine investment and planning efforts and emergency response preparedness; bringing other stakeholders, both inside and outside the fence, to the table for specific projects; strengthening relationships to improve quality of programs or services; and coordinating on study implementation.

Several specific recommendations for continued coordination that the stakeholders discussed are provided below. They were not prioritized or scored but should be seen together as examples of how to continue conversations and information-sharing enabled by the study that are already benefiting many of the stakeholders involved.

- » **Continue dialogue** between military installations, service providers, the D.C. government, COG, and community organizations to build on efforts aimed at enhancing resilience beyond the MIRR study. Continuing to convene the project MIRR TAC on an ongoing basis is one mechanism to ensure this happens. The TAC was instrumental in gathering the information needed for this study, these stakeholders can help ensure that critical information continues to be shared across partners

## RECOGNIZING LOCAL EXPERTISE AND PRIORITIZING COMMUNITY PARTNERSHIPS — ENGAGE COMMUNITIES EARLY IN MEASURE IMPLEMENTATION

This project presents a variety of potential resilience measures, ranging from investment in affordable housing and workforce development to construction of flood-resilient infrastructure.

As many of the measures would be located in communities outside the fence or benefit the surrounding community, it is **imperative that those communities be engaged early** to design, implement, and evaluate each measure. All efforts to engage with the communities should be meaningful to them and create a genuine sense of being valued as a source of knowledge. These outreach activities should aim to increase participants' understanding of the project, build their comfort and confidence in the participatory process, and ensure that their concerns and recommendations are being received and reflected at the decision-making level.

Additionally, many of the proposed measures are described at a high level (e.g., investing in affordable housing), recognizing that entities such as Advisory Neighborhood Commissions (ANCs), Business Improvement Districts (BIDs), and the Anacostia Parks and Community Collaborative (APACC) already understand and advocate for local needs and should be recognized as experts in building out these measures.

as the resilience measures are implemented, which will improve overall awareness and coordination of regional resilience efforts. This coordination could also be instrumental in ensuring that funding for the proposed measures is available in the near-term (e.g., via coordinated/joint proposals) and the medium- and long-term (e.g., via coordinated articulation of needs that require legislative action).

- » Strengthen lines of communication between infrastructure service providers (including providers for both on- and off-base military facilities), agencies and installations to **ensure that all the installation staff are aware of which service providers to contact for different needs** and vice versa. Service providers should communicate with all relevant installation facility staff.
- » Coordinate on specific ongoing efforts to **ensure community and installation resilience objectives are achieved**, including:
  - **Blue Plains Microgrid project lead, stakeholders, and funding/support organizations** (e.g., D.C. Water, Pepco, Washington Gas, ANCs and BIDs, ICPRB, FEMA, OLDCC) **coordinate throughout project**, from scoping through implementation and evaluation to share relevant information, context, and input (such as by establishing and attending routine stakeholder meetings).
  - **Washington Suburban Sanitary Commission (WSSC) and D.C. Water** enhance interconnections between water supplies and **harmonize emergency responses**, accounting for differing regulatory bodies.
  - Organizations involved in **studying and implementing stormwater control measures** (i.e., D.C. DOEE, DDOT, WMATA, D.C. Silver Jackets, D.C. Water and D.C. Flood Task Force members) establish lines of communication, including scheduling regular meetings, if necessary, with the goal of collaborative implementation (including stormwater capture pilots, increasing GI projects, and policy development for storage/use of stored stormwater).
  - All organizations **invite key stakeholders** and parallel actors inside and outside the fence **when conducting emergency response preparations**, such as tabletops, small-scale exercises, and drills, to increase information-sharing. Leverage these times as opportunities to discuss specific resource needs and supply expectations. Stakeholders may include representatives from installations, utility and telecommunications service providers, first responders, hospitals (including the new hospital in Ward 8 that is currently under construction), communities, and state regulatory organizations.
- » **Coordinate on critical activities** that affect community and installation resilience, such as:
  - **Modifying on-base energy and water resilience assets.** Increase coordination between installations and local utility service providers when modifying on-base energy and water resilience assets (e.g., backup power) on processes (e.g., interconnection; fuel supply), permitting, and available incentives or co-investment.
  - **Ensuring that water and power service providers are informed about installations' needs and capacity.** Installations should ensure that power and water service providers are informed about installations' future energy and water consumption needs and backup power availability so that sufficient traditional infrastructure (e.g., wires and pipes) will be available and infrastructure alternatives can be thoughtfully reviewed (e.g., investing in non-wires alternatives to meet load growth expected due to data servers and EVs).



- **Understanding telecommunications needs.** Telecommunication asset owners/operators should work with installations, service providers, and communities dependent on communications services to understand key needs and dependencies to be able to mitigate priority vulnerabilities with a focus on measures that benefit both nearby communities and installations.
  - **Implementing Resilient D.C. measures.** All stakeholders should coordinate the implementation of Resilient D.C. measures. In particular, the measures under “Goal 2: Climate Action” support the vision for Washington, D.C. “to be climate resilient by 2050.” These include incorporating climate projections into land use, building regulations, and capital investment; measuring and tracking climate risk (exposure and vulnerability) and adaptation progress; and a campaign to significantly reduce the UHI.
  - **Coordinating response plans for outage scenarios** expected to occur under future climate conditions (e.g., severe storm, prolonged heat wave). Service providers, installations, and other key stakeholders should develop mechanisms that facilitate climate-related extreme event planning, such as adding climate resilience planning to the agendas of routine meetings between installation representatives and service provider account managers, or initiating standing meetings or working groups dedicated to this goal. Planning discussions can begin with key information-sharing and build from there. Where possible, identify opportunities to further prioritize community needs in extreme events.
    - For example, Pepco has identified an opportunity to implement non-wires solutions for an asset that serves installations and is projected to be overloaded by high temperatures under future climate conditions. Pepco could share information about these vulnerabilities and identified resilience opportunities in planning discussions with the installations (and Dominion Power, which is responsible for distribution at Fort McNair), and together they could explore opportunities to leverage OLDCC grant program funding for solutions that will increase the installations’ energy resilience as well as support the grid, and thus surrounding communities.
  - **Ensuring pre-coordination / credentialing for maintenance and repair crews** to get through blockage and roadblocks during incident response. Potential security and logistical complexities involved in implementing this measure would need to be accounted for and/or resolved.
  - **Developing joint installation/District emergency evacuation plans** between installations and D.C. agencies.
- » **Strengthen intergovernmental relationships between Federal** (e.g., Administration for Children and Families), **city** (e.g., D.C. Child and Family Services Agency and D.C. Childcare Connections), **and community-level entities** (e.g., Far Southeast Family Strengthening Collaborative and Ward 8 Family and Child Development) **to improve access to funding opportunities and to quality and availability of childcare services** in Ward 6 and 8. Installations can also be included, for example, some local children attend JBAB’s LEARN Charter School. The installations may benefit from this through improved local childcare services.
  - » **Share maps of future projected flooding** in D.C. generated in D.C. DOEE’s integrated flood modeling study (started in 2022) **with installations, infrastructure owner-operators, and agencies for use in planning and risk management** (e.g., D.C. HSEMA can consider projected flood areas when updating the District Hazard Mitigation Plan; telecommunications asset owners can use floodplain data layers for asset risk management).

For all measures, **equity should be considered in coordination, design, implementation, and evaluation.** Organizations such as APACC, BIDs, and ANCs have a deep understanding of local community needs and priorities; meetings they hold, materials they publish, and experts within these organizations should be consulted as key resources in building out each measure. For example, one of the coordination measures recommends sharing results of a flood modeling study with infrastructure owner-operators and agencies for use in planning and risk management. Before this measure is taken, key partners and stakeholders should consider whether it could have negative side effects. For example, if indicating flood vulnerability areas could have negative impacts on property values in flood-prone areas that are flood-prone due to historic disinvestment and are areas with high concentrations of low- and middle-income populations, flood modeling outputs should come with caveats around use for cost-benefit analyses in real estate valuations, and should be updated to reflect resilience advancements.

### 3.3 **PILLAR #2—ADVANCE IMPLEMENTATION OF PHYSICAL AND POLICY MEASURES TO ADDRESS VULNERABILITIES**

The MIRR study identifies several priority physical and policy resilience measures to address the vulnerabilities identified in the vulnerability assessment. Using prioritization criteria, these measures were discussed during the stakeholder engagement process to determine a high priority “short list” of resilience measures. Details on this approach are provided in Appendix B: Resilience Measure Prioritization Process. The full list of other physical and policy measures considered can be found in Appendix C: Resilience Measures Considered.

#### **TOP PRIORITY PHYSICAL AND POLICY MEASURES**

Stakeholders selected the top 14 physical and policy measures from a prioritized shortlist. These 14 measures are listed in relative priority and are based on installation and stakeholder support, with the measures receiving the strongest support from installations indicated with a star.

Each of the following 14 measures includes an overview of key details to assist the installations and other actors carry the measure forward. These include a description of the measure, what vulnerabilities it would address, its benefits—including to the installations, community, economy, and environment—social and equity considerations, costs and potential funding sources, key partners and stakeholders who should collaborate on implementation, next steps, and additional useful information. **For all measures, next steps should involve establishing a monitoring plan, which would feature metrics for measuring the effectiveness of the measure to help adjust implementation as needed. The monitoring plan can be based in significant part on the short-, medium-, and long-term next steps that are identified for each measure.**

Note that beyond the stakeholders listed as leads and partners, others including the installations, affected communities, and the D.C. government are key stakeholders for all measures.

Funding for these measures could come from a variety of sources, including many Federal grant programs. Additionally, the Bipartisan Infrastructure Law (BIL) has resulted in \$3 billion in funding for Washington, D.C. infrastructure investments. The D.C. Build Back Better Infrastructure Task Force has identified opportunities for using this funding, including accelerating the timeline for implementing the recommendations from the D.C. Climate Resilience Plan, deploying EV charging infrastructure, improving transit mobility and equity, and expanding training and job opportunities. The BIL and the Inflation Reduction Act of 2022 represent key opportunities to fund local-level resilience projects and should be considered by those implementing the measures described below.



**STARS INDICATE MEASURES WITH STRONGEST SUPPORT FROM INSTALLATIONS**



# RETROFIT STORMWATER PUMPING STATIONS



## MEASURE DESCRIPTION

Stormwater pumping stations (SWPS) help move water and prevent flooding during heavy rain events.

**Ensuring these pumping stations can withstand flooding is important to increase resilience to flooding District-wide.**

D.C. Water owns and is currently in the process of upgrading D.C.'s 16 SWPS to improve their resilience, prioritizing the order of upgrades based on risk scores calculated by the agency. The proposed work includes retrofitting systems and structural/architectural elements; making flood-hardening modifications and increasing capacity as needed; and increasing the reliability of power at the stations.

**This measure entails providing additional funding for these upgrades—particularly dual power feeds, which require higher investments but would make the SWPS more resilient to power outages during events.** Helping to fund the SWPS upgrades could hasten the schedule of implementation (thus providing benefits, including cost savings from avoided damages, sooner) and increase the viability of implementing dual feeds (or other resources for reliable power that the D.C. Water determines as most suitable). Funding could be targeted for the pumping stations in the communities surrounding the four installations.



## VULNERABILITIES ADDRESSED

Climate change is projected to increase flood frequency and intensity; SWPS and other District infrastructure are exposed to flooding, and not all pumps are currently built to be resilient to flooding.

Energy supply to pumping stations has the potential to be disrupted during flooding events. **An offline pumping station would lead to more intense (and disruptive/damaging) localized flooding until the station came back online or the floodwaters**

**receded themselves.** In the past, an offline pumping station led to delayed evacuations and standstill traffic during a hurricane.

**The installations would benefit from retrofits to pumping stations—not just those directly adjacent to the installations—due to the pumping stations' role in ensuring transportation infrastructure is safe and usable during flood events.**



## SOCIAL & EQUITY CONSIDERATIONS

Include equity in prioritizing and sequencing retrofits (along with flood vulnerability) to ensure that benefits are felt by communities most in need. To avoid undue burdens to

communities due to construction-related disturbances, D.C. Water should engage the community to facilitate minimally invasive construction.



## BENEFITS

Retrofitting SWPS to be flood-hardened, have reliable power, and increased capacity (at four stations) will help ensure that they remain functional during flood events and can pump away stormwater—**meaning both they and surrounding infrastructure are less vulnerable to floods.**

### Installations:

Retrofitting pumping stations, particularly near installations and major transportation routes, will help bolster flood resilience of installations.

### Community:

If pumping stations are prioritized in historically disadvantaged neighborhoods, those residents directly benefit from increased flood resilience. All transportation users benefit from upgraded SWPS, which help ensure that the system is available during wet weather and reduces the likelihood of flood-related accidents.

### Economy:

Property values, infrastructure, and local economies benefit from reduced flooding. If the stations cannot operate, then there is economic loss due to reduced traffic as well as potential for flood-related accidents.



# RETROFIT STORMWATER PUMPING STATIONS

## COLLABORATION

**Key partners:** D.C. Water

**Stakeholders:** Electric utility (Pepco) for installing dual power feeds



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

- » The funding amount that would expedite the schedule of retrofits and increase the viability of installing dual feeders or other reliable power solutions at pumping stations is yet to be determined.
- » Currently, D.C. Water has planned for \$54 million in rehabilitation and upgrades for the next 10 years and has already spent \$3.6 million on retrofits.

### Potential funding sources:

- » D.C. Water
- » Department of Defense (DoD) Office of Local Defense Community Cooperation (OLDCC) grant programs
- » Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) grant program
- » FEMA Flood Mitigation Assistance (FMA) program, if the pumping stations are insured by the National Flood Insurance Program

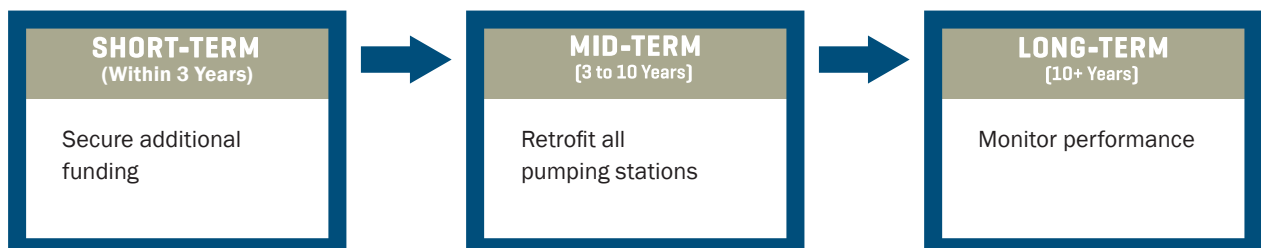


## NEXT STEPS

D.C. Water has programmed funding in their capital fund to conduct SWPS retrofits through 2032. Next steps involve implementing D.C. Water's capital improvements program for the retrofits, coordinating with Pepco, and securing additional funding. On the funding side, D.C. Water should coordinate with Metropolitan

Washington Council of Governments (COG) and the installations to identify where and how much additional funding would be strategically applied to expedite the retrofit schedule and increase the viability of installing reliable power solutions. To help ensure the retrofits confer their planned resilience benefits, D.C.

Water could revise the maintenance plan as needed and monitor performance, particularly during flood events. If possible, D.C. Water should quantify volume of stormwater pumped and its ability to stay online during outages to help collect data on efficacy of this strategy.







# RETROFIT STORMWATER PUMPING STATIONS



## ADDITIONAL DETAILS

### (RELEVANT WORK TO DRAW ON:)

- » Funding and support from OLDCC grant programs can help fast-track the implementation of the planned retrofits and free D.C. Water's resources for competing projects, including more expensive retrofits (e.g., dual-power feeds). D.C. Water could apply for funding from the FEMA BRIC program to further provide for procurement and installation of reliable power solutions.
- » Pepco's involvement would be related to installing dual-power company feeds at SWPS to improve the stations' power reliability. D.C. Water is currently (2022) evaluating resources for reliable power and has expressed a preference for dual feeds, but other options are on the table.
- » Previous climate events have highlighted the risk of not floodproofing the stations and otherwise building their resilience. During Hurricane Irene in 2011, the 14th Street Bridge SWPS flooded, which caused traffic backup on I-395 (a major evacuation route for D.C.) for several hours. After this event, D.C. Water applied for fiscal year (FY) 2014 FEMA Pre-Disaster Mitigation (DPM) funding and was awarded \$2.1 million to floodproof the 14th Street Bridge station. This work included both dry floodproofing (i.e., waterproof membrane, sealing entry points, and flood door/hatches) and wet floodproofing (i.e., submersible pumps, elevating equipment, and sump pumps). Work completed in August 2020.







# ASSESS AND ADDRESS KEY CLIMATE RISKS TO TELECOMMUNICATIONS SYSTEMS



## MEASURE DESCRIPTION

Government actors, non-governmental organizations, and telecommunications providers operating in the area should work together to (1) identify key specific risks that climate hazards may pose to critical telecommunications assets and (2) ensure that service providers and relevant government stakeholders have the resources needed to manage risks and build resilience to climate change.

First, actors that have completed or are developing telecommunications asset vulnerability and climate risk studies (see Collaboration and Additional Details sections below) should share results from these studies with telecommunications

providers in a format that telecommunications providers can use for risk management (e.g., geospatial hazard layers). Then they should synthesize findings to identify key risks and resilience measures to address them and undertake additional analyses, if they are needed to accomplish this task.

If telecommunications providers are equipped with information about key climate hazards, they can make better-informed decisions about how to upgrade, design, or relocate existing facilities and where to site future infrastructure, which will ultimately result in more resilient communications systems.



## VULNERABILITIES ADDRESSED

Critical telecommunications assets (e.g., transmission towers and above-ground fiber optic and coaxial cables and associated facilities) vulnerabilities to hazards including ice storms and high winds.

Other telecommunications assets may also be at future risk of flooding

and/or power grid instability. These include central offices (COs), internet exchange points, cable head-ends, broadcast transmission sites/towers, and satellite ground stations, as well as hybrid communications/IT assets like cloud and edge computing centers.



## SOCIAL & EQUITY CONSIDERATIONS

Increasing communications resilience may particularly benefit populations that face higher vulnerability or have less capacity to cope if communications systems go down.

Telecommunications service providers should also work with Advisory Neighborhood Commissions (ANCs) and Business Improvement Districts (BIDs) to understand how outages and construction could impact different

populations, and reflect community needs in resilience implementation plans and outage restoration plans.

Additionally, the quality of communications services and assets' resilience should be studied alongside wealth indicators to assess if the system is stronger in wealthier areas, and if it is, resilience investments should be prioritized to mitigate this inequity.



## BENEFITS

### Installations:

Installations use the civilian telecommunications system, with alternate, contingency, and emergency options to ensure service continuity. Addressing vulnerabilities to this system will increase the likelihood that installations can continue to communicate with their normal methods in emergencies.

### Community:

Increased ability of support systems (e.g., first responders, service providers, community-based organizations, nonprofits) to continue communicating and coordinating to serve the community during events.

### Economy:

Increased capacity of the local economy to continue operating during disruptive events.

### Environment:

Potential for environmental benefits if nature-based resilience measures are applied (e.g., to manage flooding).



# ASSESS AND ADDRESS KEY CLIMATE RISKS TO TELECOMMUNICATIONS SYSTEMS

## COLLABORATION

**Key partners:** D.C. HSEMA and telecommunications service providers

**Stakeholders:** Local and federal government actors (e.g., COG, DOE National Labs, CISA, FEMA), electric service providers, Communications Sector Coordinating Council first responders, Army Corps of Engineers (Baltimore District), and other major users



## COSTS & FUNDING OPPORTUNITIES

### Assessment costs:

- » Risk assessments to identify and inform the design or protection of critical equipment, buildings, and infrastructure may have a range of costs (\$25,000–\$250,000+) depending on the level of detail needed and the scope of the study.

### Implementation costs such as upgrades:

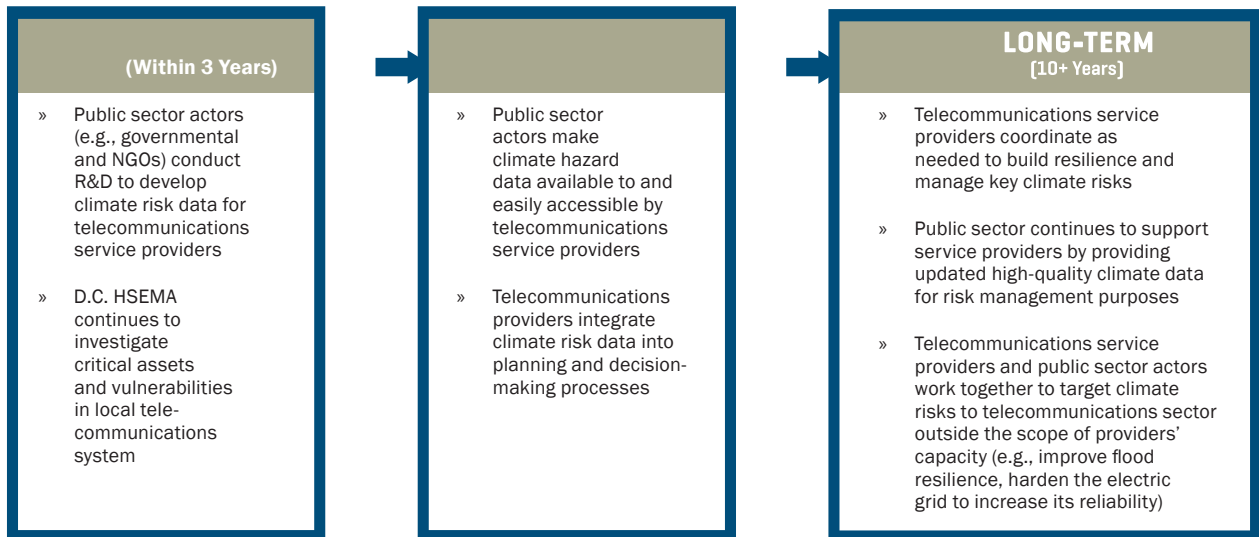
- » Undergrounding wires may cost ~\$25,000 to \$1,500,000 per mile, recognizing the need to ensure against flooding risks for buried lines. Additional equipment may be used to increase reliability and capacity, each of which will have unique unit costs.
- » Additional equipment may be used to increase reliability and capacity, each of which will have unique unit costs.

### Potential funding sources:

- » Department of Defense Office of Local Defense Community Cooperation (OLDCC) grants to fund additional risk assessments as needed
- » FEMA Building Resilient Infrastructure and Communities (BRIC) Program grants
- » Homeland Security Grant Program (HSGP) grants
- » National Telecommunications and Information Administration grants



## NEXT STEPS







# ASSESS AND ADDRESS KEY CLIMATE RISKS TO TELECOMMUNICATIONS SYSTEMS



## ADDITIONAL DETAILS

### Relevant work to draw on:

Recent efforts by D.C. HSEMA, COG, and others represent first steps toward identifying key vulnerabilities and measures to address them, as well as analyses that may represent first steps toward a cohesive resource for publicly available climate hazard data. For example:

- » D.C. HSEMA is conducting a study to identify and explore vulnerabilities of and dependencies on switching stations and other critical communications assets in the District. The study may identify risk mitigation opportunities and/or potential funding sources to implement them.
- » The COG Interoperable Communications Regional Programmatic Working Group (IC RPWG) is exploring communications resilience needs and opportunities.
- » AT&T's Climate Resiliency Project<sup>103</sup> involved developing maps of southeastern states (from North Carolina to Florida) that overlay climate hazards with physical telecommunications assets to inform understanding of potential climate vulnerabilities and resilience opportunities.
- » A variety of other actors have also developed datasets that may be relevant, such as DOE

National Labs (e.g., Sandia, Argonne), National Oceanic and Atmospheric Administration (NOAA) (e.g., precipitation intensity-duration-frequency [IDF] curves for the Chesapeake Bay region developed in partnership with RAND and Cornell), FEMA (e.g., Resilience Analysis and Planning Tool), the Chesapeake Bay Foundation (e.g., land cover data), USACE (e.g., D.C. Coastal Study,<sup>104</sup> in partnership with COG) and more; still others have relevant efforts underway (e.g., D.C. Department of Energy and Environment [D.C. DOEE] developing an integrated flood modeling study).

Collectively, these efforts will greatly increase the understanding of the level of vulnerability in areas of concern and opportunities to increase the resilience of new and existing equipment. Additional analysis may be needed to identify the most effective resilience measures to address key vulnerabilities. Just as important, these broader efforts will provide opportunities for sharing plans and scheduling implementation to limit service disruptions.

### Social and equity considerations:

Some programs are already working to target the digital divide, such as Federal Communications Commission (FCC) programs aimed at making broadband service and devices more affordable (e.g.,

to bridge the “homework gap”<sup>105</sup> and subsidize costs for qualifying low-income customers through the Universal Service Fund<sup>106</sup>), and a Task Force<sup>107</sup> that aims to combat digital discrimination and foster equal access. Considering broadband reliability alongside service accessibility may be a natural complement to these efforts.

### Example study costs:

A major telecommunications provider completed a Task Force on Climate-related Financial Disclosures-aligned scenario analysis covering a metropolitan region for \$35,000 that:

- » Reviewed the disclosures and activities of the provider and their peers
- » Identified seven critical assets and assessed physical climate risks to each asset site under a high-emissions scenario (2035 and 2060 time horizons), for both chronic and acute climate hazards
- » Identified key threats and mitigation opportunities for each asset, and prioritized the assets for additional studies and assessments
- » Created a roadmap for further analysis, including recommended additional assets to study

More complex analyses could have commensurately higher costs.









# SUPPORT BLUE PLAINS FLOODWALL CONSTRUCTION



## MEASURE DESCRIPTION

This measure focuses on providing support for continued construction of the Blue Plains Advanced Wastewater Treatment Plant (AWTP) floodwall, which is currently seeking Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure Communities (BRIC)

program grant funding to cover 70% of the design-build contract for segments A, B, and D (segment C was completed in 2021). D.C. Water is coordinating with the Naval Research Laboratory (NRL) on implementation, as the facility (and segment D of the floodwall) abuts the installation.



## VULNERABILITIES ADDRESSED

The Blue Plains AWTP is vulnerable to sea level rise, storm surge, and flooding. FEMA flood maps indicate that already, a 500-year flood would inundate the structures in the treatment plant, which would halt operations—with significant impacts to public health and the environment. Hurricane storm surge

in the Chesapeake Bay and Potomac River is the highest water level threat to inundate the Blue Plains AWTP. To mitigate this vulnerability, D.C. Water has designed a floodwall around the facility to protect it from a 500-year flood + 3 feet of freeboard and needs funding to construct the remaining segments.



## SOCIAL & EQUITY CONSIDERATIONS

If flooding halted facility operations, vulnerable communities who have fewer resources for alternatives

(e.g., securing portable toilets) could experience greater disruption and health risks.



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

- » Total project costs for the remaining segments of the floodwall are estimated at \$29 million. D.C. Water is applying for a FEMA BRIC grant to cover 70% (i.e., \$20.3 million) of the design-build contract for the remaining segments A, B, and D (segment C and three other segments—portion of the Final Dewatering Facility, portion of Filtration and Disinfection Facility, and part of the Enhanced Nitrogen Removal Project—have been constructed). The remaining 30% (i.e., \$8.7M) will need to be covered by a local match.

### Potential funding sources:

- » Planning for segments A, B, and D is partially funded by the D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA) under the FEMA Flood Mitigation Assistance (FMA) Program.
- » D.C. Water has applied for FEMA BRIC grant program funding to cover 70% of the design-build contract (i.e., \$20.3 million).
- » For the other 30% (i.e., \$8.7 million), the Department of Defense (DoD) Readiness and Environmental Protection Integration (REPI) program could provide the remaining funding as needed to complete the local match portion of the FEMA BRIC grant.



## BENEFITS

The Blue Plains AWTP operates 24/7, every day of the year and serves customers in D.C., Maryland, and Virginia. It is crucial that the facility is protected from flooding so that it can remain operational.

### Installations:

The floodwall would help ensure the installations have reliable sewage treatment. In addition, Joint Base Anacostia-Bolling (JBAB) and NRL are nearby and could potentially be affected by a spill if Blue Plains were to flood. There is also potential for NRL and JBAB to coordinate with D.C. Water to connect the floodwall with walls at the installations to provide further protection to the installations.

### Community:

The public and businesses depends on continued operation of Blue Plains AWTP for wastewater services.

### Environment:

If the facility were to be flooded and halt operations, untreated wastewater could pollute the rivers.



# SUPPORT BLUE PLAINS FLOODWALL CONSTRUCTION

## COLLABORATION

**Key partners:** D.C. Water

**Stakeholders:** Electric utility (Pepco) for installing dual power feeds

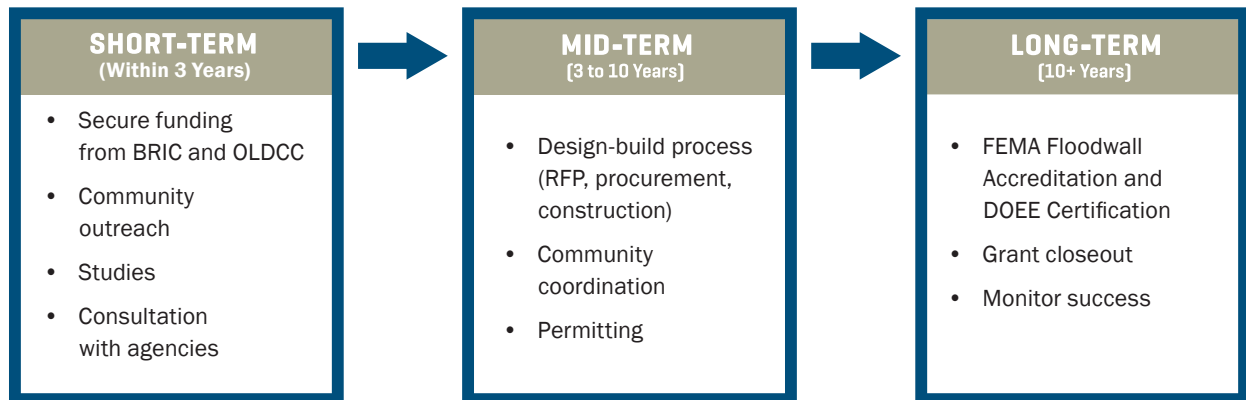


## NEXT STEPS

In 2022-2023, D.C. Water and partners should conduct consultation with permitting agencies, community outreach and coordination, and engineering studies to ensure that the floodwall provides the maximum benefits (e.g., potentially partnering

with NRL to extend the floodwall) and avoids unintended negative consequences. D.C. Water should implement the design-build process by the end of 2026, which will include a request for proposal (RFP), procurement, and construction.

In 2026 and beyond, D.C. Water should seek FEMA Floodwall Accreditation and D.C. Department of Energy and Environment (D.C. DOEE) Certification, close out its grant(s), and monitor success in preventing flooding .



## ADDITIONAL DETAILS

D.C. Water has already completed one segment of the floodwall (segment C). In FY 2016, D.C. Water applied for Pre-Disaster Mitigation (PDM) funding and was awarded to protect the Blue Plains AWTP from flooding. After completion, FEMA identified the Blue Plains floodwall as a best practice for the newly established FY 2020 FEMA BRIC Program.

Stakeholders to the existing endeavor include D.C. DOEE, NRL, National Marine Fisheries Service, and U.S. Army Corps of Engineers (USACE). D.C. Water is currently working with a variety of partner agencies to ensure the successful completion of this critical project, including FEMA and D.C. HSEMA. Regular updates will also

be provided to members of Advisory Neighborhood Commission (ANC) 8D; Ward 8 representatives in the Mayor’s Office of Community Relations and Services; and Ward 8 Councilmember Trayon White, Sr. and members of his staff.

While the specific selection of materials for each of the remaining segments of floodwall will be up to the design-builder, the scope of work as laid out by D.C. Water entails the following:

- **Segment A** – Install 1,060 feet of sheet piles to raise the elevation of the existing seawall

- **Segment B** – Install 1,490 feet of Cantilever reinforced concrete retaining wall
- **Segment D** – Install 975 feet of Jersey-Barrier Type Wall

Additionally, the study recommends that D.C. Water conducts a new flood analysis using climate change projections, as the previous flood analysis that identified the Blue Plains AWTP as vulnerable to the 500-year flood was based on historical data, and climate change is projected to increase the intensity and frequency of flood events. As such, the design of the floodwall may need to be changed to accommodate the greater threat of flooding posed by climate change.









# ENSURE LOWER ANACOSTIA WATERFRONT REDEVELOPMENT IS RESILIENT



## MEASURE DESCRIPTION

The D.C. Comprehensive Plan: Chapter 19 Lower Anacostia Waterfront/ Near Southwest Area Element states that resilient design is critical to mitigating flooding and ensuring the Lower Anacostia Waterfront/ Near Southwest Planning Area is a thriving waterfront community. Moreover, the D.C. Comprehensive Plan requires the District to conduct flood resilience studies and plans for all the communities affected by the 100-year and the 500-year floodplains under the program Resilient Focus Areas (RFA). D.C. Department of Energy and Environment (D.C. DOEE) is tasked with implementing the RFA program in conjunction with local and federal partners. D.C. Office of Planning (DCOP) should work to support D.C. DOEE's RFA program with D.C. DOEE to assess the area's current and future flood vulnerability, establish resilient guidelines for development (similar to the Buzzard Point Design Guidelines), monitor changes in flooding potential due to increased development, and implement flood resilience measures throughout the Planning Area during the redevelopment.

Poplar Point is a key redevelopment site in the Planning Area that could become a model for resilient design everywhere else by protecting and expanding natural flood resilience assets such as the existing wetlands, re-establishing Stickfoot Creek, and appropriately designing for the high risk of tidal flooding. Currently, the D.C. Deputy Mayor for Planning and Economic Development (DMPED) is leading the environmental planning effort in preparation for an environmental impact statement (EIS) for the Poplar Point site. DMPED should work in partnership with D.C. DOEE and DCOP to create a Poplar Point redevelopment plan that is rooted in flood-resilient design and environmental restoration as well as equity. On the north side, D.C. DOEE and other local agencies have been engaging Fort McNair for years over its vulnerability to both riverine and tidal flooding as well as, most recently, interior flooding. Fort McNair should continue to hold joint meetings with local agencies to better coordinate on flood vulnerability that affects both the base and the community around it.



## VULNERABILITIES ADDRESSED

Water levels in the Anacostia River increased by nearly 1 foot over the past 90 years due to sea level rise and subsidence and will continue to increase in the future. By 2045, days without tidal flooding will be

the exception rather than the norm. Additionally, the Anacostia has historically received less investment than the Potomac; improvements targeted in this Planning Area can correct this imbalance.



## BENEFITS

The redevelopment of this Planning Area presents an opportunity to build climate resilience in a way that is environmentally friendly, sustainable, and equitable. Intentionally prioritizing resilience as the area grows and develops can protect the community and D.C.'s investments for decades to come.

### Installations:

Fort McNair, Washington Navy Yard (WNY), and Joint Base Anacostia-Bolling (JBAB) are within the Planning Area and will benefit from resilience improvements.

### Community:

This Planning Area is more racially and economically diverse than the rest of D.C.; building resilience here can promote environmental and climate justice.

### Economy:

This Planning Area is projected to experience huge growth in both population and jobs. Building resilience will help ensure that this growth is not undermined by climate change.

### Environment:

The Area Element encourages natural function of floodplains and incorporating natural shorelines, which would benefit the natural environment.



# ENSURE LOWER ANACOSTIA WATERFRONT REDEVELOPMENT IS RESILIENT



## SOCIAL & EQUITY CONSIDERATIONS

When implementing this strategy, the key partners and stakeholders should aim to include the following considerations in order to make the redevelopment more equitable:

- » Ensure that the resilience benefits are shared by the public housing units in the area.
- » Involve residents of public and affordable housing in the planning process to ensure that the flood-resilient design

elements are accessible and add value to their community—and do not cut them off from critical features.

- » Include socioeconomic mapping in the flood assessment to understand the flood vulnerability of disadvantaged populations.

It is important when engaging with disadvantaged communities to clearly express the intent of the study, what the team seeks to accomplish, and

what can be expected throughout the study timeline. The content of the outreach should be reflective of and tailored toward the needs and wants of that group. For instance, outreach conducted for renters who may not have experience as homeowners, and therefore may not care as much about obtaining flood insurance, should focus more on the transportation/access and quality of life impacts that they may face because of flooding.

## COLLABORATION



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

Costs are dependent upon the resilience measures that are enacted and studies that are conducted. The D.C. Comprehensive Plan lists several potential measures, including:

- » Conducting comprehensive flood modeling of projected sea level rise and future flood hazard conditions. This is currently fully funded as the D.C. Integrated Flood Model project and will map all flood risk, including interior and sea level rise flood risk. The model will take several years to complete and cost around \$5 million to \$7 million.
  - If possible, D.C. DOEE would benefit from additional funding (in the range of \$1.5 million to \$1.7 million) to completely fund this flood model.
- » Identifying locations of future development that are vulnerable to flooding.

**Key partners:** D.C. DOEE, DCOP (to provide regulatory oversight and review), Anacostia Waterfront Corporation

**Stakeholders:** Fort McNair, WNY, JBAB, NCPC, National Park Service, D.C. HSEMA, Anacostia Parks and Community Collaborative

This can be conducted as an addendum to the flood modeling study. Cost: \$150,000.

- » Providing guidelines that promote resilient design and construction. Cost: \$100,000, depending on if guidance is adapted from an existing source or created specifically for this purpose.
- » Incorporating resilience measures into the rehabilitation of existing and new affordable housing. Cost: \$200,000+; highly variable, depending on the specific measures.
- » Including resilient design as an evaluation criterion in selecting projects or firms for new construction. Cost: Low.

### Potential funding sources:

- » D.C. RiverSmart Programs, D.C. DOEE
- » Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Grants including

Building Resilient Infrastructure and Communities (BRIC) grant with matched funding from a Department of Defense (DoD) Readiness and Environmental Protection Integration (REPI) grant.

- » FEMA Flood Mitigation Assistance (FMA) grant to reduce flood risk for properties, including neighborhoods, insured by the National Flood Insurance Program.
- » DoD Office of Local Defense Community Cooperation (OLDCC) grant programs may be applicable to the D.C. DOEE Integrated Flood Model project described above.
- » Bipartisan Infrastructure Law (BIL) funding allocated for D.C.
  - D.C. Build Back Better Infrastructure Task Force identified expanding recreation on the Anacostia River for all residents as a priority for investment.



# ENSURE LOWER ANACOSTIA WATERFRONT REDEVELOPMENT IS RESILIENT



## NEXT STEPS

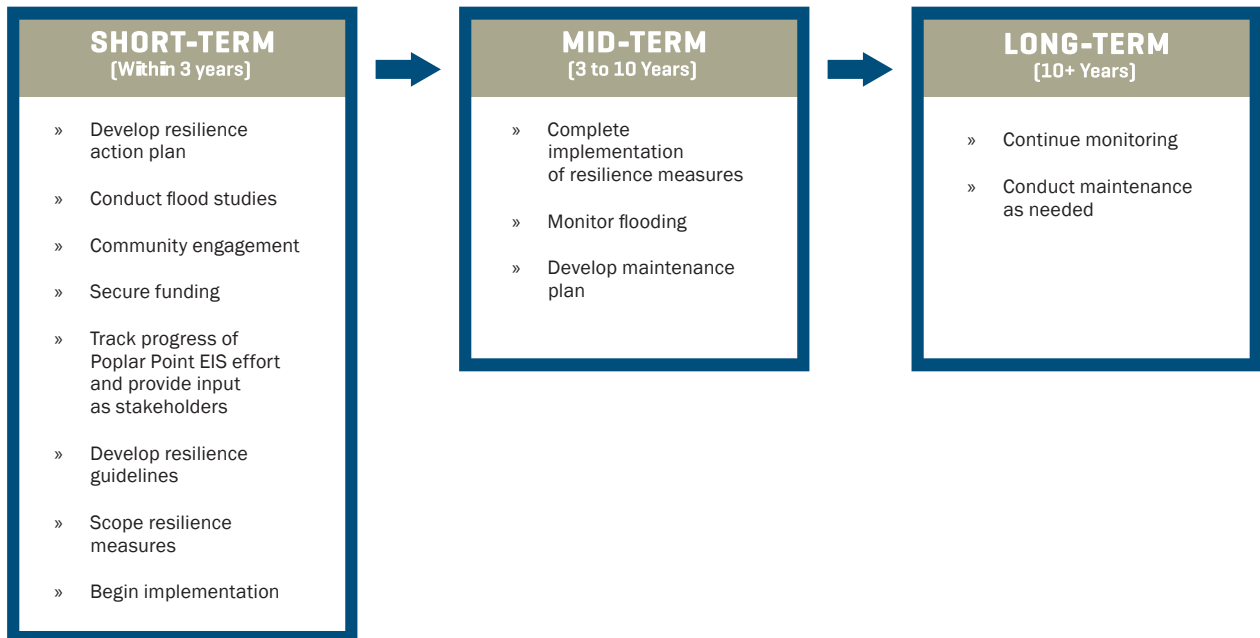
DCOP, D.C. DOEE, and partners should develop an action plan for integrating resilience into the Lower Anacostia Waterfront/Near Southwest redevelopment. This involves building off of existing flood modeling (e.g., by D.C. DDOE) and conducting additional flood modeling as necessary to identify the most vulnerable areas and opportunities for resilience measures (Comp Plan Policies AW-1.1.3 and AW-1.1.4); engaging with the community to help ensure resilience investments are equitable; encouraging or preferentially selecting resilient projects; and securing funding from OLDCC grants, FEMA BRIC, and other sources to implement resilience measures. Ongoing monitoring will

also be needed to ensure resilient designs or features are maintained, unanticipated climate changes are integrated into the overall strategy, and other projects in the area do not adversely impact the improvements.

DCOP, D.C. DOEE, and partners can implement resilience in alignment with the policies and actions of the Comprehensive Plan:

- » **Design:** Develop resilient design guidelines for the waterfront neighborhoods, new developments, and the shoreline (see Comprehensive Plan Policies AW-1.1.2, AW-1.1.5, AW-2.3.2, and AW-2.5.7).
- » **Key community infrastructure:** Incorporate resilience into affordable housing and Boathouse Row to increase climate equity (see Comprehensive Plan Policies AW-1.1.6 and AW-2.3.9).
- » **Parks:** Design parks to enhance local resilience to flooding (see Comprehensive Plan Policies AW-1.2.4 and AW-2.5.6, and Action AW-2.5.B).

After implementing resilience measures, DCOP, D.C. DOEE, and partners should continue to monitor flooding in the area to measure success and adjust resilience investments as needed.







# ENSURE LOWER ANACOSTIA WATERFRONT REDEVELOPMENT IS RESILIENT



## ADDITIONAL DETAILS

(RELEVANT WORK TO DRAW ON:)

The *D.C. Comprehensive Plan: Chapter 19 Lower Anacostia Waterfront/Near Southwest Area Element* includes key policies and actions that are called out in this measure due to their connection to climate resilience. These include:

- **General Policy:**  
AW-1.1 Guiding Growth and Neighborhood Conservation
- **Policy AW-1.1.2:**  
New Waterfront Neighborhoods
- **Policy AW-1.1.3:**  
Lower Anacostia Waterfront Infrastructure for Flood Mitigation
- **Policy AW-1.1.4:**  
Lower Anacostia Waterfront Flood Modeling
- **Policy AW-1.1.5:**  
Flood-Resilient and Climate-Adaptive Development
- **Policy AW-1.1.6:**  
Resilient Affordable Housing
- **General Policy:**  
AW-1.2 Conserving and Enhancing Community Resources
- **Policy AW-1.2.4:**  
Anacostia River Parks
- **Planning Area:**  
AW-2.3 Near Southeast/Capitol Riverfront
- **Policy AW-2.3.2:**  
Near Southeast/Capitol Riverfront Shoreline Access
- **Policy AW-2.3.9:**  
Development of Boathouse Row
- **Planning Area:**  
AW-2.5 Southwest Neighborhood
- **Policy AW-2.5.6:** Southwest Greenspaces and Parks
- **Policy AW-2.5.7:** Southwest Sustainability and Resilience
- **Action AW- 2.5.B:** Lansburgh Park
- **Planning Area:** AW-2.6 Buzzard Point
- **Policy AW-2.6.4:** Buzzard Point Resilience

When identifying ways to ensure that the redevelopment is resilient, we suggest paying close attention to these policies and actions and striving to align with and bolster them. Note, however, that these suggestions should be taken more as a starting point than a prescriptive list.

DCOP should also coordinate with D.C. DOEE, who is undertaking several relevant projects in the planning area:

- » “D.C. DOEE is embarking on a multi-year restoration planning project for the tidal Anacostia River corridor. Known as the Anacostia River Corridor Restoration Plan, this project will include robust engagement among stakeholders throughout

the District to identify implementation opportunities for enhancing resiliency, improving water quality, restoring habitat, and enhancing public access and recreation opportunities. Funding for this project is provided through a National Fish and Wildlife Foundation Chesapeake Small Watershed Grant and local funds.”<sup>109</sup> D.C. DOEE provides more information about the ARCRP on the Restore the Anacostia River website.<sup>110</sup>

- » D.C. DOEE is currently undertaking a *SW-Buzzard Point Flood Resiliency Strategy*, which will “design an integrated network of Blue/Green Infrastructure

(BGI) to protect the SW and the Buzzard Point communities from interior flooding due to extreme rain events” and also “is expected to work in concert with, and reinforce, future efforts to prevent coastal flooding due to storm surge, hurricanes and sea level rise.”<sup>111</sup> The project is set to close in March 2023, after which the agency will move forward with contracting and procurement for the construction of the first infrastructure project (specific design to be determined) with a mix of FEMA BRIC funds and a local match (about \$24 million total).







# PROVIDE FINANCIAL SUPPORT FOR THE BLUE PLAINS MICROGRID



## MEASURE DESCRIPTION

The Department of Defense (DoD) may provide financial support to D.C. Water to implement a microgrid at the Blue Plains Advanced Wastewater Treatment Plant (AWTP). The scoping and planning phase, which is already funded and expected to be complete by the summer of 2023, will be followed by plan implementation, which will require additional financial support.

The Blue Plains AWTP microgrid will increase the resilience of the wastewater systems serving installation facilities and Ward 8 communities to power outages, including those that occur due to

climate-related events (e.g., extreme storms). The microgrid is expected to incorporate existing generation, including 13.8 megawatts (MW) from a combined heat and power (CHP) plant, as well as 3.4 MW from on-site solar photovoltaic (PV) systems, and may include additional generation sources and battery storage. The microgrid implementation plan will also include electrical distribution system improvements, increased data collection and analyses to inform decision-making, and coordination with other actors (e.g., working with Pepco on planning and engineering efforts, and revising existing power purchase agreements as needed).



## VULNERABILITIES ADDRESSED

The Blue Plains AWTP depends on reliable power, and extreme heat and storms can lead to electric grid blackouts or reduced power availability. The facility serves all of D.C., including the installations, and so an interruption in power at this facility could result in a temporary loss of wastewater treatment or even sewage backup into Department of Defense (DoD) buildings and roadways, posing risks to military missions as well as to human health and the environment.

Due to its location adjacent to the Naval Research Laboratory (NRL) and near Joint Base Anacostia-Bolling (JBAB), there may also be potential to establish a public-purpose microgrid or to segment portions of the Blue Plains microgrid so that it can serve these military installations under certain conditions, through joint project planning and development between D.C. Water, DoD, Pepco, and Washington Gas (regarding gas supply to the CHP unit).



## SOCIAL & EQUITY CONSIDERATIONS

A microgrid could be a source of energy resilience and jobs (e.g., construction) for vulnerable communities. By improving wastewater treatment reliability, a microgrid will also assist these communities, which may be disproportionately affected by D.C. Water service disruptions. In deciding on planning and design, D.C.

Water can coordinate with Advisory Neighborhood Commissions (ANCs) and Business Improvement Districts (BIDs) to explore opportunities to maximize benefits, including for vulnerable communities, as well as steps needed to mitigate potential burdens or inequities (e.g., engaging the nearby community to facilitate minimally invasive construction).



## BENEFITS

The Blue Plains AWTP microgrid will improve the reliability of wastewater service to customers, including the installations and surrounding communities, and may increase the resilience of the electric grid.

### Installations:

Greater continuity of wastewater treatment service and potentially increased electric grid resilience.

### Economy:

D.C. Water is exploring a wide range of cost savings from grid hardening and a potential microgrid, including lower operations and maintenance (O&M) costs, greater energy load shifting, participation in demand response markets, and optimized use of on-site distributed generation and potential battery storage. As large customers, DoD installations can expect to share in savings via lower D.C. Water bills.

### Environment:

Microgrids can reduce emissions through improved load control, more efficient scaling and operation of on-site generators, and greater integration of renewable generation.



# PROVIDE FINANCIAL SUPPORT FOR THE BLUE PLAINS MICROGRID

## COLLABORATION

Key partners: D.C. Water

Stakeholders: Pepco



## COSTS & FUNDING OPPORTUNITIES

Potential costs associated with implementing this measure and potential funding sources to support implementation include:

### Scoping and planning phase:

- » The microgrid scoping phase has been initiated and will involve feasibility studies and defining system requirements, including recommended battery technology and cost estimates (e.g., for capital expenditures and O&M).
- » Once a contractor has been selected to complete the scoping activities and a more detailed understanding of costs is developed, additional funding needs related to scoping and planning may be identified.

### Implementation phase:

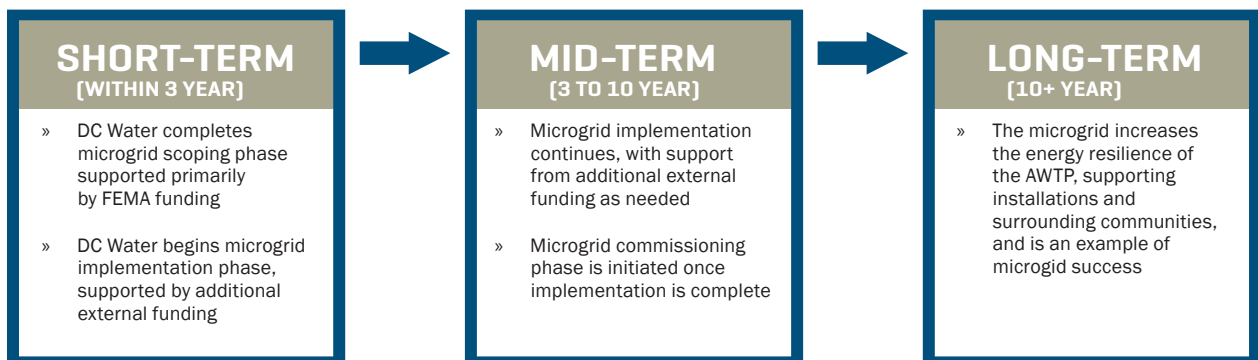
- » Cost estimates for microgrid project implementation have not yet been developed but will be explored as part of the scoping project. Scoping project results may be available as soon as late 2024. If these results indicate that a microgrid project is viable and would provide an additional level of resilience and sustainability for critical assets, D.C. Water anticipates pursuing funding support for the implementation and contraction of the project.

### Potential funding sources for implementation efforts, or additional scoping work if needed:

- » D.C. Water
- » Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) and Hazard Mitigation Program grants
- » D.C. Department of Energy and Environment (D.C. DOEE)
- » Funding sources from the 2021 Infrastructure Investment and Jobs Act
- » U.S. Army Corps of Engineers (USACE) Energy Resilience & Conservation Program (ECRIP)
- » DoD Office of Local Defense Community Cooperation (OLDCC) grant programs



## NEXT STEPS







# PROVIDE FINANCIAL SUPPORT FOR THE BLUE PLAINS MICROGRID



## ADDITIONAL DETAILS

### Benefits:

In addition to providing resilience benefits, microgrids often allow for fewer, larger backup generators that operate with better heat rates and at more efficient loading than stand-alone backup generators; they can also facilitate better load control (and lower total and peak consumption) during blue-sky operation and outages, therefore reducing air emissions.

The goals of the microgrid include improving safety, reliability, cost effectiveness, energy management and dispatch control, reporting, and resiliency. Electrical distribution system improvements such as enhanced power monitoring capabilities and control of relevant portions of the distribution system will enable establishment of the microgrid.

### Costs and funding opportunities:

- » D.C. Water estimates approximately \$4 million will be needed for microgrid and other electric grid scoping, planning, design, and owner’s engineer-type support.

- » D.C. Water has secured FEMA BRIC funding to support the initial scoping work and has issued an RFP for that work. The scoping phase will involve creating a roadmap for projects to implement over time to achieve the microgrid and electrical improvements needed to support it, including feasibility studies, concept designs, and grant application assistance.
- » D.C. Water participates in the Advanced Energy Group challenge, a collaborative process that brings together governmental, not-for-profit, and for-profit entities in D.C. and other major U.S. cities to explore and assist in presenting well-developed cases or projects deserving support and implementation. The AEG process may assist D.C. Water in considering potential funding from federal sources and taking advantage of other funding opportunities.

### Timing:

- » As of Fall 2022, D.C. Water is in the final stages of selecting a company to lead the planning work.
- » D.C. Water may have a draft schedule for microgrid implementation after the completion of the planning phase (i.e., expected summer of 2023).

### As part of the planning and scoping phase, D.C. Water may:

- » Consider the opportunity to network the microgrid to provide increased energy resilience for users in addition to supporting the AWTP. For example, this could involve designing the AWTP microgrid to be able to provide power to a DoD installation directly, charge a battery, or link with the grid to support the continuation of near-normal economic activity in the community in a major outage.
- » Investigate the potential to form an LLC to coordinate communities, the WWRP, and DoD in microgrid planning and development.

### Local regulatory context:

- » Opportunities for microgrid development are affected by local regulations, such as orders by the D.C. PSC; for example, a 2022 D.C. PSC Order on Microgrids helps clarify definitions and regulatory information relevant to single- and multi-customer microgrid development.









# ADVANCE FUEL RESILIENCE OPPORTUNITIES IDENTIFIED IN RRAP STUDY TO BENEFIT INSTALLATIONS AND COMMUNITIES



## MEASURE DESCRIPTION

The Cybersecurity Infrastructure Security Agency (CISA) is currently conducting a Regional Resiliency Assessment Program (RRAP)<sup>112</sup> study of the resilience of the petroleum supply chain serving the National Capital Region (NCR).

This measure would advance fuel resilience enhancement opportunities identified in the RRAP study that would directly support installation and community resilience.

The RRAP study entails assessing the resiliency of assets critical to petroleum fuel transportation and storage and the adaptive capabilities of public and private sector organizations, and then identifying opportunities to increase the resilience of those assets and

organizations to disruptive events. While the fuel needs and adaptive capacities of military installations within the region were not a specific focus of the project, the regional petroleum supply chain infrastructure and the resilience of its operations have clear defense implications, which have been conveyed through RRAP study partners Joint Task Force – National Capital Region (JTF-NCR) and the Defense Logistics Agency.

Future engagement of representatives from all installations and energy service providers on the findings of this study will ensure that the installations' and service providers' energy needs, contingency plans, and capabilities are informed by and can benefit from this effort.



## VULNERABILITIES ADDRESSED

If the petroleum fuel supply chain is significantly disrupted (e.g., during or following a storm), it could delay delivery of diesel or other fuels to the installations, some of which may depend on those fuels as a primary energy source, as a fuel for backup power sources in emergencies, or to support key activities. Limited regional fuel supply in a disruption may also have indirect effects on installation activities. For example, lack of access to transportation fuels could pose challenges to staff commuting to the bases via personal vehicle.

Electric power is required to operate critical components of the refined petroleum supply chain (e.g., fuel

pumps, terminal truck racks, pipeline pumping stations), and prolonged and/or widespread outages will be problematic for continued petroleum supply chain operations.

The petroleum supply chain relies on various modes of transportation to reach ultimate consumers in the region, and a range of natural and human-caused hazards can impede product movements.

IT and communications are integral to all facets of fuel supply chain operations, and loss of such capabilities can disrupt the ability of entities to efficiently deliver petroleum products to the region.



## BENEFITS

Increased engagement through the RRAP study will strengthen communication and information-sharing among study stakeholders and leaders and fuel resilience in the region should increase if study recommendations are implemented.

### Installations:

Communication and information-sharing between installations, state and local authorities, energy providers, and users may be strengthened. Additionally, if study recommendations are implemented, the resilience of installations' fuel supply may increase.

### Community:

If study recommendations are implemented, community support systems will be better prepared to deal with fuel supply challenges during emergencies. Beneficiaries may include hospitals, first responders, supports for medically dependent customers [MDC] and other residents, government agencies, and service providers, among others.

### Economy:

If study recommendations are implemented, fuel supply chain resilience should increase, and the consequences of a supply chain disruption should decrease, supporting the continuity of business, government services, and employment during power outages.

### Environment:

If renewable (e.g., solar PV), lower GHG-emitting, high fuel efficiency, or battery storage (BESS) energy sources are incorporated, they may increase installation and community resilience to petroleum fuel supply disruptions and lower greenhouse gas emissions.



# ADVANCE FUEL RESILIENCE OPPORTUNITIES IDENTIFIED IN RRAP STUDY TO BENEFIT INSTALLATIONS AND COMMUNITIES

## COLLABORATION

### Key partners:

CISA, D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA), D.C. Department of Energy and Environment (D.C. DOEE)

### Stakeholders:

RRAP study stakeholders such as petroleum pipeline operators, terminal operators, energy marketers, state and local energy assurance planners, state and local emergency management agencies, and electric power utilities; critical loads such as installations, hospitals, first responder fleets, and lifeline utilities



## SOCIAL & EQUITY CONSIDERATIONS

Hospitals, first responders, and some commercial and residential customers rely on diesel fuel deliveries for backup power. In recent storms, supply chain disruptions have delayed deliveries, resulting in competition

for limited diesel resources. Better understanding of critical backup power needs and the ability of the current system to provide them, and increased fuel system resilience to address any deficiencies, will have a

variety of social and equity benefits (to all area citizens and businesses) if this resilience leads to increased power availability in emergencies.



## COSTS & FUNDING OPPORTUNITIES

Potential costs associated with implementing this measure, and potential funding sources to support implementation, include:

### Approximate costs:

- » The RRAP study is already underway and funded by the Department of Homeland Security (DHS); engaging installations and energy service providers may require adjustment of staffing or resources. The study may include recommendations, but funding for infrastructure construction and other capital investments are not within the scope of the RRAP. The recommended measures are expected to have a wide range of costs.

### Potential funding sources:

The RRAP study has already been funded, but implementation of recommendations from the study will likely require funding. Potential funders may include:

- » Port Security Grant Program funding (PSGP) (e.g., for emergency backup generators at petroleum facilities)
- » State or local government funding for developing plans or facilitating information-sharing or operational coordination
- » Homeland Security Grant Program (HSGP) funding to develop plans or invest in training or capabilities to be able to coordinate with the petroleum industry more effectively
- » Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) or U.S. Department of Housing and Urban Development (HUD) Block Grant (e.g., Community Development Block Grant Program [CDBG]) programs to support development with petroleum resilience benefits
- » Department of Defense (DoD) Office of Local Defense Community Cooperation (OLDCC) grant programs (e.g., for resilience enhancement opportunities that would particularly benefit the installations and nearby communities)





# ADVANCE FUEL RESILIENCE OPPORTUNITIES IDENTIFIED IN RRAP STUDY TO BENEFIT INSTALLATIONS AND COMMUNITIES



## NEXT STEPS



## ADDITIONAL DETAILS

When the RRAP study is complete, it will include discussion of key fuel system vulnerabilities as well as resilience opportunities; the study may be followed by resilience investments. Ultimately, increased resiliency of the regional fuel supply can come from measures such as:

- » Increased distributed energy resources options, including energy storage and generation involving multiple technologies (e.g., solar energy and hydrogen)
- » Greater availability or redundancy of petroleum fuel delivery options
- » Reduced non-emergency reliance on fuel sources such as diesel that are essential for backup power in emergencies
- » Improved efficiency of fuel use (e.g., non-networked generators may consume fuel inefficiently)
- » Increased redundancy in staff able to transport fuel to tanks that feed generators in emergencies.







# CONSTRUCT COMMUNITY ELECTRIC VEHICLE CHARGING STATIONS



## MEASURE DESCRIPTION

Installations, surrounding communities, and many other governmental and non-governmental actors in the region are planning to develop and would benefit from accessible electric vehicle (EV) charging stations. Opportunities should be identified to construct EV charging stations for mutual benefit to communities and installations.

A plan should be developed and implemented for constructing the needed EV charging infrastructure in communities adjacent to installations, for use by the community and installations' non-tactical fleet. This effort will involve partnership between the installations, communities, utilities, federal EV fleet managers, and an EV charging company.



## VULNERABILITIES ADDRESSED

Investing in EV charging stations will build transportation resiliency by increasing power options available to

installation vehicles under blue-sky and emergency conditions and will reduce emissions.



## SOCIAL & EQUITY CONSIDERATIONS

Installing EV charging stations in neighborhoods can make EVs more logistically viable for surrounding communities, helping to address "range anxiety," a common barrier to increased EV adoption. Charging stations may also be used by EV drivers without the technical or financial means to charge at home (e.g., multifamily building residents).

Planning should include engaging with nearby communities and Advisory Neighborhood Commissions (ANCs) to receive input on a variety of charging station elements (see Additional Details).



## BENEFITS

### Installations:

Additional power source for installation vehicles; potentially reduced costs associated with electric infrastructure upgrades on-base.

### Community:

Increased practicality and financial accessibility of EVs and environmental education opportunities.

### Economy:

Installation and maintenance of EV chargers in community locations may provide local workforce development opportunities.

### Environment:

EVs reduce gas and particulate emissions if they replace internal combustion engines, and powering charging stations in part or completely with renewable energy (e.g., solar canopies) will increase greenhouse gas emissions reductions.



# CONSTRUCT COMMUNITY ELECTRIC VEHICLE CHARGING STATIONS

## COLLABORATION

### Key partners:

Charging station site hosts

**Stakeholders:** Pepco, Metropolitan Washington Council of Governments (COG) (technical resource), D.C. Department of Transportation (DDOT), D.C. Department of Energy and Environment (D.C. DOEE), EV service providers (e.g., ChargePoint),

D.C. Public Service Commission (DCPSC), Regional Transportation Planning Board, and Pennsylvania-New Jersey-Maryland Interconnection (PJM); these partners and leaders may also identify additional relevant partners to engage, such as federal EV fleet managers, other utilities, and planning organizations.



## COSTS & FUNDING OPPORTUNITIES

Potential costs associated with implementing this measure, and potential funding sources to support implementation, include:

### Approximate costs:

- » The RRAP study is already o The cost to install an EV charging station varies widely depending on the power level provided, the extent to which site work is needed, and the features and complexity of the charging station. In general, a Level 2 charging station available for

public charging will cost between \$5,000 and \$15,000 per port installed.

- » A solar canopy for an average-size system that meets 98% of American’s transportation energy needs (~11 kilowatts/year) is expected to cost around \$38,000.<sup>113</sup>

### Potential funding sources:

- » Department of Defense (DoD) Energy Resilience and Conservation Investment Program (ERCIP)

- » Pepco (EVsmart program and future EV charging incentive offerings)
- » DoD Office of Local Defense Community Cooperation (OLDCC) grant programs
- » Federal Highway Administration (FHWA) National Electric Vehicle Infrastructure Grant Program (NEVI)
- » Federal Transit Administration (FTA) Low or No Emission Vehicle Program



## NEXT STEPS







# CONSTRUCT COMMUNITY ELECTRIC VEHICLE CHARGING STATIONS



## ADDITIONAL DETAILS

### Measure description:

Existing efforts to increase EV adoption and scale up charging infrastructure include: work by actors that include DDOT, D.C. DOEE, DCPSC, Greater Washington Region Clean Cities Coalition (GWRCCC), FHWA, and Pepco; initiatives such as Alternative Fuel Corridors network development, Sustainable D.C. 2.0, Clean Energy D.C., and moveDC; federal tax credit for EV charging stations; General Services Administration’s (GSA) multiple initiatives related to EV charging; and regulatory progress such as the Clean Energy D.C. Omnibus Act of 2018. The key and supporting actors for this measure should coordinate with and build on these existing efforts, both to avoid duplicating work and to align and identify mutual benefit where possible.

Development of the EV charging stations should consider:

- » Building on other efforts to increase EV adoption and fuel options in the District.
- » Considering both installation and community/District-wide EV uses to avoid over-building.

- » Considering expected uses and resilient and renewable power source options to inform selection of charger types (e.g., battery storage could mitigate high-demand charges for direct-current fast chargers and enable use in emergencies; solar photovoltaic (PV) cells may help power slower-charging Level 2 stations).
- » Prioritizing siting stations outside the fence to support flexible use by communities and creating a “call option” to give installations priority access to EV charging stations for their critical equipment and their personnel’s private vehicles in emergencies.

Exploring opportunities to leverage EV stations and other related electric infrastructure investments for other purposes (e.g., to power batteries to deploy to communities in emergencies, or link up with microgrids), if aligned with installation needs.

### Cost and funding:

Pepco currently offers make-ready rebates,<sup>114</sup> which would cover eligible costs for equipment and installation up to the actual charging station. Pepco is providing infrastructure for 55 public EV charging stations (35 Level 2 and 20 direct-current Fast Chargers) across the District of Columbia. Charging stations can be installed on commercial sites that are available to the public.

Applicants that qualify can include parties that own, operate, or lease a commercial space for public parking or parties who own and operate an EV charging station. Once a project is approved by the District’s Public Space Committee and Pepco completes its Engineering Design process (see Make Ready Program overview<sup>115</sup> for more detail), Pepco will coordinate all construction activities

and install charging equipment. Charging stations in the public right-of-way will be reviewed by Pepco and the District’s Public Space Committee, which includes representatives from DDOT and Pepco. Pepco may also introduce additional programs in line with its Climate Solutions Plan, which may provide incentives for the make-ready infrastructure.



# CONSTRUCT COMMUNITY ELECTRIC VEHICLE CHARGING STATIONS



## ADDITIONAL DETAILS

### Benefits

As the federal vehicles fleet needs to scale up its use of alternative fuels and electric vehicles (EVs), charging installation vehicles at EV stations could support efforts toward this mandate. The stations can also offer education and job training opportunities, such as:

- » Partnering with schools and community organizations to host programs (e.g., tours, field trips) to learn about EVs; how charging stations work; what vehicles they are compatible with; and how EVs and renewables affect emissions, the environment, and our daily lives.
- » Giving work training organizations such as D.C. Academy the opportunity to take ownership over maintenance needs (e.g., repairs and replacements) for the stations.

Additionally, partners engaged in this measure may also explore opportunities for synergies between EVs and microgrids.











# EXPAND CONNECTIVITY TO/FROM HIGH-CAPACITY TRANSIT STATION AREAS



## MEASURE DESCRIPTION

Expand bus, bike, and pedestrian connectivity between installations and High-Capacity Transit Station Areas (HCTs) in neighborhoods of Ward 6 and Ward 8. This may involve adding sidewalks, crosswalks, streetlights, and bike lanes to roads that currently lack them as well as increasing bus service, adding bus stops, and expanding high-capacity transit options that will strengthen the transportation network between installations and HCTs. HCTs are locations around Metrorail, commuter rail, light rail, and bus rapid transit (BRT); three of which (Waterfront, Navy Yard-Ballpark, and Anacostia Metrorail Station) are located within a half-mile of an installation (Fort McNair, Washington Navy Yard [WNY], and the northern section of Joint Base Anacostia Bolling [JBAB]). These HCTs are located within or near the Southwest Waterfront, Capitol Riverfront, Poplar Point, and St. Elizabeth's Regional Activity Centers (RACs). These RACs are COG-designated areas for targeted commercial construction and household development. In this measure, the key partners and stakeholders should assess the existing deficiencies and demand for high-capacity transportation, bus routes and stops, bike infrastructure, and pedestrian networks between the installations and HCTs in Ward 6 and Ward 8 in addition to noting existing projects, planned or implemented, that will help address these deficiencies.

For example, there is a need for high-capacity transportation options capable of transporting 10,000 commuters per day to and from the Arnold Gate/Naval Research Laboratory (NRL) Boulevard section of JBAB.

D.C. Department of Transportation's (DDOT) D.C. Streetcar project has already demonstrated that a high-capacity solution is able to connect JBAB to Metrorail via its Anacostia Initial Line Segment (AILS). Launched in 2012, the 0.75-mile AILS, which connects the Navy Annex with the Barry Farms Residential Area to Anacostia Metro Station, was meant to demonstrate the D.C. Streetcar to the public and act as a connection to the D.C. Streetcar storage and maintenance facility located at 2750 South Capitol Street. DDOT plans to expand the infrastructure and service of the D.C. Streetcar System to extend the current AILS at the Anacostia Metrorail Station to Historic Downtown Anacostia and the 11th Street Bridge. This Anacostia Extension project will ultimately allow for future extension across the Anacostia River, the Navy Yard/Near Southeast RAC, and Buzzard Point.

Washington Metropolitan Area Transit Authority (WMATA) recently kicked off a 1.5-year Metrobus network redesign project in October 2022 that should incorporate installation connectivity needs.



## VULNERABILITIES ADDRESSED

Population growth is projected to increase vehicle volumes on major roadways, thereby putting a strain on installation commuters with modes of travel that rely on the road network. Commuters whose places of work are

located outside of a walkable HCT have reduced mode choice and often resort to driving in a single-occupancy vehicle, further exacerbating the cycle of traffic congestion.



## BENEFITS

### Installations:

There will be greater connectivity between the installations and HCTs, allowing more service members and staff to have options on how they get to work. This greater connectivity will involve an increase in high-capacity mobility options serving JBAB and NRL.

### Community:

Providing greater connectivity between public transit, non-motorized infrastructure and HCTs will create safer, more reliable ways to get around the community.

### Economy:

The presence of safe and convenient public and non-motorized transportation options will increase the viability of residential and commercial developments within HCTs.

### Environment:

Greater access to safe and reliable modes of transit and non-motorized transportation will reduce the number of single-occupancy vehicles on roads and the associated vehicle emissions.





# EXPAND CONNECTIVITY TO/FROM HIGH-CAPACITY TRANSIT STATION AREAS

## COLLABORATION

### Key partners:

DDOT Vision Zero Department, DDOT Planning and Sustainability Department; WMATA

DDOT will lead pedestrian, bike, and other connectivity enhancements; WMATA Metrobus and Metro Access will lead the bus-related service.

### Stakeholders:

DCOP Citywide Strategy and Analysis and Community Planning and Design, Anacostia Business Improvement District (BID), Anacostia Coordinating Council, Advisory Neighborhood Commissions (ANCs), D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA)



## SOCIAL & EQUITY CONSIDERATIONS

Gentrification and displacement of communities are often some of the unintended consequences that follow the implementation of transit and non-motorized infrastructure

improvements. To prevent these effects from occurring, local Advisory Neighborhood Commissions (ANCs) should be consulted during the planning phase.



## COSTS & FUNDING OPPORTUNITIES

Potential costs associated with implementing this measure and potential funding sources to support implementation include:

### Approximate Costs:

- » Study: ~\$1 million for a study to assess connectivity of public transit and non-motorized modes between the installations and HCTs.
- » Implementation: Implementation costs will depend on the recommendations of the assessment for bus, bike, and pedestrian infrastructure.
  - For example, increasing bus access to the installations may involve:
    - Increasing pedestrian infrastructure: \$2.5 million (for 5 miles of sidewalks)<sup>11,16</sup>

- Increasing bike infrastructure: \$3.4 million (for 3 miles of bike lanes)
- Bus lanes and bus priority traffic signals: \$7.7 million (for 5 miles and 25 intersections)

### Potential funding sources:

- » Federal Transit Administration (FTA) Capital Investment Grants Program and Expedited Project Delivery Pilot Program
- » Department of Defense (DoD) Office of Local Defense Community Cooperation (OLDCC) grant programs
- » U.S. Department of Transportation (U.S. DOT) Safe Streets and Roads for all (SS4A) Grant Program

- » U.S. DOT Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant Program
- » Some of the bus connectivity study may be met through WMATA's ongoing Metrobus network review project.

- » Bipartisan Infrastructure Law (BIL) funding allocated for D.C.
  - D.C. Build Back Better Infrastructure Task Force identified clean transportation micro-mobility hubs as a priority for investment



# EXPAND CONNECTIVITY TO/FROM HIGH-CAPACITY TRANSIT STATION AREAS

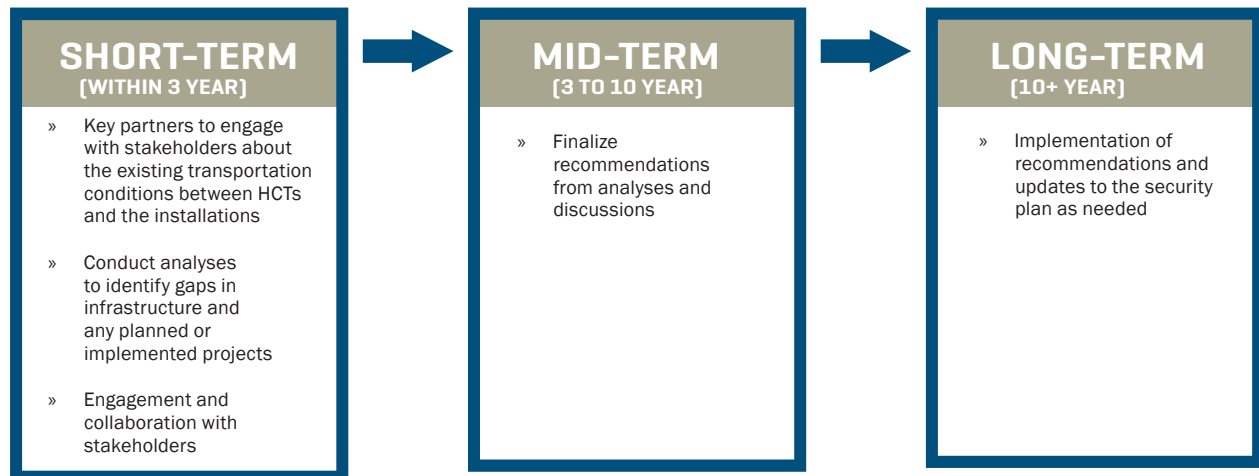


## NEXT STEPS

The assessment effort should commence with DDOT and WMATA engaging with partners about the existing state of connectivity of public transit and pedestrian and bicycle infrastructure between the installations and HCTs. During this period, key partners and stakeholders will conduct analyses to identify gaps in

public transit and non-motorized transportation networks in addition to identification of any existing planned and implemented projects. Engagement and collaboration with stakeholders on existing planning efforts such as the WMATA Metrobus network redesign project should also occur in tandem with the study. Recommendations

from the assessment should be finalized within a year, after the design and implementation of infrastructure projects that will improve connectivity between the installations and HCTs will be performed. The measure is anticipated to take 1-2 years from initiation of the assessment to completion of the report.



## ADDITIONAL DETAILS

**Measure Description:** HCTs<sup>117</sup> are designated areas that are within a ½ mile distance from 225 Metrorail, commuter rail, light rail, BRT, and streetcar stations that are currently in place or will be in place by 2030 in the D.C. region. Regional Activity Centers (RACs)<sup>118</sup> are areas that are projected to accommodate the majority of the region's future growth.

They play a key role in the Region Forward Vision's prosperity, sustainability, accessibility, and livability goals. Improving access within half a mile of the 208 HCTs is projected to increase accessibility to over 70% of Activity Centers or 98% of Activity Centers with HCTs.

DDOT D.C. Streetcar's plans to expand the AILS to connect JBAB to the Anacostia Metrorail Station and Downtown Anacostia is documented in the D.C. Streetcar System Plan<sup>119</sup> and expanded upon in the *D.C.'s Transit Future System Plan*.<sup>120</sup>









# CREATE INSTALLATION VIEWSHED SECURITY PLAN



## MEASURE DESCRIPTION

A viewshed security plan should be developed that addresses current and future conflicts between the security requirements of the installations and increased building heights of adjacent developments. This measure should involve a review of previous and current studies (e.g., National Capital Planning Commission [NCPC] Urban Design Element<sup>121</sup> and Buzzard Point Vision Framework and Design Review Guide<sup>122</sup>), a line-of-sight or viewshed analysis from surrounding

buildings to the installations, a series of roundtable discussions between key partners and stakeholders, and the development of programmatic and physical interventions to achieve the desired level of security within the installations. Joint Base Anacostia-Bolling (JBAB), for instance, is anticipated to conduct a Compatible Use Plan in the coming years that will address viewshed security among other topics.



## VULNERABILITIES ADDRESSED

The development of taller buildings creates additional lines of sight into the installations. This poses a potential security threat to the operations and mission of the installations. Currently, there may

not be measures in place to discourage new lines of sight into the installations during design and development of new construction.



## SOCIAL & EQUITY CONSIDERATIONS

The viewshed security plan should carefully consider the sense of privacy and trust of the surrounding communities. It should integrate a robust community and stakeholder engagement program. Key partners and stakeholders in charge of implementing this measure should

coordinate housing developers as well as Business Improvement Districts (BIDs) and Advisory Neighborhood Commissions (ANCs) to attempt to identify mutually agreeable solutions to any conflicts that may arise as a result of the plan.



## BENEFITS

### Installations:

Developing a viewshed security plan will protect the privacy of activities on the installations and enhance security for important facilities.





# CREATE INSTALLATION VIEWSHED SECURITY PLAN

## COLLABORATION

### Key Partner:

NCPC Heights and Views<sup>124</sup>

### Stakeholders:

D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA), D.C. Fusion Center, D.C. Office of Planning (DCOP) Community Planning and Design Division, Installations (Fort McNair, Navy Yard, JBAB, Naval Research Laboratory [NRL]), COG Department of Homeland Security and Public Safety, Department of Homeland Security (DHS) Protective Security Advisor, FBI Washington Field Office, Capitol Riverfront BID, Anacostia BID, Advisory Neighborhood Commissions (ANCs)



## COSTS & FUNDING OPPORTUNITIES

### Approximate Costs:

- » Review: \$50,000
- » Analysis: \$200,000
- » Stakeholder engagement: \$150,000

» Total costs are ultimately dependent on implementation items included in the plan; physical implementation methods would typically involve greater costs than purely programmatic methods.

### Potential funding sources:

- » Federal Emergency Management Agency (FEMA) Homeland Security Grant Programs (HSGP) including State Homeland Security Program (SHSP) and the Urban Areas Security Initiative Grant Program<sup>123</sup>



# CREATE INSTALLATION VIEWSHED SECURITY PLAN

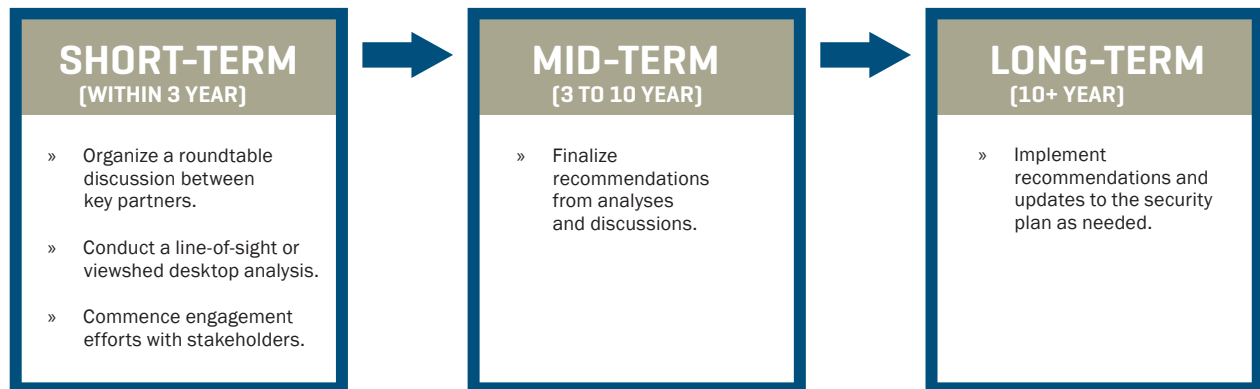


## NEXT STEPS

The effort in generating the plan should begin in the near-term with a roundtable discussion between key partners and stakeholders. A line-of-sight or viewshed desktop analysis should be conducted to determine which buildings, existing or planned, have lines of sight into the installations. Engagement efforts should build understanding with surrounding

residential, office, and commercial developments. The results of the analysis would allow key partners and stakeholders to determine existing and potential viewsheds into the installations and can help to guide policy discussions for viewshed security. Recommendations for both programmatic and physical interventions should be drafted, prioritized, and reviewed. A plan,

which should be developed over the course of approximately a year, should include recommendations for addressing viewshed security concerns regarding existing and planned developments based on use-type. Implementation of the recommendations should occur within 3 years, and beyond, as needed.



## ADDITIONAL DETAILS

The following sources represent prior efforts analyzing the viewshed within the District of Columbia.

The NCPC reviews heights and views within its Urban Design Element. The Heights and Views Master Plan (Final Report) has a chapter on security of government institutions and national symbols from taller buildings.

It provides general guidance on analyzing and protecting viewsheds.<sup>125</sup>

In the Buzzard Point Vision Framework and Design Review Guide, coordination between the installation and development entities over the topic of security of Fort McNair and the development of Buzzard Point was recommended as part of

Goal 1: A Well-Designed Waterfront Neighborhood, N.8: Coordinate Fort McNair and Buzzard Point projects. The review of designs and discussion of security technology is mentioned in this recommendation. The viewshed security plan to be developed should consider these recommendations.<sup>126</sup>









# IMPLEMENT CONGESTION RELIEF AND TRAFFIC CONTROL MEASURES



## MEASURE DESCRIPTION

Installations should work closely with D.C. Department of Transportation (DDOT) and regional partners to deploy innovative policies, technologies, and physical improvements to manage traffic congestion on key access routes. Installations should support the DDOT Traffic Management Center's expansion of new traffic signals,<sup>127</sup> which respond to real-time traffic conditions, and DDOT's StreetSafe Automated Traffic Enforcement (ATE)

to curtail unsafe and aggressive driving that cause traffic delays, particularly in proximity to the installations. Transportation Demand Management (TDM) programs,<sup>128</sup> including commuter benefit and incentive programs; planning and outreach for the Potomac Commuter Fast Ferry; and transit, pedestrian, and bicycle facilities, should be promoted to reduce or redistribute travel demand with alternative modes, routes, or travel times.



## VULNERABILITIES ADDRESSED

Ongoing roadway congestion near the installations hinders mobility for the installation workforce, delays emergency response and freight deliveries, and reduces overall roadway safety. All four installations

are largely auto-dependent; however, both Fort McNair and Washington Navy Yard (WNY) have entrances within a 10-minute walk of robust multi-modal transportation infrastructure.



## SOCIAL & EQUITY CONSIDERATIONS

As Joint Base Anacostia-Bolling (JBAB) and the Naval Research Laboratory (NRL) are located near historically disadvantaged communities whose residents have a greater reliance on public transit for daily commuting needs and face a greater financial burden from traffic citations when compared to the average D.C. commuter, precautions should be taken to ensure that congestion

measures are equitably implemented and enforced, financial support is available for citation payments, and citation revenue is earmarked to fund road safety improvements within these communities. The selection of traffic control should be informed by community insights on areas experiencing frequent congestions, high rates of speeding, and high instances of traffic crashes.



## BENEFITS

### Installations:

Increased reliability and efficiency of installation operations, emergency response, overall traffic safety, workforce mobility, and freight delivery.

### Community:

Increased overall roadway safety and more reliable commute times for communities surrounding the installations.

### Economy:

Benefits to local businesses from improved transportation access, streamlined pick-up/drop-off zones, and increased foot traffic.

### Environment:

Improved air quality and reduced greenhouse gas emissions would generally result from some congestion management measures.



# IMPLEMENT CONGESTION RELIEF AND TRAFFIC CONTROL MEASURES

## COLLABORATION

### Key Partners:

DDOT, Northern Virginia Regional Commission (NVRC)

### Partner:

Washington Metropolitan Area Transit Authority (WMATA), Metropolitan Washington Council of Governments (COG), Department of Homeland Security (DHS), Metropolitan Police Department (MPD)



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

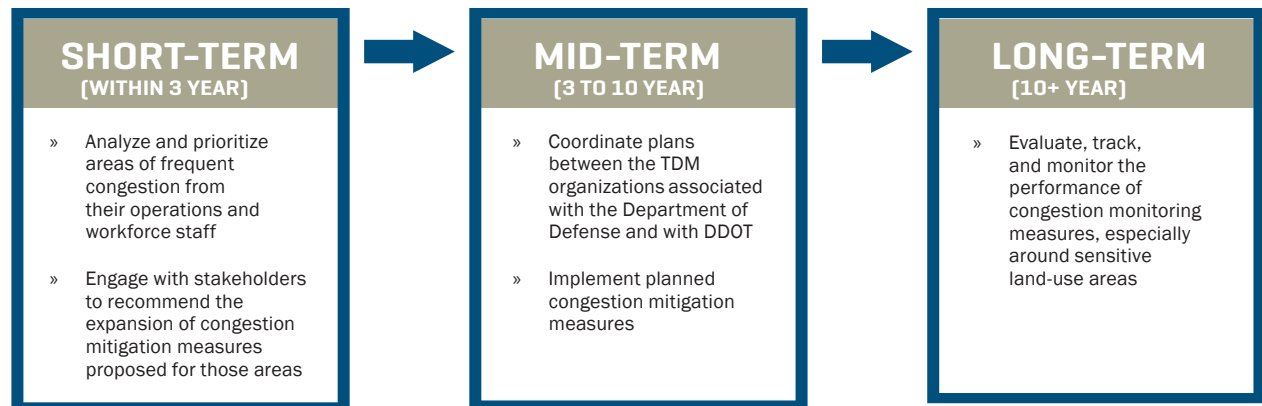
- » Implementation and analysis costs would depend on the types of traffic control measures selected, including TDM activities (which are typically low cost), Traffic Management Center operations, Intelligent Traffic Signals (~\$35,000-\$90,000 per intersection), ATE (~\$60,000 to purchase, \$25,000 to install, and ~\$5,000 per month in maintenance), and Stadium Performance Parking Zones.

### Potential funding sources:

- » Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) grant with matched funding from a Department of Defense (DoD) Readiness and Environmental Protection Integration (REPI) grant to the installation.
- » Bipartisan Infrastructure Law (BIL) funding allocated for D.C.
  - D.C. Build Back Better Infrastructure Task Force identified clean transportation micro-mobility hubs and redesigning major arterials as priorities for investment.



## NEXT STEPS





# IMPLEMENT CONGESTION RELIEF AND TRAFFIC CONTROL MEASURES



## ADDITIONAL DETAILS

### PLANNING CONTEXT:

The 2021 update to moveDC, DDOT's long range transportation plan, revealed segments of roadways during peak periods that have a record of unreliable travel times due to disruptions in roadway conditions, weather, construction, collisions, and special events. Specifically, for residents around the installations, commute times are the highest in the District, averaging 35 minutes, with the longest commute times born by transit users, who travel an average of 40 minutes to work (using data from the American Community Survey 2018

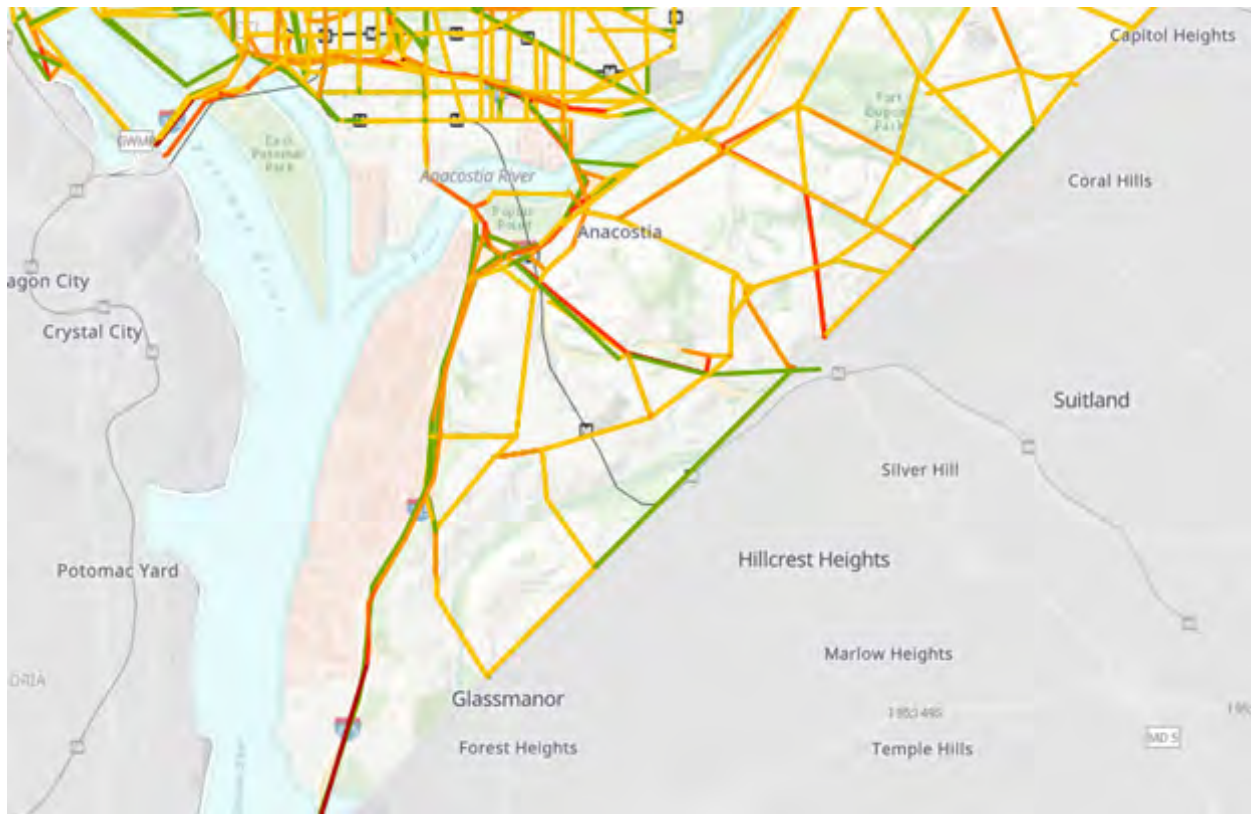
Five-Year Estimates from the U.S. Census Bureau).<sup>129</sup>

DDOT developed the Planning Time Index (PTI) map below to look at variation in congestion across the District during the morning rush hour. Roadway segments are assigned a score of 1 when the 95th percentile of travel time is found to be consistent from day to day, and a score of 2 when travel times are found to double depending on traffic.

The map shows that travel times can be very unreliable, nearly doubling depending on traffic, for commuters

traveling on the following roadways:

- » I-295 (Suitland Parkway) and South Capitol Street between JBAB, NRL and Fort McNair
- » I-695 (Southeast Freeway) for commuters traveling toward the 11th Street Bridge to Navy Yard, on I-395 (Southwest Freeway)
- » Route 50 (New York Avenue NE) for commuters approaching the installations from Northern Virginia and Prince George's County, respectively



Source: moveDC: 2021 Planning Time Index: Weekday AM Peak. Accessible at: <https://movedc.dc.gov/maps/DCGIS::planning-time-index-weekday-am-peak/explore?location=38.863697%2C-76.950353%2C11.88>





# IMPLEMENT CONGESTION RELIEF AND TRAFFIC CONTROL MEASURES



## ADDITIONAL DETAILS

### Social and equity considerations:

The recommendations have the potential to reduce the types of injustices identified in the 2021 Police Reform Commission Report,<sup>130</sup> which found that 86% of all traffic stops in the District that did not result in a citation, warning, or arrest involved drivers that were African American. Additionally, in 2018, the D.C. Policy Center found that, despite having similar levels of collisions per capita, there are a disproportionate number of citations and moving violations imposed upon predominantly African American neighborhoods (often twice as many) when compared to more predominantly white neighborhoods.<sup>131</sup>

### DDOT projects for congestion management:

DDOT projects that will serve to mitigate vehicular traffic in the District include:

1. **South Capitol Trail:** A shovel-ready project, which recently was awarded \$10 million from the FY 22 Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant,<sup>132</sup> could also be eligible for Defense Community Infrastructure Pilot Program (DCIP) funding to cover the rest of its estimated total project costs of \$25 million.
2. **I-695 and M St. Improvements:** Protected bike lane expansion and interstate ramp improvements in Navy Yard.
  - This project needs construction funding.

3. **Buzzard Point Trail:** Expansion from South Capitol to the SW Waterfront
  - Army Corps has completed preliminary economic analysis, which indicated that DoD funding would be needed for Fort McNair's resilience to flooding.
  - This trail project will have a temporary alignment until DDOT forms partnerships with all stakeholders, including Fort McNair, the U.S. Army, and the Joint Task Force— National Capital Region, toward an ultimate alignment.
4. **D.C. Streetcar South Capitol Street Facility:** Upgrade will be made to the electric bus charging facility to charge D.C. Circulator buses and to accommodate future testing, commissioning site, and Anacostia Extension for the D.C. Streetcar.
5. **Southeast Boulevard and Barney Circle:** This large \$650 million project encompasses a 0.5-mile, four-lane road and the Barney Circle interchange located in the Southwest quadrant of the District. Project goals include multi-modal access and community redevelopment along the river, a conversion of what was once the Southeast Freeway into an urban boulevard that will facilitate multi-modal travel.
6. **Anacostia Metrorail Pedestrian Bridge:** Located at the south entrance of the Anacostia Station, the bridge will cross over Suitland Parkway to connect to the Barry Farm development.

7. **11th Street Bridge:** The completed project is critical to improving travel on the Anacostia waterfront. The project replaces two bridges with three new bridges and completes interstate connection between I-695 and DC-295.

### Additional resources that may support the development of this measure include:

- » **Transportation Demand Management:** As part of a suite of TDM measures, installations could work to evaluate and to provide input on the effectiveness of DDOT's Stadium Zone, which uses demand-based parking rates on event days in the zone between the WNY and Fort McNair, with the goals of reducing congestion from cars looking for parking and improving parking turnover.<sup>133</sup>
- » **National Capital Planning Commission (NCPC) Transportation Element:** The Comprehensive Plan's Transportation Element seeks to reduce single-occupancy vehicle use, increase transit use, and advance sustainable transportation and development. The most recent version of the Element was adopted in July 2020.<sup>134</sup>
- » **Metropolitan Washington COG/ NCPC Transportation Management Plan Handbook:** Provides guidance on federal agencies to prepare a Transportation Management Plan for federal campuses and installations.<sup>135</sup>









# INCREASE SHADE COVER AND GREEN INFRASTRUCTURE



## MEASURE DESCRIPTION

Increase tree canopy cover and green infrastructure (GI) to manage stormwater runoff; improve air and water quality; and mitigate extreme heat along transit, bicycle, and pedestrian access routes frequently used by installation service members and staff.

This measure should consider the installations' role in move DC's policy strategy #18 to "cover 40% of the District with a healthy tree canopy by 2032 to enhance sidewalks,<sup>136</sup> walkability, and neighborhood amenities" in concordance with the D.C. State Forest Action Plan,<sup>137, 138</sup> and the Sustainable D.C. 2.0 Plan.<sup>139</sup>



## VULNERABILITIES ADDRESSED

The urban tree canopy deficit in the installation area (at 21% and 32% of Ward 6's and Ward 8's land area, respectively), in addition to the higher proportion of asphalt and dark roof surfaces at the Washington Navy Yard (WNY) and to the east of Joint Base Anacostia-Bolling (JBAB), exposes

the area's transportation network to the effects of extreme heat. Extreme heat can expand and stress bridge structure, soften pavement, buckle Metrorail lines, and cause health risks and discomfort to transit users, pedestrians, and bicyclists.



## SOCIAL & EQUITY CONSIDERATIONS

Extreme heat will greatly impact historically disadvantaged and underserved communities with reliance on public transit. The community needs to have an active role in the selection of locations for extreme heat mitigation efforts, as temperatures, according to the National Oceanic and Atmospheric Administration (NOAA), can vary from 10-20 degrees higher in areas where tree canopy cover is lacking and impermeable surfaces, such as asphalt and concrete, predominate.<sup>140</sup> According to the Environmental Protection Agency (EPA), the increase in smog and increased temperatures from the urban heat island (UHI) effect disproportionately impact those with chronic health conditions, including physical and cognitive disabilities, diabetes, and asthma; those who work outdoors, young children, and the elderly; and those in crowded

and poorly ventilated housing.<sup>141</sup> A co-benefit is that the shading can enhance recreation in a part of the city that has limited, high-quality outdoor recreation venues. There is also potential to increase tree cover at transit rail and bus stops to provide commuters with shade and relief from the heat.<sup>142</sup> Community engagement is also needed to mitigate the potential for displacement of the local community in areas where GI is installed and the tree canopy is expanded. Opportunities to increase access, incentives,<sup>143</sup> and training for GI and planting of fruit-, nut-, and shade-bearing trees provided by D.C. Department of Transportation (DDOT),<sup>144</sup> D.C. Department of Energy and Environment (D.C. DOEE),<sup>145</sup> University of the District of Columbia,<sup>146</sup> and the community should be considered.<sup>147</sup>



## BENEFITS

### Installations:

Safer and more comfortable access to installations.

### Community:

Benefits from reduced stormwater runoff, shaded bus stops and paths, and reduced temperatures, particularly to low-income and majority-minority communities, which are often in vegetation-sparse areas, as well as growing families and commuters.

### Economy:

Increased foot traffic at local businesses, as reduced temperatures, increased landscaping, and shade cover would create more comfortable commercial areas.

### Environment:

Improved air and water quality, as well as carbon sequestration benefits from tree canopy cover and GI.





# INCREASE SHADE COVER AND GREEN INFRASTRUCTURE

## COLLABORATION

### Key partners:

DDOT Urban Forestry, D.C. DOEE

### Stakeholders:

National Park Service (NPS), USDA Forestry Service, Casey Trees, University of the District of Columbia, COG



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

- » Analysis to inventory GI needs and assets: ~\$100,000
- » Dependent on how many trees are planted/GI projects are installed
  - Approximately \$185/tree
  - GI projects vary:
    - Rain gardens/bioretention systems are ~\$2,000-\$35,000 for systems 200 to 1,000 square feet
    - Rain barrels (residential) are \$50-\$300

- Permeable pavements are \$12,000/square ft (porous asphalt) to \$34,000 (permeable pavers)
- Costs of watering trees twice a week and regular upkeep

### Potential funding sources:

- » Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Grants including Building Resilient Infrastructure and Communities (BRIC) grant with matched funding from a Department of Defense (DoD) Readiness and Environmental

Protection Integration (REPI) grant, FEMA Hazardous Mitigation Program Grants (HMGP), and FEMA Flood Mitigation Assistance (FMA)

- » Metropolitan Washington Council of Governments (COG) current tree planting partnerships with RiverSmart and Casey Trees

- » National Association of State Foresters (NASF) and U.S. Department of Agriculture (USDA) State Urban Forest Resilience (SUFR) Grant Initiative



## NEXT STEPS

Tree canopy expansion efforts entail DDOT Urban Forestry and D.C. DOEE working with installations and communities to:



## ADDITIONAL DETAILS

Hot spots to prioritize the deployment of GI and urban canopy cover expansions can be identified through our analysis of UHIs around the installations, which revealed Metrorail lines face greater vulnerability and bridge entrances face medium vulnerability from extreme heat

based on their level of exposure and sensitivity. COG has established a Regional Tree Canopy Subcommittee to maintain healthy urban tree canopy through best management practices (BMPs) and unified information exchange between local governments.

Beyond planting the trees and other GI, this measure should also include regular watering and other maintenance that is critical to the health and longevity of GI.







# INVEST IN WORKFORCE DEVELOPMENT FOR IN-DEMAND SKILLS



## MEASURE DESCRIPTION

This measure involves building skills within the D.C. workforce to prepare them for high-value jobs serving installations and other employers in the District, particularly for residents of Ward 6 and Ward 8. Investing in workforce development involves forming partnerships between existing nonprofits, D.C. agencies, and any other public or private actors involved in workforce development in Ward 6 and Ward 8; expanding the capacity of job training and workforce development programs; and providing supplemental funding

to these programs. These actors may include government agencies, regional business associations, trade schools, community employment organizations, and private businesses. Actors involved in workforce development either operate skill training programs, employ graduates of workforce training programs, or act as grant-makers and funders for workforce development activities. The key partners and stakeholders should leverage these partnerships to build programs that develop skills valuable to the installations.



## VULNERABILITIES ADDRESSED

The efficient management and operations of the installations are threatened by a workforce shortage due to competition from competing employers combined with a lack

of skilled labor. Investments made to existing workforce development nonprofits will close the gap between the demand for skilled labor and the available supply in the labor market.



## SOCIAL AND EQUITY CONSIDERATIONS

The training programs should provide a clear pathway to skilled employment for their participants. This measure will directly affect the availability of job training opportunities in Ward 6 and Ward 8 and, by extension, pathways to skilled employment. Programs need to have a robust plan for future funding streams to fully cover education, job training, and employment services throughout the duration of the participants' involvement. Any gaps in the programs may hurt the employability of the participants.

The key partners and stakeholders should engage existing workforce development nonprofits and ANCs early in the process to identify gaps and challenges toward stable and skilled employment for participants. The roles and responsibilities between the training program and the key partners and stakeholders involved should be clarified and coordinated at the program onset to build upon existing staffing and community resources.



## BENEFITS

### Installations:

Installations will gain access to a greater pool of skilled workers for the reliable and efficient management of the bases.

### Community:

Communities comprising members who benefited from workforce development programs will have greater resilience to the changing demands of the labor market and access to new, potentially higher-paying jobs.

### Economy:

The local economy will benefit as more pathways to economic mobility are generated and household incomes improve.

### Environment:

If green infrastructure (GI) and water resources maintenance training is offered, then staffing capacity for stormwater and sewage sectors will increase.





# INVEST IN WORKFORCE DEVELOPMENT FOR IN-DEMAND SKILLS

## COLLABORATION

### Key partner:

Department of Employment Services (DOES)

### Stakeholders:

D.C. Department of Energy and Environment (D.C. DOEE) Sustainable Energy Utility and Green Infrastructure, D.C. Water (especially Blue Plains

Advanced Wastewater Treatment Plant [AWTP]), D.C. Department of Transportation (DDOT) Public Space Management and Maintenance, D.C. Mayor's Office of Veterans Affairs, Congress Heights Community Training and Development Corporation, D.C. Office of Planning (DCOP) Citywide Strategy and Analysis



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

- » Outreach and engagement: \$80,000
- » Gaps and challenges review: \$50,000
- » Scope of involvement: \$20,000
- » Training program development: \$200,000

### Potential funding sources:

- » Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) grant with matched funding from a Department of Defense (DoD) Readiness and Environmental Protection Integration (REPI) grant
- » Department of Defense (DoD) Office of Local Defense Community Cooperation (OLDCC) grant programs

- » Increased funding to Washington, D.C. from the Bipartisan Infrastructure Law (BIL) may provide financial support for Workforce Capacity Building
- » BIL funding allocated for D.C.
  - D.C. Build Back Better Infrastructure Task Force identified paid apprenticeship programs, establishing a Green Jobs Academy, and other workforce development initiatives as priorities for investment



## NEXT STEPS

Key partners and stakeholders should first identify existing nonprofits, D.C. agencies, and any other public or private actors involved in workforce development in Ward 6 and Ward 8. Discussions with the installations to identify a list of skilled labor needs should be developed at this time. The

actors should then reach out to the workforce development organizations and, through a series of roundtable discussions, identify current gaps and challenges these organizations face. Together with the workforce development programs, the key partners and stakeholders should

establish a scope of involvement that outlines the roles, expectations, and project duration within the first year. The expansion of training program capacity and grant funding assistance should occur throughout the first and second year.





## ADDITIONAL DETAILS

### Measure Description:

The following information highlights existing workforce development programs currently operating within Ward 6 and Ward 8. Organizations like the D.C. Infrastructure Academy (DCIA) offers training for the maintenance of GI, stormwater, and wastewater resources. DCIA, led by the DOES, coordinates, trains, screens, and recruits residents in skills that are in demand by the area's leading employers. DCIA is based in the Fort Stanton neighborhood in Ward 8. Partnerships between nonprofits and D.C. agencies typically handling the maintenance of public space, stormwater, and water infrastructure (DDOT, D.C. DOEE, D.C. Water) will aid in the expansion of capacity and distribution of funding assistance.

The DCIA 18 Month Report features statistics on recruitment, retention, participation, and employment rates for each skill offered by the academy.<sup>149</sup> This report provides a good case study in developing a metrics-based approach to gauge the success of a workforce training program.

### Vulnerabilities addressed:

Stakeholders and leadership from the installations have frequently raised the difficulty of finding qualified staff and retaining those employees in a hot job market with competing employers who offer competitive pay and benefits. The following recommendations may help in addressing this workforce supply vulnerability.

According to discussions with stakeholders, there is currently an unmet opportunity to train workforce development program participants to maintain GI in their community. Participants with this skillset will be able to meet D.C. DOEE's current needs for additional operational and maintenance support for existing and future GI throughout the District. D.C. DOEE has a story map titled "Stormwater Retention Credit (SRC) Reduce Stormwater Runoff with Green Infrastructure" that shows where GI assets are currently located throughout the city and how the SRC trading program can be used to leverage private investment in GI projects.

An opportunity to connect youths to the installations and educate prospective employees on the mission and day-to-day operations of the installations can come in the form of a youth employment program. Currently, the Summer Youth Employment Program, which lasts from June through August, hires youths ages 14 through 24 to participate in paid work with employers throughout the District.<sup>150</sup> These employment opportunities may be tied to a pathway program to train youth in specific skillsets that are in demand by local employers such as the installations.

On-the-Job Training (OJT) is a workforce development strategy involving the training, mentorship, and hiring of candidates by employers of all sizes as they acquire and master a certain skillset or role.<sup>151</sup> DOES provides incentives such as wage reimbursements of up to 75% of the candidate's salary from 1 to 6 months to participating employers.









# DEVELOP SUSPICIOUS ACTIVITY AND TRESPASSING PREVENTION PLAN



## MEASURE DESCRIPTION

D.C. Office of Planning (DCOP), in partnership with the National Capital Planning Commission (NCPC), the Metropolitan Washington Council of Governments (COG), and the installations, should develop and implement a plan to track and prevent suspicious activity within public spaces immediately outside the installations, including activity leading to trespassing into installations.

Planning efforts will review past and current efforts to track suspicious activity and trespassing, identify key segments for security improvements, determine how to integrate security solutions while complying with historic preservation requirements, and research additional funding, toolkits, and guidance.



## VULNERABILITIES ADDRESSED

Public spaces, including roads and waterways immediately outside installation boundaries, could serve as points of access for bad actors to conduct suspicious activity that may lead to trespassing on the installations. Suspicious activity within public areas immediately outside of

the installations poses a potential vulnerability to the buildings and people within the installations as well as users of the public spaces. These include the sidewalks, bike lanes, and roadways that make up the public right-of-way as well as navigable rivers like the Potomac and Anacostia.



## SOCIAL AND EQUITY CONSIDERATIONS

If it is not thoughtfully developed, the security plan could impose measures that could compromise usage of the public space or be over-reliant on surveillance strategies deemed undesirable by the public. Therefore, key partners and stakeholders should engage with residents, Advisory

Neighborhood Commissions (ANCs), and recreational groups in Ward 6 and Ward 8 throughout the planning process to maintain a balance between security concerns and civic freedom.



## BENEFITS

### Installations:

Increased security for critical facilities and operations on the installations.

### Community:

Awareness of security activities and peace of mind for users of the public space.



# DEVELOP SUSPICIOUS ACTIVITY AND TRESPASSING PREVENTION PLAN

## COLLABORATION

### Key partners:

Installations (Fort McNair, Washington Navy Yard [WNY], Joint Base Anacostia-Bolling [JBAB], Naval Research Laboratory [NRL], DCOP Development Review and Historic Preservation Preservation (in the case of site-wide redevelopment, they could be a leader; otherwise, they would be a partner), NCPC Security of Federal and Public Spaces

### Stakeholders:

COG Department of Homeland Security and Public Safety, D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA), D.C. Fusion Center, U.S. National Park Service—National Park Police, Advisory Neighborhood Commissions (ANC), Business Improvement Districts (BIDs)



## COSTS & FUNDING OPPORTUNITIES

### Approximate costs:

- » Consultant facilitation and analysis: \$225,000
- » The development of the plan will involve time for analysis and facilitation of roundtable discussions, stakeholder engagement, formation of recommendations, and plan review by the consultant in addition to the demands on the time of the key partners and stakeholders. The final details and recommendations of the plan will determine further costs associated with implementation.

### Potential funding sources:

- » Department of Defense (DoD) Readiness and Environmental Protection Integration (REPI) grant program
- » Federal Emergency Management Agency (FEMA) Homeland Security Grant Program (HSGP)
- » FEMA Non-Disaster Grants



# DEVELOP SUSPICIOUS ACTIVITY AND TRESPASSING PREVENTION PLAN

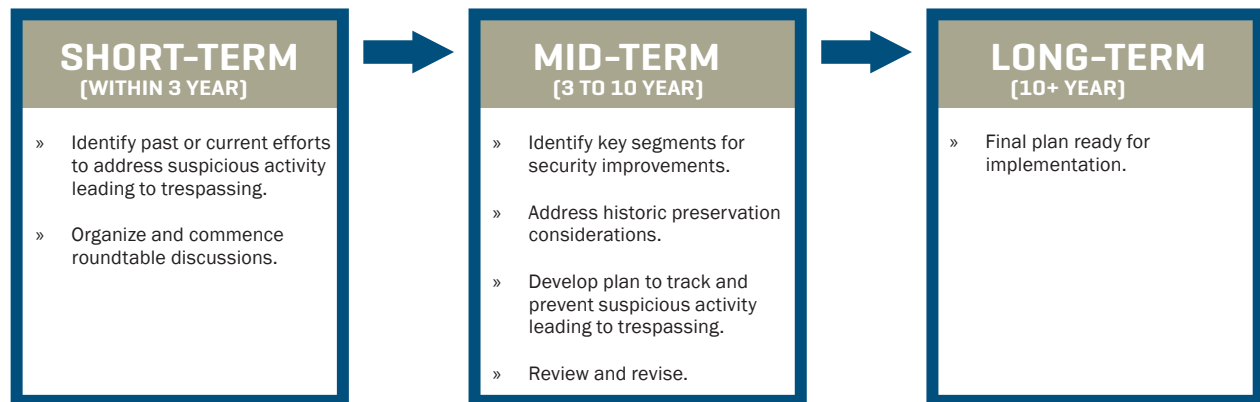


## NEXT STEPS

The short-term planning effort should begin in earnest with roundtable discussion between key partners and stakeholders. A plan review effort identifying prior and current plans to address suspicious activity that may lead to trespassing should also coincide with the discussions. From this early-stage discussion and plan

review, the group should begin to identify vulnerabilities that could be expanded upon in an assessment of the current state of adjacent roadways, paths, and waterways immediately outside of the installation boundary. Plan recommendations should be drafted to address these vulnerable segments while also considering

historic preservation requirements of installation structures. Once the plan recommendations have undergone a series of review and revision from the key partners and stakeholders, they should be finalized within the second year, with significant implementation efforts in that year.



## ADDITIONAL DETAILS

Measure Description: Security plays a key role in the safety of personnel and the operations of the installations. It is for this reason that areas immediately outside of the installations should be analyzed and integrated into any plan dealing with threats to security. The items below highlight prior efforts to analyze security risks as well as develop solutions to prevent suspicious activity that may lead to trespassing onto the installations.

NCPC has made public space security a priority following WNY shooting and the January 6th Insurrection.

On May 25, 2021, NCPC hosted an online panel event titled “Open to the Public: What’s the Big Deal with a Little Security?” to examine the relationship between security and public space. The link to the symposium recordings and the associated Symposium Proceedings Report can be found here: <https://www.ncpc.gov/initiatives/publicspace/>.

D.C. HSEMA has prepared a National Prevention Framework that focuses on imminent threats or acts of terrorism on U.S. soil.<sup>152</sup>

This may extend to suspicious activity on or immediately outside of federal property such as those of the installations. The Framework also covers the roles of security actors and prevention-related activities to actively prevent terrorism. The key partners may derive recommendations from the D.C. HSEMA National Preparedness System and the National Prevention Framework during the course of the Plan Review.









# INVEST IN AFFORDABLE HOUSING



## MEASURE DESCRIPTION

The installations should leverage their status as a major employer in Ward 6 and Ward 8 to advocate for affordable housing subsidies and to ensure the District's allocation of affordable housing meets the needs of their medium- to low-income workforce. According to the D.C. Mayor's 2019 affordable housing strategy,<sup>153</sup> most affordable housing in the city is concentrated in Ward 7 and Ward 8, which overlap with Equity Emphasis Areas (EEAs) and High-Capacity Transit Stations adjacent to the installations. Key partners and stakeholders implementing this measure will be tasked with gathering

funding and developing feasibility studies, land-use assessments, and community outreach efforts. They will also coordinate with developers and agencies throughout the design, construction, and housing phases. This measure aligns with the Mayor's goal to equitably distribute affordable housing throughout all eight wards of the District and to ensure at least 15% of the housing stock in each of the District's ten Comprehensive Planning Areas is affordable by 2050, according to the 2019 D.C. Housing Equity Report.<sup>154</sup>



## VULNERABILITIES ADDRESSED

Installations reported a shortage of affordable housing close to the installations, leading to a large portion of their workforce living further from the base and being

heavily reliant on a congested transportation network. Shorter commutes for workforce could increase retention and ability for staff to respond to emergency situations.



## SOCIAL AND EQUITY CONSIDERATIONS

Strategies should be developed to avoid the disruption or displacement of current residents as affordable housing is created. The development of affordable housing should be sited in locations that are environmentally sound to ensure that the livability and structural integrity of housing units remain uncompromised and that people without access to cars have safe routes home in the event of a climatic hazard, such as a flash flood or extreme heat. As this measure, like all measures within this report, prioritizes benefits to the installations, those who directly benefit from this measure maybe skewed toward military personnel rather than balanced with those living in the local community. Careful consideration should be taken throughout planning and

implementation phases to ensure that an equitable share of affordable housing and housing benefits are granted to those working at the installations and those living in the surrounding communities. Advisory Neighborhood Commissions (ANCs) and the D.C. Department of Housing and Community Development (D.C. DHCD) would need to conduct a robust community engagement program to identify and address any community concerns about the distribution of affordable housing. In addition, care should be taken to ensure that affordable housing options are also accessible to employees that are not officially low-income but still need to live in close proximity to the installations. If this measure is planned and executed poorly, there may be adverse social impacts.



## BENEFITS

### Installations:

Installations would be able to attract high-demand workers when affordable housing is available within a reasonable commerce.

### Community:

An increased number of installation workers would be able to live closer to their jobs when housing choices are expanded in the region, decreasing the general cost of living.

### Economy:

Local businesses would be able to attract and retain more employees when affordable housing options are increased.

### Environment:

Improvement of local air quality and reductions to greenhouse gas emissions reduction due to availability of alternative transit options including public transit, biking, and walking.

A more thoughtful planning and execution of this measure should result in a win-win for the installations and the community.



# INVEST IN AFFORDABLE HOUSING

## COLLABORATION

### Key partners:

D.C. DHCD, Development Finance Division, and D.C. Housing Authority, D.C. Office of Planning (DCOP) Development Review, DCOP Citywide Strategy and Analysis Division

### Stakeholders:

Non-profit organizations that are working to connect families and individuals to affordable housing



## COSTS & FUNDING OPPORTUNITIES

### APPROXIMATE COSTS:

» Multifamily affordable housing (50-unit apartment for 30% area median income (AMI) renters with no tax credits): \$12 million or \$240,000 per unit

- Acquisition costs: \$1,100,000
- Design costs: \$550,000
- Interim costs: \$440,000

- Financing and operation costs: \$520,000
- Project management: \$60,000
- Construction costs: \$9.1 million

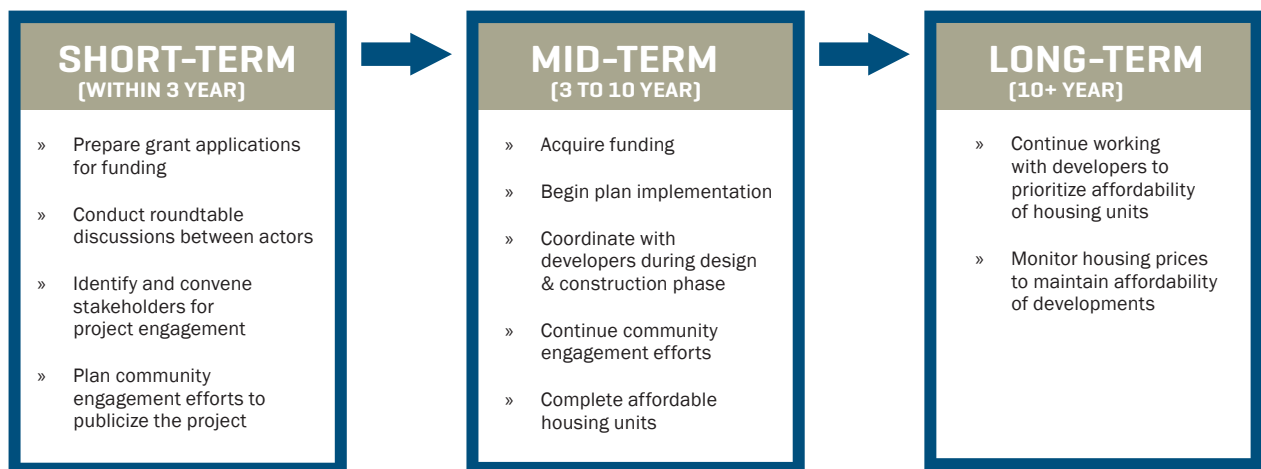
- » Stakeholder engagement: \$60,000
- » Community outreach: \$80,000
- » Funding acquisition: \$20,000

### POTENTIAL FUNDING SOURCES:

- » U.S. Department of Housing and Urban Development (HUD) Community Development Block Grants (CDBGs)
- » Metropolitan Washington Council of Governments (COG) Housing Affordability Planning Program (HAPP) Grants
- » D.C. Government Housing Production Trust Fund (HPTF)



## NEXT STEPS







# INVEST IN AFFORDABLE HOUSING

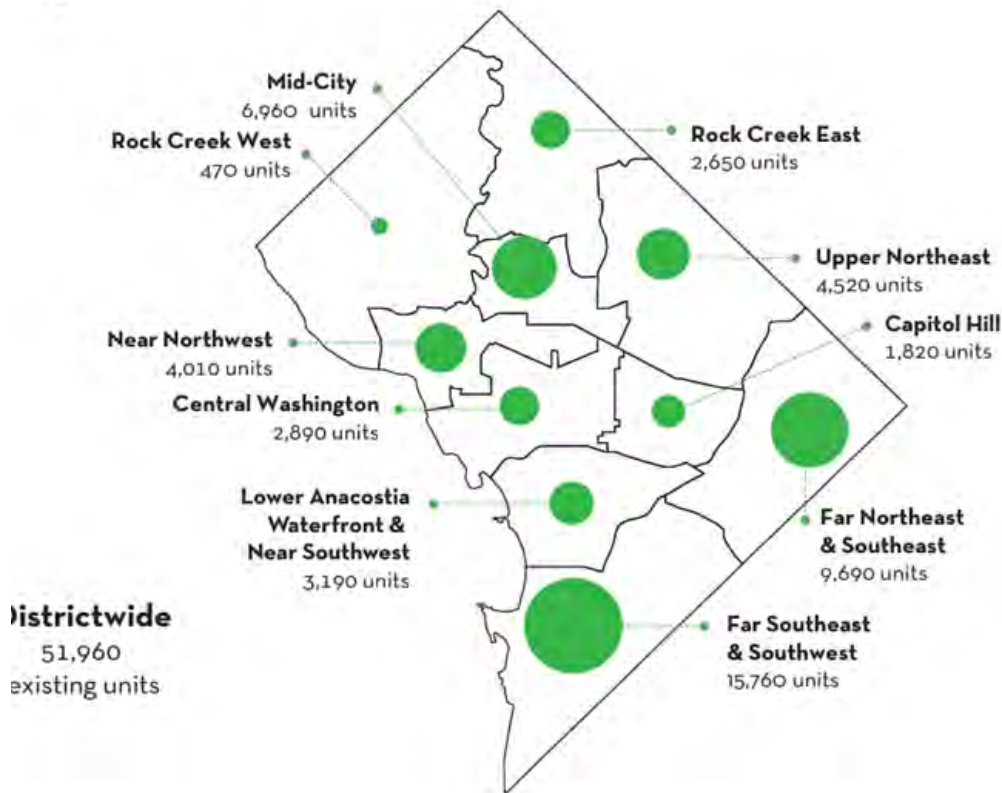


## ADDITIONAL DETAILS

According to the Mayor's April 2019 Resilient D.C. Strategy, rent increases are outpacing wage increases in the District.<sup>155</sup> This was the case between 2002 and 2013, when rent increased by 44% while wages increased 9% for the middle 20% of earners. Forty percent of renters in the District spend at least one-third of their income on housing. The District's Resilient D.C. Strategy has a goal to increase the supply of market-rate affordable housing by 25% by the year 2030 and to preserve 100% of existing affordable housing subsidies.

According to the Mayor's October 2019 Housing Equity Report, the District's affordable housing is unevenly distributed across the city.<sup>156</sup> Currently, there is a housing shortage on-base with military personnel on long waitlists. This on-base housing demand could be alleviated with an equitable distribution of affordable housing throughout the District.

The map below illustrates the Far Southeast and Southwest area of the District, which has over 15,000 affordable units, or about 31% of all of the city's affordable housing. In contrast, the Rock Creek West has fewer than 500 affordable units, or approximately 1% of the District's supply of affordable housing.



Source: D.C. DHCD. 2018 Estimated Distribution of Dedicated Affordable Units. Housing Equity Report. Accessible at: [https://planning.dc.gov/sites/default/files/dc/sites/housingdc/publication/attachments/Housing\\_Equity\\_Report.pdf](https://planning.dc.gov/sites/default/files/dc/sites/housingdc/publication/attachments/Housing_Equity_Report.pdf)

## HONORABLE MENTION PHYSICAL AND POLICY MEASURES

In addition to the 14 priority measures, several additional measures were also discussed during the prioritization process as strong contenders for advancing regional and installation resilience. These measures did not make the top priority list since they already have strong momentum and support, but they are mentioned here to emphasize the importance of these measures for overall regional resilience, including for military installations:

- » **Coordinate and advocate for funding for water supply alternatives.** The Interstate Commission on the Potomac River Basin (ICPRB) helps coordinate the main water suppliers in the basin in Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia. Studies conducted by ICPRB indicate that as early as 2040, the combined pressures of growing water demand, decreasing river flows due to upstream use, and the potential impacts of climate change on the river would result in current water infrastructure not being able to meet full demand.<sup>157</sup>
  - ICPRB evaluated a suite of alternative strategic options to maintain reliability in the face of these pressures.<sup>158</sup> The alternatives include the development of three reservoirs—Vulcan Quarry in Fairfax County, Virginia; Luck Stone Quarry (aka Milestone Reservoir) in Loudon County, Virginia; and Travilah Quarry in Montgomery County, Maryland. Vulcan and Luck Stone have received funding (in part from the Federal Emergency Management Agency [FEMA]) and are under development. To fully meet projected demand in the face of climate change beyond 2045, ICPRB’s study recommended investing in all three reservoirs. One of the reservoirs (Travilah Quarry) would be managed by the U.S. Army Corps of Engineers (USACE), so this project would not be eligible for other federal pass-through grants and instead would require an act of Congress to apportion funds for USACE. If approved, installations should coordinate with USACE on the plans for using Travilah Quarry to build resilience against future water shortages.
  - In addition, water agencies in the region should work together to consider how these **new reservoirs could be coordinated among users holistically to help ensure broader reliability and resilience of water in the region.**
- » **Continue to explore opportunities to expand the ferry service as a commuting option, which may include adding Potomac River Ferry stops near installations** (e.g., Washington Navy Yard [WNY], Joint Base Anacostia-Bolling [JBAB]) to provide alternative transportation options for installation staff and to provide multiple fueling options in alignment with regional efforts to build fuel supply resilience. Additional ferry services may ease transportation stress placed on roadway systems and provide additional transportation capacity in the event of an emergency. Stakeholders should continue to build upon prior efforts, such as the Northern Virginia Regional Commission (NVRC) report on the M-495 Commuter Fast Ferry Project Development Phase, which has looked at competitiveness of the fast ferry service compared to other modes, potential service areas, and funding sources.<sup>159</sup> The fast ferry service is stated to run at a standard speed of 26 mph and at an optimum speed of 35 mph. The report shows that a potential commute from Woodbridge, Virginia, to The Wharf in D.C. via fast ferry would save commuters up to 20 minutes in travel time when compared with Virginia Railway Express (VRE) or Amtrak and Metrorail options. As such, this measure is not simply focused on adding stops, but also about expanding the ferry as a viable and useful commute option.

- » **Train workers to maintain green infrastructure (GI) and other capital projects** after construction completion. The task can be filled by workforce training programs such as D.C. Infrastructure Academy (DCIA) through an infrastructure operations and maintenance program. The program can be funded through the FEMA Building Resilient Infrastructure and Communities (BRIC) grant and matching DoD Readiness and Environmental Protection Integration (REPI) grant on the installation side.

### 3.4 PILLAR #3 – CONTINUE TO ADVANCE MILITARY INSTALLATION RESILIENCE THROUGH MEASURES INSIDE THE FENCE

The purpose of the study is to assess potential measures to be taken “outside the fence” of the installations, it will be important for military installations to continue to implement coordinated, complementary measures inside the fence to address vulnerabilities. The DoD’s United Facilities Criteria 2-100-01 requires all major installations to assess vulnerabilities from extreme weather and climate change and to develop a Master Plan to address and mitigate those vulnerabilities.<sup>160</sup>

The report provides an initial assessment of the threats the four installations are likely to face in the future that can be used as a starting point for installation-specific vulnerability assessments and resilience plans. **The study recommends that the installations undertake additional analysis and planning as needed to identify installation-specific vulnerabilities and resilience opportunities best suited for implementation inside the fence.** For example, the study assesses flood vulnerabilities in Washington D.C.; the installations should similarly conduct a flood vulnerability assessment for their individual installation. Undertaking installation-specific analysis and resilience planning may result in measures described in Pillar 2, such as infrastructure hardening (e.g., retrofitting SWPS, supporting floodwall construction).

Additionally, in developing the list of outside-the-fence resilience measures for this report, the study noted complementary inside-the-fence measures that would further enhance installation resilience, shown in Table 2. These measures were identified as most appropriate for implementation on-base. Factors included: Building the resilience of assets that are under the responsibility of the installation rather than a service provider, operations and plans that largely concern installation staff, risks that are more relevant to the installations than the surrounding communities, and efforts that would be solely under the purview of the installations and not outside partners.

**This is not an exhaustive list, but rather a starting point for future resilience plans.** For example, increasing water storage on-base, developing alternate commute routes for workers who live off-site, and developing grey water purification capabilities would assist installations maintain operations in the case of an extreme event.

While specific measures are better suited for on-base implementation and others for off-base implementation, **all resilience activities should be undertaken collaboratively.** The installations should work to break down silos between their fellow installations as well as with the surrounding communities, D.C. government, utilities, and related stakeholders to help drive the installations—and the region—toward an integrated, holistic resilience effort. Collective, coordinated work is the path toward resilience.



Table 2: Example “Inside-the-Fence” Resilience Measures

Measure Overview	Details
<b>Maintain fire hydrants</b>	Ensure installations have a robust system for maintaining and inspecting fire hydrants, potentially through a memorandum of understanding (MOU) and funding to D.C. Water.
<b>Increase water storage</b>	Store more non-potable water on-site for firefighting.
<b>Greywater purification</b>	Increasing greywater purification capabilities on-site.
<b>Mutual aid</b>	Establish mutual aid agreements in the case of water shortages.
<b>Develop plan for alternate commute routes</b>	Develop plan/guidance for alternative commute modes/routes for installation staff in event of flood or other disruptive events.
<b>Develop signage plan to notify passerby of installations' presence</b>	Multilingual signage may be posted at frequent points along the waterfront side and on installation walls/fencing notifying passersby and potential trespassers of the nature of the installation and consequences of trespass. Signage plan can be developed to identify placement locations, frequency, and distance between signs as well as address maintenance and inspection schedules for posted signs.
<b>Increase redundancy in repair options for critical assets</b>	Identify critical assets for which there are few technicians capable of performing repairs in an extreme event, and 1) train several backup personnel and 2) ensure backup fuel and spare parts are available on-base to increase resilience of repair capabilities.
<b>Increase on-base backup power and fuel storage</b>	Explore opportunities to increase backup power options installations, including investing in resilient on-base renewable or low-emissions generation sources or energy storage, potentially as part of a microgrid. Notably, increasing installations' on-site power may also benefit communities if it allows reduction of installations' demand on shared power systems in extreme events and therefore increases availability for off-base users.
<b>Support teleworking</b>	Support continued teleworking for applicable installation staff to reduce personal occupancy vehicle load on roadways.

### 3.5 PILLAR #4 – CREATE AN ENABLING ENVIRONMENT FOR RESILIENCE

The final pillar of the resilience strategy is to ensure an enabling environment for the implementation of resilience measures, which would involve **diminishing any existing barriers and identifying or creating new opportunities**. While this study does not include a full analysis of regulations and policies that affect implementation of resilience efforts, several recommendations have been identified to promote an enabling environment.

The study found two main barriers to the implementation of the resilience strategy: Jurisdictional boundaries and related logistics, and funding:

- » **Jurisdictional boundaries.** Successful implementation of the resilience measures described in this report involves coordination across jurisdictional boundaries (e.g., implementing stormwater management on both installation and public property). Such cross-jurisdictional implementation carries the potential for logistical challenges. For example, some funding sources only allow for off-base projects and vice versa. Jurisdictional boundaries may also lead to tension among stakeholders if there is not clear communication and agreement on who is leading implementation, who is being consulted during the process, who is affected by the process of implementation (e.g., road closures and noise pollution during construction of physical measures), and who is benefiting from the measure.
  - It is essential explicitly identify and address any logistical hurdles related to cross-jurisdictional projects.
  - Additionally, partners involved in implementing the measure should undertake deliberate coordination with all relevant stakeholders, including the community members where the measure is being implemented.
- » **Funding.** Obtaining funding and managing costs can be a stumbling block for successful project implementation. This challenge is magnified by the cross-jurisdictional and multi-layered nature of resilience efforts. Identifying multiple sources of funding and increasing collaboration across different stakeholder groups will be important to successfully advance resilience measures. Leveraging multiple funding streams that can be used toward implementation of resilience measures through the establishment of intergovernmental agreements and cost-sharing agreements is recommended.

**Additionally, there may be measure-specific barriers.** For example, microgrids are a key resilience measure but also face considerable regulatory hurdles. Regulations around microgrid development and ownership affect the ability of the installations and other entities (e.g., D.C. Water) to pursue microgrid projects, and microgrid project design and timing. For example, a June 2022 DCPSC Order on microgrids provides definitions and regulatory information relevant to single customer microgrids (including campuses) and clarifies that they would not be regulated as electricity service providers by the DCPSC. That Order also establishes that multi-customer microgrids would be regulated by the DCPSC<sup>161</sup> but do not need to be provided by Pepco. There are significant organizational, contractual, operational, and cybersecurity complexities to multi-customer microgrids with both DoD (i.e., installations) and civilian (e.g., commercial or residential) customers, and it would be rare to build a multi-customer microgrid that did not use any of the local utility's distribution system (e.g., Pepco) or require close coordination with Pepco.

**Planning and developing opportunities** for resilience involves changing the way we make decisions by incorporating new and evolving principles into existing and new processes. As we adapt to and address challenges, **resilience needs to be built into the decision-making processes of governmental organizations.** Resilience will require decision-makers to look forward; incorporate new types of data and analysis; and collaborate across disciplines to make determinations about how to allocate and deploy resources, prioritize plans, initiate conversations, and react to situations.



## **4 | CONCLUSION AND NEXT STEPS**

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The findings and recommendations in this report are the result of extensive research and dialogue with local experts and key stakeholders who share a vested interest in improving the resilience of the metropolitan Washington region. Successful implementation of the measures herein will improve the capacity of installations to continue critical operations during extreme weather events and other hazards. Furthermore, implementation of the measures will yield positive social, environmental, and economic impacts. This work will also help advance equity with tangible benefits for historically disadvantaged and vulnerable communities through improved transportation connectivity, workforce training, and improved climate resilience. The relationships developed during the MIRR study will help facilitate continued collaboration among installations, utilities, local agencies, special interest groups, and residents to continue working toward shared goals of community and installation resilience.

## NEXT STEPS

Leveraging the lessons learned and recommendations of this MIRR report will support efforts to build the resilience of the installations and the region. Measuring outcomes and tracking progress will be necessary to monitor the effectiveness of efforts and help inform future planning.

This report is designed to be a tool for decision-makers to foster collaborative work that moves installations and surrounding communities toward improved resilience. This guidance should help installations track progress and remain adaptable to changing dynamics over time. The work of implementing these strategies should establish processes by which installations continue to monitor their progress and should be periodically revisited and updated after a period of 5 to 7 years. Immediate next steps are outlined below.

On **coordination**, the Policy and Technical Advisory Committees (or similar body) should continue to meet regularly to coordinate implementation of the resilience strategy, discuss issues, and evaluate progress. COG can provide support to these committees and continue to coordinate relevant stakeholders to drive implementation of the priority measures. This work should also seek to identify additional opportunities for relationship building and new resilience projects across different sectors. For measures that impact historically disadvantaged communities, key partners and stakeholders should prioritize work with local leaders to support genuine community engagement that generates two-way learning, capacity building, and mutual benefit.

On **implementing the top priority physical and policy measures**, COG, the installations, and the key partners and stakeholders identified in each measure should work to secure funding and implement the next steps laid out for each measure. COG and the installations should focus particularly on any measure(s) that could be eligible for OLDCC grant funding. Measures that are implemented should include a monitoring plan to track the effectiveness and progress of each measure so that the plan for next steps can evolve as needed.

On **advancing military installation resilience**, installations can build on the findings from the vulnerability assessment and the “inside-the-fence” measures identified in the study to further assess vulnerabilities and implement resilience measures on-base. Ideally, this work will happen as part of a coordinated resilience strategy shared across the installations but should also remain context-sensitive to the unique qualities of each installation.

Finally, as efforts move forward, all involved parties should be looking to adapt systems and thinking to build on successes and mitigate issues as they arise. Foundational to this work will be establishing a culture that promotes preemptive action instead of reaction. Implementing the resilience measures outlined in this report will help decision-makers respond to future threats before they become more tangible hazards—though decision-makers should keep in mind that specific measures needed to build resilience may evolve as conversations among the various stakeholders continue. **This MIRR study should be seen as a foundational effort that launches collaborative work on community and installation resilience activities: a beginning, rather than a conclusion.**



# 5 | APPENDICES

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## APPENDIX A: VULNERABILITY ASSESSMENT METHODOLOGY

This assessment took a two-pronged approach to identify priority vulnerabilities, or instances where there may be potential impacts to infrastructure or services that are relevant to the installations, as illustrated in Figure 21 below.

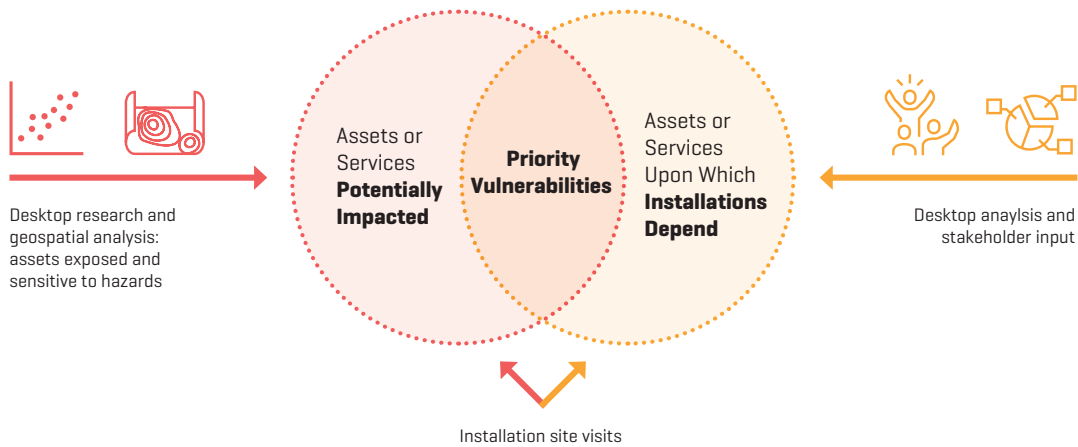


Figure 21: Vulnerability Assessment Methodology Overview

### Identifying Assets or Services Potentially Impacted by Hazards

The study applied the following methodology to determine assets or services potentially impacted by each of the priority hazards. Potentially impacted assets were defined as both exposed to the hazard and sensitive to impacts. For the purpose of this assessment, **vulnerabilities** are defined as impacts outside the fence with relevance to the installations.

#### ASSETS AND SERVICES INCLUDED IN THE ANALYSIS

For the geospatial analyses described below, the study analyzed exposure and sensitivity of the following asset classes (see Table 3), with all layers clipped to the Washington, D.C. boundary.

In addition, important vulnerabilities based outside the immediate installation study area such as transportation in and out of the region, water supply, and power generation were assessed.



Table 3: Asset Classes Included in Vulnerability Assessment

Sector	Asset Class
Transportation	Roads (represented by Traffic Volume Annual Average Daily Traffic (AADT) 2019)
	Metrorail Lines
	Metrobus Routes
	Metrobus Stops
	D.C. Circulator Routes
	Emergency Evacuation Routes
	Snow Emergency Roads
	Regional Evacuation Routes
	Hurricane Evacuation Routes
	Bridge and Tunnel Entrances
	Truck and Bus Through Routes
	Ferry Routes
	Ferry Terminal
	Energy
Electric Power Distribution Lines (above ground)	
Power Plants	
D.C. DPW Fuel Sites	
Electric Power Facilities	
Telecommunications	Utility Poles
	Transmission Towers AM/FM
	Cellular Towers
	Fiber Optic
Water/Wastewater	Storm Drains
	Water Distribution Lines
	Stormwater Lines
	Sewer Lines
	Pumping Stations
	Fire Hydrants
	Sanitary Sewer Pumping Stations
	SSO Incidents
	CSO Outfalls
	MS4 Outfalls
Emergency Services	Hospitals
	Fire Stations
	Emergency Transfer Locations
	Local Emergency Operations Centers (EOC)
	Levee and Floodwall System

## FLOODING

- The analysis identified flooding impacts at the individual asset level, based on whether the assets would be exposed to flooding under various scenarios and whether flood depths would exceed a critical operational threshold for the asset.

## FLOODING EXPOSURE SCENARIOS AND DATASETS

- The study analyzed exposure to flooding under two primary scenarios and a third, more extreme scenario for additional considerations:<sup>162</sup>
  1. Future (2050) 10% annual chance flood (assuming 2.5 ft sea level rise [SLR])<sup>1</sup>
  2. Future (2050) 1% annual chance flood (assuming 2.5 ft SLR)
  3. (Extreme future (2050) 1% annual chance flood (assuming 3.6 ft SLR))\*

These scenarios provide some bookends of potential flooding over the next few decades, capturing potential areas that would be flooded relatively frequently and under extreme events by mid-century. This can inform two key types of potential impacts and needed measures.

- The third, “extreme” scenario would provide a means to sensitivity-test other potential impacts and measures to ensure they would be robust against higher potential amounts of sea level rise or other changes, or for longer periods of time. This scenario is also approximately projected sea level change under the Intermediate-High scenario by 2060-2070 (see Figure 22).

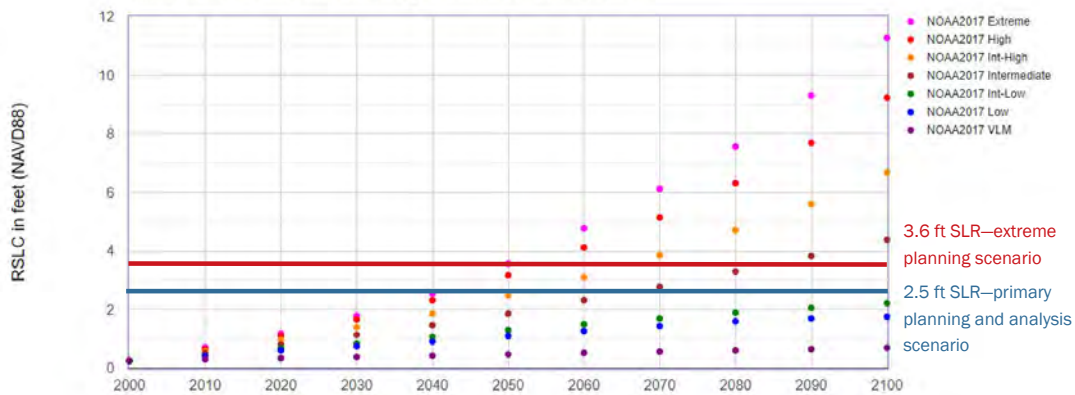


Figure 22: NOAA et al. 2017 Relative Sea Level Change Scenarios for Washington, D.C.  
Source: USACE Sea Level Change Calculator

\* 3.6 ft. represents 2050 projected sea level under the NOAA et al. 2017 Extreme scenario at the Washington, D.C. tide gauge. It is also approximately projected sea level change under the Intermediate-High scenario by 2060-2070.

First, the team used the FEMA flood profiles (located in FEMA FIS Report) to identify the flood elevations as they correlate with the various percent annual chances of flooding.<sup>163</sup> The team averaged across the relevant cross-sections for each of the two National Weather Service (NWS) stations.

**Table 4: Computation of Water Surface Elevations for Flood Scenarios**

Stream	Cross Section	Elevation (ft. NAVD88)	
		10% annual chance	1% annual chance
Potomac River	A	5.0	8.8
Potomac River	B	5.8	10.4
<i>AXTV2 gauge</i>	<b>AVERAGE</b>	5.4	9.6
	w/ 2.5 ft SLR	7.9	12.1
	w/ 3.6 ft SLR		13.2
Anacostia River	A	6.2	10.6
Anacostia River	B	6.8	10.6
Anacostia River	C	7.1	10.6
Anacostia River	D	7.1	10.6
Anacostia River	E	7.8	10.6
<i>WASD2 gage</i>	<b>AVERAGE</b>	7.0	10.6
	w/ 2.5 ft SLR	9.5	13.1
	w/ 3.6 ft SLR		14.2

Then, the team pulled the closest available flood depth grids to those elevations, summarized in Table 5.<sup>†</sup> For Scenarios 2 and 3, the exposure mapping also includes the FEMA 100-year flood depth to capture pluvial flooding, particularly in the Federal Triangle and Oxon Run areas.

**Table 5: Flood Depth Layers Used in Analysis**

		Flood Elevation	Available Layer	Flood Elevation	Available Layer	100-year?
<b>Scenario 1</b>	Future 10% annual chance	7.9	7.9	9.5	9.6	N
<b>Scenario 2</b>	Future 1% annual chance	12.1	12.2	13.1	13.2	Y
<b>Scenario 3</b>	Extreme future 1% annual chance	13.2	13.4	14.2	14.1	Y

## FLOODING SENSITIVITY THRESHOLDS

Based on available depth-damage functions through Hazus and other sources or expert judgment where applicable, the study identified critical impact thresholds for each asset type, as shown in Table 6.

<sup>†</sup> When two available flood depth layers were available equally close to the target flood depth, the team selected the higher depth to capture any potentially impacted assets. For example, layers showing flooding at 9.4 ft and 9.6 ft were available to represent the target flood elevation of 9.5 ft NAVD88, and the study team selected 9.6 ft.



Table 6: Flood Depth Impact Thresholds by Asset Type

Sector	Asset Type	Flood Depth Threshold (ft)	Source(s)
Transportation	Roads	1	Hazus-MH Technical Manual; <sup>164</sup> Pregolato, Ford, Wilkinson, & Dawson, 2017 <sup>165</sup>
	Bridge Entrances	1	Hazus-MH Technical Manual <sup>166</sup>
	Tunnel Entrances	1	Hazus-MH Technical Manual <sup>167</sup>
	Metrorail Stations	0	FTA <sup>168</sup>
	Metrorail Lines	0	FTA <sup>169</sup>
	Metrobus Stops	1	Same as roads
	Metrobus Routes	1	Same as roads
	Ferry Routes	0*	Expert judgment
Energy	Ferry Terminals	1	Expert judgment
	Electric Substation	4	Hazus-MH Technical Manual <sup>170</sup>
	Power Plants	4	Hazus-MH Technical Manual <sup>171</sup>
	D.C. DPW Fuel Sites	1	Hazus-MH Technical Manual <sup>172</sup>
	Electric Power Facilities	4	Hazus-MH Technical Manual <sup>173</sup>
Tele-communications	Electric Distribution Lines (above ground)	N/A	Hazus-MH Technical Manual <sup>174</sup>
	Utility Poles	N/A	Oak Ridge National Laboratory <sup>175</sup>
	Transmission Towers AM/FM	N/A	Oak Ridge National Laboratory <sup>176</sup>
	Cellular Towers	N/A	Oak Ridge National Laboratory <sup>177</sup>
Drinking water	Fiber Optic	N/A	Hazus-MH Technical Manual <sup>178</sup>
	Storm Drains	0	Expert judgment
	Pumping Stations	4	Hazus-MH Technical Manual <sup>179</sup>
	Water Distribution Lines	N/A	Hazus-MH Technical Manual <sup>180</sup>
Wastewater/ stormwater	Fire Hydrants	1	Expert judgment
	Stormwater Lines	0	Hazus-MH Technical Manual <sup>181</sup>
	Sewer Lines	N/A	Hazus-MH Technical Manual <sup>182</sup>
	Sanitary Sewer Pumping Stations	4	Hazus-MH Technical Manual <sup>183</sup>
	CSO Outfalls	>0	Expert judgment
	MS4 Outfalls	>0	Expert judgment
Other	SSO Incidents	>0	Expert judgment
	Hospitals	0.5	Hazus-MH Technical Manual <sup>184</sup>
	Fire Stations	0.5	Hazus-MH Technical Manual <sup>185</sup>
	Emergency Transfer Locations	0.5	Hazus-MH Technical Manual <sup>186</sup>
	Local Emergency Operations Centers (EOC)	0.5	Hazus-MH Technical Manual <sup>187</sup>
Levee and Floodwall System	11	National Levee Database <sup>188</sup>	

\*Impacts to ferry routes were rated as moderate impact because the disruption is temporary.

## FLOODING IMPACT RATINGS

Based on the flood depth and flood impact threshold for each asset type, each asset was assigned to one of the following categories for each flooding scenario:

- » **Not exposed** = Not exposed to flooding
- » **Low impact** = Exposed, with depth below key threshold
- » **High impact** = Exposed to flood depths greater than or equal to key threshold

## HEAT

The analysis identified extreme heat impacts at the individual asset level, based on whether the assets are exposed to extreme heat, and how sensitive the asset type is to extreme heat.

### HEAT EXPOSURE SCENARIOS AND DATASETS

Although the entire COG region experiences high temperatures and extreme heat, specific locations within the region are particular “hot spots,” due to UHI effects and other factors.

To capture spatial heterogeneity in heat exposure, the study used the Land Surface Temperature July 2018 dataset.<sup>\*189</sup> The raster dataset comprises Landsat 8 imagery (Level 1) July 8, 2018, processed to estimate land surface temperature. The study divided the temperature data into ranges and identified the top two quartiles of values as high (95-106°F) and medium (90-95°F) exposure thresholds (since all of Washington, D.C. can experience extreme heat, no areas are considered “low” exposure)—this approach is intended to home in on those areas that are particular UHIs.

### HEAT SENSITIVITY THRESHOLDS

The study rated each asset type as high, medium, or low sensitivity based on available information, past experience, and expert judgment. See Table 7.

### HEAT IMPACT RATINGS

Assets are assigned a high, medium, or low impact rating based on the combination of their exposure and sensitivity, per the matrix in Table 8 below.

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\* Another potential heat exposure map from Shandas, V.; Voelkel, J.; Williams, J.; Hoffman, J. Integrating Satellite and Ground Measurements for Predicting Locations of Extreme Urban Heat. *Climate* 2019, 7.5 was not available in digital form for the study team to use.

Table 7: Sensitivity Ratings by Asset Type and Hazard

Sector	Asset Type	Heat	Ice Storm	High Wind
Transportation	Roads	L	M	M
	Snow Emergency Roads	L	M	M
	Truck and Bus Through Route	L	M	M
	Regional Evacuation Route	L	M	M
	Hurricane Evacuation Route	L	M	M
	Bridge Entrances	M	M	H
	Tunnel Entrances	L	M	H
	Metrorail Stations	L	L	M
	Metrorail Lines	H	M	M
	Bus Stops	L	L	M
	Bus Routes	L	M	M
	Emergency Walkout Routes	L	H	H
	Ferry Routes	L	M	M
	Ferry Terminals	L	L	M
Energy	Electric Substation	M	M	H
	Power Plants	M	M	H
	D.C. DPW Fuel Sites	L	L	L
	Electric Power Facilities	M	L	H
	Electric Distribution Lines (above ground)	H	H	H
Tele-communications	Utility Poles	L	M	H
	Transmission Towers AM/FM	L	H	H
	Cellular Towers	L	H	H
	Fiber Optic	L	L	L
Drinking water	Storm Drains	L	L	L
	Pumping Stations	L	L	M
	Water Distribution Lines	N/A	L	N/A
	Fire Hydrants	L	L	L
Wastewater/ stormwater	Stormwater lines	N/A	L	N/A
	Sewer Lines	N/A	L	N/A
	Sanitary Sewer Pumping Stations	L	L	M
	CSO Outfalls	L	L	L
	MS4 Outfalls	L	L	L
	SSO Incidents	L	L	L
Other	Hospitals	M	M	M
	Fire Stations	L	M	M
	Emergency Transfer Locations	L	M	M
	Local Emergency Operations Centers	L	M	M
	Levee and Floodwall System	L	L	L

L = Asset may experience no damage or minor damage, and no material disruption to services | M = Asset may suffer damages that can be repaired with moderate cost and ease, or experience short-term, temporary disruption to services | H = Asset may be severely damaged, be out of service for an extended period, or be subject to significant costs of restoration | N/A = Stressor/hazard is not applicable to this asset type (not sensitive)

Table 8: Heat Impact Rating Matrix

Sensitivity	High	High	High
	Med	Med	High
	Low	Low	Med
	Med	High	
	Exposure		



## ICE STORMS

The analysis identified ice storm impacts at the asset class level. All assets are assumed to be uniformly exposed across the study area, and potential impact ratings are based on the asset's sensitivity to ice storms. The study rated each asset type as high, medium, or low sensitivity based on available information, past experience, and expert judgment. See Table 7.

## HEAVY WINDS

The analysis identified heavy wind impacts at the asset class level. All assets are assumed to be uniformly exposed across the study area, and potential impact ratings are based on the asset's sensitivity to heavy winds. The study rated each asset type as high, medium, or low sensitivity based on available information, past experience, and expert judgment. See Table 7.

## POPULATION GROWTH

Vulnerabilities to population growth are identified in the assessment based on the types of assets that would be most affected by increased demand.

## LAND USE, DEVELOPMENT, AND ENCROACHMENT

Vulnerabilities to this hazard are not applicable to individual assets. Instead, cross-cutting vulnerabilities to land use, development, and encroachment are described qualitatively in the assessment.

## Identifying Assets or Services Relevant to Installations

Whether potential infrastructure impacts outside the fence represent vulnerabilities to the installations depends on how dependent the installations are on those assets or services.

The ratings for the level of installation dependency on a sector are defined as follows in relation to the disruption to installation activities:

- » **Low** indicates no disruption, minor disruption, or manageable and temporary disruption of installation activities.
- » **Medium** indicates extended, but non-significant disruption to installation activities that does not impair the long-term accomplishment of installations' activities.
- » **High** indicates significant disruption to installation activities and/or significant costs of restoration.

This vulnerability assessment focuses on the following sectors that the installations all rely on to some extent:

- » Power
- » Emergency Response (e.g., fire, rescue, access to hospitals)
- » Telecommunications
- » Natural Gas/Fuel
- » Water

These sectors were selected through a prioritization exercise based on surveys of the installations' reported level of dependence,\* stakeholder input, and literature review.

To determine specific priority vulnerabilities, the study:

- » Prepared a draft list of potentially relevant assets and services, based on those identified as sensitive to and exposed to hazards, and near or key to installation operations
- » Presented those potentially relevant and vulnerable assets and services to the installations and stakeholders for review
- » Developed a short list of relevant, vulnerable assets and services tailored from this review

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\* To prioritize sectors, the study team distributed a survey to installations regarding their installation activities, the extent to which the activities are affected by natural hazards, and dependence of those activities on sectors. Two of the four installations responded as of 9/3/2021.

## APPENDIX B: RESILIENCE MEASURE PRIORITIZATION PROCESS

### Prioritization Process

#### MEASURE IDENTIFICATION

After identifying priority vulnerabilities through the vulnerability assessment, the MIRR study and stakeholders developed an extensive list of opportunities to build resilience and a short list of key resilience measures to address priority vulnerabilities.

The list of potential resilience measures came from two primary sources:

- » First, the study compiled existing planning initiatives and previously proposed resilience measures (e.g., those recommended by stakeholders during the MIRR study or as part of other initiatives such as Resilient D.C. and the D.C. Silver Jackets).
- » Next, the study conducted a gap analysis of resilience needs to address priority vulnerabilities to identify which priority vulnerabilities were not addressed through the existing planned measures.
- » Finally, the team conducted additional desk research and work with MIRR stakeholders and resilience experts to build out a list of resilience measures to fill those gaps.

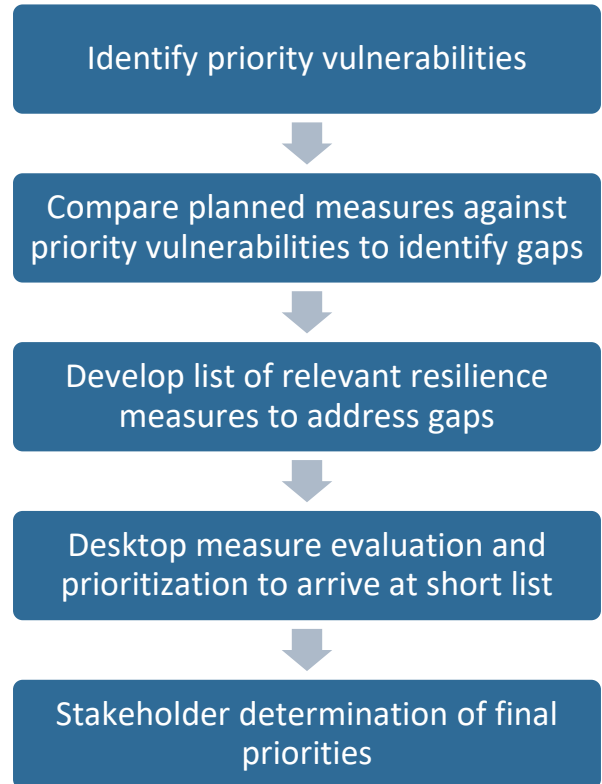
#### MEASURE EVALUATION AND SHORTLISTING

Then, the study developed and applied a set of criteria to prioritize the resilience measures, drawing on desk research and stakeholder input.

The prioritization criteria were divided into two tiers:

First, all measures had to “pass” three **Tier 1** criteria to move forward and into evaluation against the Tier 2 criteria:

- » **Gap:** Measure must address a priority vulnerability in a way that is currently missing or would help to propel a planned activity that would address the vulnerability.
- » **Location:** Measure must address vulnerabilities of installations through intervention(s) outside the fence.
- » **No harm:** Measure must not clearly create inequities, place burden on disadvantaged populations, or introduce other major negative unintended consequences for the community, the installations, the environment, or the economy.





Those measures that passed the Tier 1 criteria were then each evaluated against the following **Tier 2** criteria:

» **Cost**

- *Level of effort*: Consider labor costs and effort to implement (assumes measure has been approved by all partners).
- *Material costs*: Consider upfront and ongoing costs, and potential savings.
- *Fund applicability*: Are there funds that could be applied to this measure?

» **Benefits**

- *Effectiveness*: Anticipated effectiveness in reducing one or more priority vulnerabilities and increasing resilience.
- *Environmental co-benefits*: Provides environmental benefits (e.g., improved air or water quality, ecosystem health).
- *Social and equity co-benefits*: Provides equity or other social benefits (e.g., directly benefits Ward 6 and Ward 8).
- *Economic co-benefits*: Provides economic benefits (e.g., creates jobs or economic growth/stability).

» **Feasibility**

- *Leadership and partnerships*: To implement the measure, is there a clear leader, and are there existing partnerships or do they need to be created/adjusted?
- *Barriers and enabling factors*: Are there legal, social, or practical barriers to implementation?

The study rated each measure against each Tier 2 criteria on a scale of 1 to 3, where 1 represented the best possible rating. Table 10, Table 11, and Table 12 below provide additional detail on how each of these criteria were evaluated.

Finally, each measure received an overall score based on the following formula:

**Overall Score = Average (Cost, Benefits, Feasibility)**

Where:

*Cost score = Average(Level of effort, Material costs vs. funding)*

Where the team calculated a single Material costs vs. funding score from the individual Material costs and Fund applicability criteria to capture whether there was a funding gap for any measure. This approach was designed as not to penalize measures for being ambitious or high cost, as long as they were conceivably fundable. The study applied the matrix in Table 9 below to derive the Material costs vs. funding score.

**Table 9: Material Costs vs. Funding Scoring Methodology**

		Funding Availability Score		
		1 (High)	2 (Med)	3 (Low)
Material Cost Score	1 (Low)	1 (High)	1 (High)	1 (High)
	2 (Med)	1 (High)	2 (Med)	2 (Med)
	3 (High)	1 (High)	2 (Med)	3 (Low)

*Benefits score = Average(Effectiveness, Co-Benefits)*

Where the Co-benefits score is the average of the Environmental co-benefits, Social and equity co-benefits, and Economic co-benefits scores.

*Feasibility score = Average(Leadership and partnerships, Barriers and enabling factors)*

Through this scoring process, the study arrived at a short list of 20 measures that received the highest overall ratings and addressed the full range of priority vulnerabilities.

## MEASURE PRIORITIZATION

Finally, the study presented the short list of 20 measures to the PAC for further prioritization. Each PAC member identified their top three measures as well as three “second choice” measures. To make their selections, committee members considered factors such as cost, effectiveness, and feasibility, and installations were given the opportunity to indicate measures they thought were likely to have the greatest impact on installation resilience.

The study then synthesized the results of this ranking exercise to arrive at a list of 14 top priority measures (Top Priority Physical and Policy Measures, presented in Section 3.3) that accounted for key priorities of the installations and other stakeholders.

### Prioritization Criteria Details

Table 10, Table 11, and Table 12 detail how each measure was scored according to the costs and resources, benefits, and feasibility criteria.

**Table 10: Definitions of Scores for Cost and Resources Criteria**

Score	Level of Effort	Material Costs and Funding	
		Material Costs	Fund Applicability
1	Effort well within existing staffing capacity and resources	Low (small-scale, little to no infrastructure); high potential savings	Clearly fulfills grant checklist and/or status shows that agencies are willing/ planning to provide some funds
2	Effort requires adjustment of staffing and resources or some training or otherwise adding to staffing/resource capacity	Medium (medium scale, some infrastructure but not major construction); moderate savings	Partially fulfills grant checklist and/or status shows that this is a “wish list” item for agencies
3	Requires time or expertise well outside what is available within existing staff and resources	High (large scale, involves major construction); marginal savings	Does not fulfill grant checklist and/or status shows that agencies have not yet tried to budget for this

**Table 11: Definitions of Scores for Benefits Criteria**

<i>Score</i>	<i>Effectiveness</i>	<i>Co-Benefits</i>		
		<i>Environmental</i>	<i>Social and Equity</i>	<i>Economic</i>
<b>1</b>	Highly effective measure for addressing particular priority vulnerability	High	High (e.g., benefits directly to Ward 6 and Ward 8)	High
<b>2</b>	Relatively effective measure for addressing particular priority vulnerability	Medium	Medium (potential for equity and social benefits if done properly)	Medium
<b>3</b>	Less effective measure for addressing particular priority vulnerability	Low	Low (minimal social co-benefits)	Low

**Table 12: Definitions of Scores for Feasibility Criteria**

<i>Score</i>	<i>Leadership and Partnerships</i>	<i>Barriers and Enabling Factors</i>
<b>1</b>	There is a clear leader and existing, established, and/or effective partnerships for implementation	Barriers do not exist or are easily overcome, or have already been overcome (e.g., public outreach has already been done)
<b>2</b>	Leadership is unclear or would need to adjust existing partnerships	Some effort will need to be put into overcoming barriers (e.g., applying for permits; garnering public or political support)
<b>3</b>	No clear leader or champion, and would need to create new partnerships	Barriers would require a lot of effort to overcome (e.g., regulations would require project redesign or not allow project altogether; public or political opinion is currently against this type of measure)



## APPENDIX C: RESILIENCE MEASURES CONSIDERED

The prioritized measures were chosen from an initial list of approximately 75 measures that address vulnerabilities in the transportation, energy, water, and telecommunications sectors. Below are all of the measures that entered the prioritization process. Measures that were not chosen as priority measures can be used to inform future policy and strategy decisions.

The measures are roughly organized by sectoral focus areas below, with prioritized measures denoted by one asterisk and honorable mention measures denoted by two asterisks.

\*Prioritized Resilience Measure

\*\*Honorable Mention Resilience Measure

### TRANSPORTATION AND TRANSIT RESILIENCE MEASURES

- » **\*Coordinate with Metro's study of the Blue, Orange, and Silver Metrorail lines:** In 2019 Metro launched the [Blue/Orange/Silver Corridor Capacity and Reliability Study](#). The study will recommend a project or package of projects to address Metro's capacity and reliability needs and improve customer experience on those lines. The study may recommend a new Metrorail line or realignment of an existing line. Involving military planners and ANC representatives will provide a unique perspective on the commuting needs of service members, civilian staff, and residents, and will help the WMATA, DDOT, and NCPC better understand those who work in the area.
- » **\*Increase shade cover and GI along bus routes,** including along pedestrian sidewalks between Metrorail stations and Metrobus stops to and from the installations.
- » **\*Implement congestion relief and traffic control measures, including metering on-ramps, improving signage, etc.**
- » **\*Construct community EV charging stations** that can serve civilian and DoD vehicles, the latter providing potential emergency battery backup capability for installations.
- » **\*Expand connectivity to/from HCTs** in neighborhoods of Ward 8. Currently, there are two designated HCTs in Ward 8 that do not extend to JBAB and the NRL. These HCTs are located within the Poplar Point and St. Elizabeth's RACs, COG-designated areas for targeted commercial construction and household development. Assessing the existing state of bus routes, bike infrastructure, sidewalk networks between JBAB and NRL installations, and the HCTs in Ward 8 will allow the key partners and stakeholders to identify existing deficiencies and gaps and provide recommendations.
- » **\*\*Continue to explore opportunities to add Potomac River Ferry stops near installations** (e.g., WNY, JBAB) to provide alternative transportation options for installation staff and to provide multiple fueling options in alignment with regional efforts to build fuel supply resilience. The proposed River Ferry will be high speed, and new and expanded stops being downriver are being considered. Additional ferry services may ease transportation stress placed on roadway systems and provide additional transportation capacity in the event of an emergency.

- » **Install backup power at traffic signals.** Use fuel cell technology and/or solar as a backup power supply for signals at key locations.
- » **Improve last-mile connectivity to and from public transit facilities and the installations.** Conduct an analysis of and improvements to “last-mile” transportation to installations, including bus, pedestrian, carpool/vanpool, and bike, and including improvements to non-automotive travel from Alexandria to JBAB and NRL and north-south in the WNY-JBAB-NRL corridor.
- » **Support the ferry service initiative** through public outreach and education; input on governance structure and “critical” customers; call out resilience benefits.
- » **Expand subsidized D.C. Neighborhood Connect service in Ward 6 and Ward 8** for commuters traveling within Ward 6 and Ward 8 for work, school, childcare, groceries, or essential errands.
- » **Apply for Defense Access Roads Program funding.** Identify specific interchanges that would benefit from funding under this program, which enables the military to pay for public highway improvements to cover the impact of defense activity.
- » **Implement EV infrastructure planning and construction.** Coordinate on developing EV charging infrastructure for community and installations to avoid over-building, prioritizing infrastructure outside the fence to support more flexible use by communities while maintaining a “call option” to give installations priority access in emergencies. Consider opportunities to leverage new electric infrastructure investments with mobile battery strategy.
- » **Support teleworking for installation staff.** Continued teleworking can reduce personal occupancy vehicle load on roadways.
- » **Extend transit service and stations along S Capitol St and other key corridors in Ward 8, including a terminus station that could be located right outside the installations.** Given the proximity of the plug-in charging station and DDOT’s bus facility to JBAB’s entrance, there is an opportunity for a terminus station to be established outside the base near Ward 8 neighborhoods such as Congress Heights. This would be a benefit for service members, civilian staff, and residents of communities living and working near the bus station.
- » Identify most vulnerable or critical storm drains for implementation of an **adopt-a-storm-drain system** (push notification—if a storm is coming, you would go out and ensure the storm drain is not blocked by leaves/debris).

## ENERGY RESILIENCE MEASURES

- » **\*Continue advancing the RRAP study**, which involves assessing the resiliency of critical infrastructure in the region, including petroleum fuel transportation and storage assets, and identifying potential additional fuel sources outside the region to increase regional resiliency of fuel supply with installation representatives as well as energy service providers engaged as key stakeholders.
- » **Energy utilities advance climate resilience efforts:**
  - Washington Gas could create a climate risk mitigation roadmap that assesses the vulnerability of assets, operations, and services to future climate impacts and identifies priority next steps, then

implement priority next steps, so that natural gas assets can help reinforce and support other infrastructure and services.

- Pepco could build on existing work by reviewing projects proposed for other programs to identify any that would advance resilience. Additionally, Pepco should continue to review, and then develop and implement plans to address priority vulnerabilities to assets identified in the MIRR analysis.
- » **Enhance understanding of installation and community capacity for backup power.** Installations, service providers (e.g., energy, water, telecommunications), and representatives from key community support systems off-base (e.g., hospitals, first responders, shelters, community organizers) coordinate to understand existing backup energy storage capacity, identify gaps between existing and needed capacity, and work together to find solutions, potentially with support from outside funding.
- » **Strengthen utility programs** for energy efficiency, weatherization, and small-scale battery storage with higher incentives to encourage increased community involvement in these programs, resulting in higher baseline community resilience when severe events occur.
- » **Invest in mobile backup energy storage capacity** to support local communities and off-base critical assets in extreme events (e.g., large mobile batteries that can be deployed where needed).
- » **Continue to explore opportunities for microgrid development** in the District, including through researching case studies and conducting scoping and feasibility studies.

## WATER AND WASTEWATER RESILIENCE MEASURES

- » **\*Retrofit all SWPS** in D.C. with flood-hardening infrastructure (via DoD grants).
- » **\*Support construction of the Blue Plains floodwall**, which is currently seeking FEMA BRIC funding to complete implementation. If BRIC funding is not secured, then support financially.
- » **\*Provide financial support for Blue Plains microgrid** once D.C. Water has a portfolio of infrastructural projects for completing Blue Plains microgrid (expected summer 2023), especially if it is possible to expand the footprint of the microgrid to provide power to neighboring community and installation.
- » **\*Ensure Lower Anacostia Waterfront redevelopment is resilient** (envisioned through the D.C. Comprehensive Plan: Chapter 19 Lower Anacostia Waterfront/Near Southwest Area Element).
- » **\*\*Coordinate and advocate for funding for water supply alternatives.** The ICPRB helps coordinate the main water suppliers in Washington, D.C. Studies conducted by ICPRB indicate that as early as 2040, the combined pressures of growing water demand, decreasing river flows due to upstream use, and the potential impacts of climate change on the river would result in current water infrastructure not being able to meet full demand.<sup>190</sup>
  - **DoD could advocate for Congress to fund Travilah Quarry to build greater resilience of the D.C. installations to future water shortages.** This quarry's water would be managed by USACE, so this project would not be eligible for other federal pass-through grants and instead require an act of Congress to apportion funds for USACE.
  - In addition, water agencies in the region should work together to consider how these **new reservoirs could be coordinated among users holistically to help ensure broader reliability and resilience of water in the region.**

- » **Further study drainage patterns from community to installations.** Analyze flows from outside the fence onto installations based on elevation contours to understand to what extent stormwater issues on-base originate from outside the fence. Incorporate the D.C. DOEE database of BMPs installed as appropriate.
- » **Install water tanks.** Increase freshwater storage locally and remotely by installing water tanks for easy access. Prioritized locations that increase access for both installations as well as vulnerable communities.
- » **Install backup power generation at D.C. Water pumping stations** for individual electrical processes at Blue Plains and elsewhere in the D.C. Water system that affect the installations, such as Potomac pump station. Seek diversity in fuel suppliers.
- » **Elevate the ART.** Raise the Riverwalk to act as a flood barrier for WNY while maintaining its functionality for the community. Support the NPS in improvements to the ART, as they are currently pursuing funding sources.
- » **Increase infrastructure to support greywater recycling** throughout D.C. (on-base and off-base).
- » **Encourage greywater usage.** Develop policy to encourage use of greywater and fit-for-purpose water quality.
- » **Demand side water management** to help ensure reliable water supply, such as implementation of long-term water efficiency measures and participation in ICPRB drought exercises.
- » **Map water chemical supply chains** for essential treatment chemicals to identify and address vulnerabilities in movement of these commodities.

## TELECOMMUNICATIONS RESILIENCE MEASURES

- » **\*Assess and address key climate risks to telecommunications systems.** Telecommunications asset owners, operators, and service providers: 1) identify critical assets (e.g., fiber optic and coaxial cables, cable head-end facilities, cell towers, switching stations, radio assets and facilities), 2) assess vulnerabilities and dependencies, 3) build on existing efforts to address climate risks to those assets (e.g., flood-related), and 4) develop plans to increase resilience of infrastructure and operations. Coordinate and securely and anonymously share key vulnerabilities (e.g., through an anonymous survey or coordinated by trusted partners such as trade associations and Information Sharing and Analysis Centers [ISACS]) to identify and partner to address shared needs.
- » **Increase redundancy of communications options.** Follow the PACE model (Primary, Alternate, Contingency, Emergency) or a similar approach to increase communications availability for installations regardless of the situation (e.g., blue-sky, short-term or long-term outages). The alternate to normal cell service (primary) may be cell service supported by temporary cell towers (e.g., cell on wheels [COWs] or cell on light trucks [COLTs]), and a contingency plan may be radio communication. Next steps to bolster the alternate and contingency plans include:
  - Alternate: Identify and implement measures to boost the cellular service network contribution to telecommunications redundancy and resiliency, working with zoning and other restrictions that may limit placement of permanent and temporary cellular towers.
  - Contingency: Increase resilience of radio communications if cell service is lost. Ensure backup power at several broadcast stations and land mobile radio stations so key officials and emergency responders can communicate, accounting for resilient/redundant backhaul for radio frequency capabilities such as via fiber optic, satellite, or microwave. Distribute battery-powered radios to on- and off-base installations staff as well as to community centers so staff and community members can tune in.



- » **Support priority communications for event management.** Establish multiple channels of communication between installations and critical agencies to ensure reliable communication during an event, and arrange for priority services such as Government Emergency Telecommunications Service (GETS) and Wireless Priority Service (WPS) for service provider staff who are critical to installation functionality.
- » **Bring 5G service to installations and surrounding communities.** Build on 5G prototyping, experimentation, and testing examples at bases such as Norfolk and JBSA, recognizing that community-wide 5G service introduces a significant amount of new infrastructure to protect or harden.

## CROSS-SECTOR RESILIENCE MEASURES

- » **Identify critical personnel.** Ensure that off-site staff (both installation and non-installation staff, such as staff at energy service providers) are identified and designated as critical to continuity of operations so they can receive necessary supports such as backup power and communications options (e.g., radio) via special dispensation.
- » **Address the maintenance of GI and other capital projects after construction completion.** The task can be filled by workforce training programs such as DCIA through an infrastructure O&M program. The program can be funded through the FEMA BRIC grant and matching DoD REPI grant on the installation side.
- » **Update design standards and operations/maintenance protocols for all assets to account for future climate conditions,** aligning with Climate Ready D.C. Resilient Design Guidelines where possible. Then implement changes to meet updated standards (e.g., upgrade assets, practice conducting new system protocols). Notably, many industry actors are already working toward this goal.
- » **Coordinate to manage shared vulnerabilities to telecommunications and energy assets.** Owner-operators of assets with shared vulnerabilities (e.g., above-ground fiber optic cables and above-ground electric distribution lines) coordinate with each other to develop mitigation measures and share costs.
- » **Strengthen ability to quickly restore power to assets that serve communities in outages.** Utility, installation, and relevant off-base stakeholders (e.g., first responders) review emergency response plans together to identify scenarios where community assets and installation assets may need servicing and/or have peak use at the same times to (i) minimize situations in which service providers (e.g., utilities, backup power technicians) would need to choose between on- and off-installation restorations, and (ii) ensure that there is clarity on how such choices will be made. If the coordinated emergency response reviews expose unsatisfactory outcomes, consider increasing technology and service provider redundancies. Also, consider standardizing backup power system sizes, providers, and configurations, as feasible, between on- and off-installation users to create service provider efficiencies and even offer the possibility of on- and off-installation equipment and burden-sharing in extreme situations.
- » **Identify measures recommended by other local climate resilience initiatives** (e.g., the D.C. Flood Task Force) that would benefit the installations as well as nearby communities and vulnerable or marginalized populations.
- » **Coordinate with the D.C. State Historic Preservation Office (DCSHPO) to develop a program to fortify historic walls while preserving their historical significance.** The effort would involve preparation of impact documents, discussions regarding any construction and staging process as well as material usage, and collaboration between installations and DCSHPO.

## WORKFORCE TRAINING AND CAPACITY BUILDING MEASURES

- » **\*Invest in workforce development for in-demand skills** by forming partnerships between existing workforce development nonprofits in Ward 6 and Ward 8 and D.C. agencies responsible for infrastructure maintenance to provide grant writing and funding assistance and guidance in developing training programs for skills valuable to the installations.
- » **\*\*Train workers to maintain GI and other capital projects** after construction completion. The task can be filled by workforce training programs such as DCIA through an infrastructure O&M program. The program can be funded through the FEMA BRIC grant and matching DoD REPI grant on the installation side.
- » **Support employer-led training partnerships and career coaching within Equity Emphasis Areas (EEAs).** Provide grant writing assistance and funding assistance via cost-sharing to training programs that partner with employers near transit accessible and/or within EEAs in Ward 6 and Ward 8. The D.C. Workforce Investment Council (WIC) has grants to support employer-led training partnerships and career coaches for District residents. Local initiatives like the DCIA are an example of a successful win-win model for both employers and employees.
- » **Invest in apprenticeships that train residents to be qualified for careers within EEAs.** Invest in apprenticeships between underserved residents and regional business associations, trade schools, community employment organizations, and businesses in HCTs in Ward 6 and Ward 8. Apprenticeships will combine classroom instruction with OJT.
- » **Partner with the DoD Office for Diversity, Equity, and Inclusion (ODEI) and local communities to host career events for local youth within EEAs** to generate engagement and interest from youths within EEAs in Ward 6 and Ward 8 for work opportunities in trade skills. An example of such career events is #FairShot Jobs Week by the D.C. Mayor's Office.
- » **Study the effectiveness of existing workforce training and employment programs** to determine gaps.
- » **Expand training opportunities in trade and non-automatable fields within EEAs** in Ward 6 and Ward 8 through forming partnerships with workforce development organizations such as Potomac Job Corps, DCIA, D.C. DOES, D.C. WIC, and Office of Neighborhood Safety and Engagement.
- » **Support the creation of an economic mobility lab to implement innovative approaches.** Aims of this effort include identifying gaps within the employment pipeline for vocational professions and developing strategies to connect available employment and training programs to residents in Ward 6 and Ward 8.
- » **Create incentives for early childcare programs and daycare businesses to locate within areas lacking said services within EEAs.** Work with community family organizations, the Office of the State Superintendent of Education, and the Department of Child and Family Services to subsidize childcare programs for families making 80% or less than family median income. Work with space providers in HCTs of Ward 6 and Ward 8 to host childcare programs. Look into ways to offer childcare for parents who do not work jobs from 9 to 5.

## HOUSING AND DEVELOPMENT MEASURES

- » **\*Invest in affordable housing** by seeing grants from federal, regional, and District sources to support affordable housing within close proximity to the installations, specifically in Ward 6 and Ward 8. This would include high-priority areas, such as EEAs or HCTs in Ward 6 and Ward 8. Possible funding includes cost-sharing DoD grants, HAPP grants, HPTF (according to Resilient D.C.), etc.
- » **Support equitable distribution of affordable housing throughout all eight wards of the city.** Provide financial support via cost-sharing DoD grants to the mayor's vision of achieving 36,000 new homes (12,000 of which are affordable) and an equitable distribution of no less than 15% affordable housing in each Planning Area by 2050. As stated in the D.C. Housing Equity Report, Washington, D.C.'s current supply of dedicated affordable housing is concentrated in some areas of the city and almost nonexistent in others, restricting low-income residents' choice and opportunities of where to live in the District.
- » **Market the activation of Poplar Point and RFK Campus to community members and leaders to ensure projects deliver affordable housing.** Involving local stakeholders and creating mechanisms where they have oversight over the projects will ensure that promises of affordable, quality housing units and amenities are kept.
- » **Connect D.C.'s affordable housing efforts with COG's regional housing development efforts in EEAs and HCT areas throughout the COG region.** Have COG, county departments of housing, and community organizations in neighborhoods within EEAs to coordinate efforts that would expand affordable housing for workers, commuters, seniors, and families in the area.
- » **Tap into the HAPP to fund affordable housing implementation within EEAs.** The HAPP provides flexible grants of up to \$75,000 to support market and feasibility studies, development of affordable housing, and community outreach. Apply for such grants to fund existing planning efforts and affordable housing within areas identified as EEAs and/or HCTs in Ward 6 and Ward 8.
- » **Coordinate with housing and community organizations to place most vulnerable residents in affordable housing near healthcare, grocery, transit, and community amenities.**
- » **Engage housing and community organizations within EEAs to develop a plan to channel 2030 Housing Target into affordable housing for their community.** The 2030 target calls for at least 75,000 additional housing units by 2030. Of the 75,000 housing units, 75% will be designated Activity Centers or HCTs, and 75% of the units will be affordable to low- and middle-income households.
- » **Support initiatives that create new mix of housing at the low to medium cost band.** Provide financial support via DoD grants that the framework established by the Urban Institute's "Meeting the Washington Region's Future Housing Needs" and COG's "The Future of Housing in Greater Washington" report that, in its Target 3, says "at least 75% of new housing units in low and middle income" cost bands is needed in order for the region to keep up with its projected housing demand for 2030.
- » **Conduct a multi-jurisdictional workforce housing study and survey for the greater D.C. metro area** comparing the typical pay of relevant skills and trade to the cost of living in the D.C. metropolitan area. Identify existing goals, strategies, and methodologies employed between D.C.'s affordable housing agencies and those of the surrounding counties outside of D.C.
- » **Identify and prioritize at-risk affordable housing stock and initiate interagency collaboration to ensure the preservation of these existing affordable housing units.** Work with Department of Housing, DCOP, and local ANCs to identify and prioritize at-risk affordable housing stock with the goal to preserve 100% of the existing subsidized affordable housing stock within Ward 6 and Ward 8.

- » **Support revisiting and updating the Housing Preservation Strike Force Report** from 2016 to reflect current housing conditions and with additional actions to improve the condition of rental properties while minimizing renter displacement.
- » **Coordinate with housing and community organizations to identify and preserve low-cost, subsidized affordable units through conversion into dedicated affordable units.**

## SECURITY, COMMUNICATION, AND COORDINATION MEASURES

- » **\*Develop suspicious activity and trespassing prevention plan.** This plan will include a vulnerability assessment that will identify existing and future vulnerable segments of the installation boundary caused by potential activities and incursions occurring from adjacent roads and waterways. Strategies will be developed to address potential installation boundary vulnerabilities of current and future transportation corridors like the South Capitol Street Trail, from Navy Yard to National Harbor. Maintaining regular coordination and planning activities throughout the development and implementation of the prevention plan will ensure that sensitivities and boundaries are protected from trespassing.
- » **\*Create installation viewshed security plan** that addresses current and future sightlines into the installations. This could be applied to new and existing development within an established buffer area where critical sightlines have been determined. This measure will involve a line-of-sight analysis to identify vulnerable viewsheds, a series of roundtable discussions between key partners and stakeholders, as well as the development of programmatic and physical interventions to achieve the desired level of security within the installations. The policy should address residential, office, and commercial developments.
- » **Work with DCOP and installations to develop security and coordination plan regarding the South Capitol Street Trail.** Work with DCOP and installations to implement a plan to track suspicious activity, trespassing into installations and potential vulnerable points along the South Capitol Street Trail, from Navy Yard to National Harbor. Regular coordination and planning will ensure that sensitivities and boundaries are protected from trespassing.
- » **Develop screening policy that addresses sightlines into installations.** Policy area could be applied to new and existing development within an established buffer area where critical sightlines have been determined.
- » **Work with MPD to add surveillance devices on streets outside installations.**
- » **Develop a notification system for river traffic** between installations, Coast Guard, and D.C. boating organizations to track and notify recreational vessels on the river.
- » **Notify current and future tenants in Buzzard Point of presence of installations.** Coordinate with surrounding developers and landlords near the installations to notify tenants of military base presence and the basic do's and don'ts of living close to an installation.
- » **Increase buffer planning coordination and cooperation between military and local community planning initiatives.** Develop a partnership between installations, Ward 6 and Ward 8 ANCs , and DCOP that meets regularly (e.g., once every other month) to exchange knowledge, provide updates, and arrive at a common ground regarding future land-use activity in the area.



## APPENDIX D: TECHNICAL AND POLICY ADVISORY COMMITTEES

We greatly appreciate the time, expertise, and feedback that the TAC and PAC members provided. The committees were integral to the development of this MIRR study.

Table 13: Technical Advisory Committee (TAC) and Policy Advisory Committee (PAC) Composition

	Agency	TAC	PAC
Installations	Joint Base Anacostia-Bolling (JBAB)	X	X
	Naval Service Authority South Potomac	X	
	Naval Research Laboratory (NRL)	X	X
	Washington Navy Yard (WNY)	X	X
	Fort McNair, Joint Base Meyer Henderson Hall (JBM-HH)	X	X
	Joint Task Force, Natural Capital Region	X	X
Federal Agencies	Department of Defense (DoD) Office of Local Defense Community Cooperation (OLDCC)	X	X
	National Park Service (NPS)	X	
	Cybersecurity and Infrastructure Security Agency (CISA)		
	U.S. Army Corps of Engineers (USACE)	X	X
District Agencies	D.C. Department of Energy and Environment (D.C. DOEE)	X	X
	D.C. Office of Planning (DCOP)	X	X
	D.C. Department of Transportation (DDOT)	X	X
	Washington Metropolitan Area Transit Authority (WMATA)	X	X
	D.C. Homeland Security and Emergency Management Agency (D.C. HSEMA)	X	X (Chair)
Utilities	Pepco	X	X
	Washington Gas	X	
	D.C. Water	X	X
	Lumen	X	X
Regional Planning Agencies	Northern Virginia Regional Commission (NVRC)	X	
	National Capital Planning Commission (NCPC)		X

## APPENDIX E: FUNDING OPPORTUNITIES

In the course of identifying potential resilience measures, the study also compiled the below list of potential funding sources for resilience. This is not an exhaustive list but rather a resource for the key partners and stakeholders described in this report to help move forward with implementation of the resilience strategy and individual measures.

This table does not include all the newly-established funding programs under the 2022 Inflation Reduction Act or the BIL. For more information on funding programs and opportunities under these new pieces of legislation, see:

- » BIL, (aka the Infrastructure Investment and Jobs Act) fact sheet on resilience  
<https://www.georgetownclimate.org/adaptation/toolkits/resilient-infrastructure-investments/how-is-resilience-incorporated-in-the-infrastructure-investment-and-jobs-act-ijja.html>
- » User Guide for the BIL: <https://www.bluegreenalliance.org/site/a-user-guide-to-the-bipartisan-infrastructure-law-bil/>
- » A summary of the energy security and climate change investments in the Inflation Reduction Act  
[https://www.democrats.senate.gov/imo/media/doc/summary\\_of\\_the\\_energy\\_security\\_and\\_climate\\_change\\_investments\\_in\\_the\\_inflation\\_reduction\\_act\\_of\\_2022.pdf](https://www.democrats.senate.gov/imo/media/doc/summary_of_the_energy_security_and_climate_change_investments_in_the_inflation_reduction_act_of_2022.pdf)
- » User Guide for the Inflation Reduction Act, including leveraging the Act to fund climate efforts:  
<https://www.bluegreenalliance.org/wp-content/uploads/2022/10/BGA-IRA-User-GuideFINAL-1.pdf>

Table 14: Funding Grants and Opportunities for Resilience Solutions

Grant/opportunity	Eligible applicants	Applicable activities that may be funded	Funding amount	Cost share and other requirements
<a href="#">D.C. DOEE, D.C. RiverSmart Program</a> Community Stormwater Solutions Grants	Local communities, neighborhoods, ANCs, 501(c)(3) nonprofit organizations	Provides start-up funding for community-oriented projects that improve stormwater management in the District. Includes installation of practices that will reduce pollution of local waterways, reduce their stormwater fees, and educate the public about water pollution. Program also emphasizes the community engagement and outreach activities that will accompany the installation of stormwater projects.	\$300,000 is available for projects up to \$35,000	<i>Unknown</i>
DoD <a href="#">REPI</a>	State, government, political subdivision of a state,  or private conservation groups	Projects that enhance the resilience of installations to climate change and land use conversion. Includes removing land use conflicts near installations and addressing regulatory restrictions that inhibit military activities.	\$25 million (of \$40 million available) may be allocated toward climate resilient projects. The remaining \$15 million may be allocated toward projects that promote land conservation or management activities. In 2022, REPI provided \$31.6 million that was coupled with \$60.3 million to benefit 9 projects and 13 installations	Though there is no minimum, a 50% cost share is usually required, with preference given to higher ratios. Other federal grants, state and local grants, or private capital from conservation partners can be used.

DoD <a href="#">OLDCC</a>	State and local governments	<p>Financial and technical assistance is awarded to communities to develop site-specific responses that benefit both civilian and Department of Defense interests:</p> <ul style="list-style-type: none"> <li>• DCIP, which addresses deficiencies in community infrastructure that supports a military installation.</li> <li>• Installation Resilience Program provides technical and financial assistance to state and local governments to carry out activities in planning, enhancing infrastructure, and implementing measures.</li> <li>• Projects that contribute to maintaining or improving military installation resilience or will prevent or mitigate encroachment.</li> </ul>	<p>In 2021, OLDCC awarded 13 DCIP grants totaling ~\$60 million.</p> <p>In 2021, OLDCC awarded 13 Installation Resilience grants worth \$8.5 million</p>	<p>DCIP requires a 30% local match.</p> <p>Installation Resilience requires a 10% local match.</p>
DoD <a href="#">ERCIP</a>	State and local governments	<p>Intended to provide energy resilience to critical electrical loads at an installation or joint base, implement energy and water conservation measures and renewable energy technologies.</p> <p>ERCIP projects are prioritized within the following categories:</p> <ul style="list-style-type: none"> <li>• Energy Resilience</li> <li>• Energy Conservation</li> <li>• Water Resilience</li> <li>• Water Conservation</li> <li>• Renewable Energy Technologies</li> </ul>	<i>Unknown</i>	<i>Unknown</i>



<a href="#">FEMA HMGP</a>	<p>State, local, tribal, and territorial governments. Funding must be requested after a presidentially declared disaster</p>	<p>HMGP provides funding for risk reduction activities.</p> <p>Eligible activities include developing a hazard mitigation plan development; acquisition of hazard-prone homes; protecting homes and businesses from flooding with levees, floodwalls, and floodproofing; drainage improvements; and more.</p>	<p>No federal statutory maximums exist for eligible activities. The average project funding value for HMGP in 2018 was approximately \$600,000 for flood-related projects</p>	<p>A nonfederal cost share of 75% federal/25% nonfederal is required. The nonfederal comes from state or local governments, funds from a flood insurance policy, or Small Business Administration loans.</p>
<a href="#">FEMA BRIC program</a>	<p>States, local communities, tribes and territories</p>	<p>Supports capability and capacity building (C&amp;CB) activities and mitigation projects.</p> <p>Projects must be cost-effective; reduce or eliminate risk and damage from future natural hazards; meet either of the two latest published editions of relevant consensus-based codes, specifications and standards; align with the applicable hazard mitigation plan; and meet all environmental and historic preservation (EHP) requirements.</p>	<p>For 2021, \$1 billion was divided three ways:</p> <ul style="list-style-type: none"> <li>• \$56 million to the State/Territory Allocation, up to \$1 million per applicant</li> <li>• \$25 million to Tribal Set-aside. All federally recognized tribal governments may apply for \$1 million federal cost share.</li> <li>• National Competition for Mitigation Projects (remaining \$919 million, estimated [up to \$50 million federal share to the national competition])</li> </ul>	<p>A cost share of 75% federal/25% nonfederal is required. Economically disadvantaged rural communities are eligible for a 90% federal/10% nonfederal cost share.</p>
<a href="#">FEMA PSGP</a>	<p>Port authorities, facility operators, and state and local agencies that assist with port-wide mitigation efforts</p>	<p>Protect critical port infrastructure from terrorism, enhance maritime domain awareness, improve port-wide maritime security risk management, and maintain or reestablish maritime security mitigation protocols that support port recovery and resiliency capabilities.</p>	<p>Total funding for FY 2022 was \$100 million</p>	<p>A cost share is required based on the total of all PGSP funds awarded to an eligible entity.</p>

FEMA <a href="#">FMA</a>	States, local communities, tribes, and territories	Flood mitigation projects for buildings insured by the National Flood Insurance Program. All applicants must develop a hazard mitigation plan to be eligible for funding.	No floor or ceiling; \$160 million total funding allotted. In FY 2021, 194 sub-applications from 25 states asking for \$649 million were submitted.	A cost share of 75% federal/25% nonfederal is required. A FEMA-approved flood mitigation plan is required.
FEMA <a href="#">HSGP</a>	States and territories	<p>HSGP is composed of three interconnected grant programs:</p> <ol style="list-style-type: none"> <li>1. State Homeland Security Program (SHSP) implements risk-based strategies.</li> <li>2. Urban Area Security Initiative (UASI) enhances regional preparedness in urban areas.</li> <li>3. Operation Stonegarden (OPSG) promotes coordination among local, tribal, and federal law enforcement agencies.</li> </ol> <p>Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration.</p>	For FY 2022, \$1.12 billion was available. SHSP received \$415 million, UASI received \$615 million, and OPSG received \$90 million	No cost share or match requirement.
NOAA and National Fish and Wildlife Foundation <a href="#">National Coastal Resilience Fund</a>	<p>Nonprofit 501(c) organizations, state and territorial government agencies;</p> <p>local governments; tribal governments; and educational institutions, or commercial (for-profit) organizations</p>	<p>Conservation projects that strengthen and restore natural infrastructure, such as expanding or restoring marshes, wetlands, beaches, forests, floodplains, etc. Funds projects across four categories from planning to implementation:</p> <ol style="list-style-type: none"> <li>1. Community capacity building and planning</li> <li>2. Site assessment and preliminary design</li> <li>3. Final design and permitting</li> <li>4. Restoration implementation.</li> </ol>	For FY 2022, \$25.2 million was awarded for coastal resilience projects	Matching funds are not required. Some awardees have matching funds and other do not.

<a href="#">National Estuary Program (NEP) Restoring America's Estuaries Grant</a>	<p>State, interstate, tribal, intertribal consortia, and regional water pollution control agencies and entities; state coastal zone management agencies; and other public or nonprofit private agencies, institutions, and organizations, including universities</p>	<p>Projects that prevent habitat loss, harmful algae blooms, marine mammal mortalities, flooding and coastal erosion related to sea level rise or wetlands degradation, low dissolved oxygen, and contamination from pharmaceuticals or microplastics.</p>	<p>Approximately \$1 million awarded each year, with awards ranging from \$75,000 to \$250,000</p>	<p>25% match of the total project cost or 33% match with non-federal funds</p>
<p>NOAA Climate Program Office (CPO), <a href="#">Regional Integrated Science and Assessments (RISA)</a></p>	<p>Higher education institutions; other nonprofits; commercial organizations; international organizations; and state, local, and Indian tribal governments. Federal agencies or institutions are not eligible to receive federal assistance under this notice</p>	<p>C&amp;CB activities, such as helping researchers and decision-makers collaborate to promote regional, equitable adaptation to climate change.</p>	<p>Four competitions for different regions: West and Southwest</p> <ol style="list-style-type: none"> <li>1. Caribbean and Central Midwest</li> <li>2. Upper Northeast and Appalachia</li> <li>3. Rural areas across the United States</li> </ol> <p>In FY 2022, \$5.86 million funded 16 projects. Competitions 1 and 2 will be funded at \$1 million per year for 5 years. Competition 3 is funded at \$100,000 and Competition 4 at \$150,000</p>	<p>No match required; submit through grants.gov</p>
<p><a href="#">Pepco EVsmart Public Charging program</a></p>	<p>Current Pepco commercial customers within Pepco's service territory with available electricity distribution capacity, jurisdiction over parking area, and available right-of-way (ROW) allowance</p>	<p>A total of 250 EV Public Charging Network stations will be installed throughout Pepco's territory, at no cost to government sites. Two types of chargers (Level 2 and direct-current fast) are available through the program. Pepco's EVsmart team will communicate and collaborate with the government site host partners throughout the process—from application to construction—to ensure the installation meets the host's needs.</p>	<p>Full cost coverage for consultation, site assessment, licensing, engineering and design, permitting and construction, and inspection and activation</p>	<p>Unknown</p>

<p>HUD <a href="#">State CDBG Program</a></p>	<p>States, cities, and counties</p>	<p>Projects that address threats to community health and welfare, including threats stemming from flooding and sea level rise. The program works to ensure decent affordable housing, to provide services to the most vulnerable members of communities, and to create jobs through the expansion and retention of businesses.</p>	<p>Generally, no federal statutory maximums exist for eligible projects, although individual states allocate funds to prioritized projects and may impose additional limitations</p>	<p>Does not require a cost share or matching funds. 70% of CDBG funds should benefit low- to moderate-income persons.</p>
<p>HUD <a href="#">Community Development Block Grant Disaster Recovery (CDBG-DR)</a></p>	<p>HUD will notify states, municipalities, and counties if they are eligible to receive CDBG-DR grants. HUD allocates funds based on unmet recovery needs. Funds can be used to meet the nonfederal matching fund requirement of other federal programs. Applicants are only eligible after a Presidential Disaster Declaration</p>	<p>CDBG-DR funding is particularly useful for small municipalities because of its broad list of eligible projects. Small municipalities needing funds to recover from a debilitating disaster may benefit from HUD Disaster Recovery grants. A subset of the larger CDBG program, these grants provide crucial seed money and address the long-term recovery and restoration of infrastructure, housing, and economic activity, including mitigation and mitigation-planning activities intended to reduce or eliminate damage from future disasters.</p>	<p>In response to a natural disaster, Congress appropriates funds to HUD, which then allocates funds to eligible states and municipalities based on unmet recovery needs</p>	<p>Does not require a cost share or matching funds. CDBG-DR funds can be used to match other federal resources.</p>
<p>HUD <a href="#">Community Development Block Grant Mitigation (CDBG-MIT)</a></p>	<p>HUD will notify states, municipalities, and counties if they are eligible to receive CDBG. HUD allocates funds based on unmet recovery needs. Funds can be used to meet the nonfederal matching fund requirement of other federal programs. Applicants are only eligible after a Presidential Disaster Declaration</p>	<p>Funds projects that increase resilience to disasters and reduces the risk of future disasters.</p>	<p>Applicants must submit a Mitigation Needs Assessment that is created from local stakeholder input, reviewing the local Hazard Mitigation Plan</p>	<p>Does not require a cost share or matching funds. CDBG-MIT funds can be used to match other federal resources.</p>



<p>U.S. DOT <a href="#">RAISE Transportation Discretionary Grants</a> <i>Formerly TIGER/ BUILD Transportation grants</i></p>	<p>States, territories, local governments, public agencies, public authorities with a transportation function (including port authorities), transit agencies, and tribal agencies</p>	<p>Planning, preparation, design, or construction of capital projects such as road or bridge projects; public transportation projects; passenger and freight rail transportation projects; port infrastructure investments; and intermodal projects. Examples include flood protection and mitigation measures such as flood-prone bridge replacement, roadway elevation, flood warning sensors, and GI.</p>	<p>A total of \$2.275 billion was available for FY 2022, with nearly two-thirds of projects in areas of persistent poverty or historically disadvantaged communities</p>	<p>Cost share: Up to 100% federal/0% local, for projects in rural areas. 80% federal/20% local, for all other projects.</p>
<p>U.S. DOT <a href="#">Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT)</a> discretionary grants</p>	<p>States, metropolitan planning organizations (MPOs), local governments, tribal agencies, federal land management agency (jointly with state), and special purpose districts or public authorities with a transportation function.</p> <p><i>Funding to states is distributed through a formula</i></p>	<p>Planning grants enable communities to design transportation improvement plans based on vulnerabilities to current and future weather events.</p> <p>Competitive resilience improvement grants protect surface transportation assets, communities, and coastal infrastructure.</p>	<p>\$7.3 billion is divided among states, with the remaining \$1.4 billion available as competitive grants</p>	<p><i>Unknown</i></p>
<p>Economic Development Agency (EDA) <a href="#">Economic Development Grants</a></p>	<p>States, private higher education institutions, nonprofits, tribal governments</p>	<p>Relevant grant programs include the:</p> <p>Public Works and Economic Adjustment Assistance Program, which provides communities with resources to expand workforce development and attract investments.</p> <p>The Coronavirus Aid, Relief, and Economic Security (CARES) Act Economic Recovery Corps and Equity Impact Investments programs, which will launch a network of Economic Recovery Corps Fellows and provide technical assistance and support to organizations.</p>	<p>\$30 million is available in the Public Works and Economic Adjustment Assistance Program with a \$100,000 minimum.</p> <p>Funding for the Economic Recover Corps is \$20 million to \$25 million over 5 years. Funding for the Equity Impact Investments program is between \$3 million and \$10 million</p>	<p>There is a cost share required for the Public Works and Economic Adjustment Program.</p> <p>There is no cost share for the Economic Recovery Corps and Equity Impact Investments program.</p>

<a href="#">EPA Clean Water State Revolving Fund (CWSRF)</a>	States	CWSRF is a program that provides low interest loans for water infrastructure projects. Projects can include construction of publicly owned treatment works, implementation of a nonpoint source pollution management program, construction or repair to a decentralized wastewater treatment system, measures to treat or reduce stormwater, and energy efficiency and water reuse projects.	States can provide various types of assistance, including loans, debt purchases, guarantees, insurance, and additional subsidization	Cost share is 80% federal/20% nonfederal. EPA provides direct funding for the District of Columbia and territories.
<a href="#">EPA Water Infrastructure Finance and Innovation Act (WIFIA) Program</a>	Local, state, tribal, and federal agencies; partnerships and joint ventures; corporations and trusts; and Clean Water and Drinking Water State Revolving Fund (SRF) programs	The WIFIA program is a federal credit program for water and wastewater infrastructure projects. Eligible projects include development phase activities (e.g., preliminary engineering and design), construction, acquisition, and environmental mitigation.	\$20 million minimum project size for large communities and \$5 million minimum project size for communities with fewer than 25,000 residents	WIFIA can fund up to 49% of a project. Total federal assistance cannot exceed 80% of the project's cost.
<a href="#">EPA Environmental Education Local Grants</a>	Small municipalities	Environmental education projects that increase the ability for participants to make informed decisions and take responsible actions toward the environment.	Awards are \$50,000 to \$100,000	25% of EPA funding must be used for subawards, with each subaward having a value of \$5,000 or less. EPA expects to award three to four grants from each of the EPA's 10 regional offices for a total of approximately 30 to 35 grants nationwide.
<a href="#">USACE Energy Resilience &amp; Conservation Program</a>	U.S. military districts	Projects that save energy and water, reduce installation's energy costs, improve energy resilience and security, and contribute to mission assurance.	<i>Unknown</i>	<i>Unknown</i>

USACE <a href="#">Inter-agency Non-structural Flood Risk Management Program (FRMP)</a>	Military districts can apply for the program. Requires at least two government partners beyond USACE	Projects include flood hazard evaluation, storm-water management, and comprehensive floodplain management. All projects reduce flood vulnerability through nonstructural means by reducing flood consequences.	<i>Unknown</i>	<i>Unknown</i>
FHWA <a href="#">NEVI Formula Program</a>	States	The overall goal of the program is to construct publicly accessible EV charging stations. Funds can go toward the installation and network connection of EV charging stations, operation and maintenance, and station data sharing.	\$5 billion from 2022 to 2027 to help states create a network of 500,000 EV charging stations along alternative fuel corridors. Funds are distributed based on a funding formula	80% federal funding/ 20% local
COG <a href="#">HAPP Grants</a>	Local governments and nonprofit developers engaged in planning, approval, or development of housing near transit stations	Housing projects that increase the amount, affordability, and accessibility of the region's housing supply, especially close to transit stations.	Grants are up to \$75,000	No cost share required.
D.C. DHCD <a href="#">HPTF</a>	Developers apply for HPTF funding. Special revenue fund administered by the D.C. DHCD Development and Finance Division that provides gap financing for projects affordable to low- and moderate-income households	The fund provides financing in various ways, including providing pre-development loans for nonprofit housing developers, financing for site acquisition, bridge loans and gap financing, outreach and housing production counseling to groups interested in producing affordable housing, grants to finance on-site child development facilities, and more.	HPTF is funded by 15% of revenue from deed recordation and transfer taxes	<i>Unknown</i>

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