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Flood Risk Reduction from Natural and Nature-Based Features: Army Corps of Engineers Authorities

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SUMMARY

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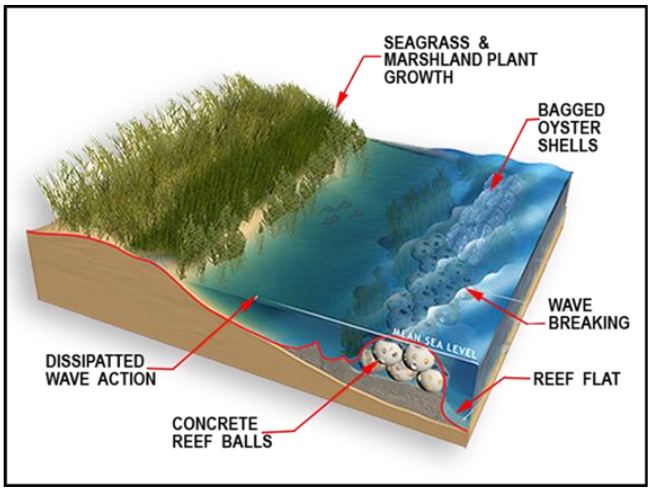
Flood Risk Reduction from Natural and Nature-Based Features: Army Corps of Engineers Authorities

The U.S. Army Corps of Engineers (USACE) is the primary federal agency involved in federal construction to help reduce community flood risk. Congressional direction on USACE flood risk reduction activities has evolved from primarily supporting levees, dams, and engineered dunes and beaches. Since 1974, Congress has required that USACE evaluate nonstructural alternatives, such as elevation of structures and acquisition of floodplain lands, during its planning of projects. Since the mid-2010s, Congress also has directed the consideration of natural and nature-based features (NNBFs). Examples of potential NNBFs for reducing flood risk include wetlands; oyster, mussel, and coral reefs; and the combination of these natural features with hard components, such as rock and concrete. Various factors are shaping how USACE is incorporating NNBFs into its flood risk reduction projects and post-flood repair activities.

NNBFs in Flood Risk Reduction Projects

Congress specifically included NNBFs as a planning requirement for USACE flood risk reduction projects in 2016. In 2018, Congress required that USACE feasibility reports for flood risk reduction projects consider using traditional and natural infrastructure, alone or in conjunction with each other. In recent feasibility reports, USACE primarily has proposed using NNBFs (other than engineered dunes and beaches) in combination with traditional structural measures rather than having the NNBFs as the primary means for reducing flood risk. To be recommended for congressional construction authorization, a USACE flood risk reduction project generally must have national flood risk reduction benefits that exceed the project's costs. Under current Administration guidance, USACE's evaluation of NNBFs is tailored to each project (i.e., it is case-by-case rather than standardized).

Examples of Coastal Natural and Nature-Based Features



Source: U.S. Army Corps of Engineers, Engineering With Nature.

NNBFs in Program to Repair Damaged Nonfederal Flood Control Works

In 1996, Congress amended USACE's program to repair damage to certain nonfederal flood control works. Congress allowed for the program to fund nonstructural alternatives in lieu of USACE making repairs if a nonfederal entity requests and assumes responsibility for the nonstructural alternative. In 2016, Congress defined the program's nonstructural alternatives to include restoring and protecting natural resources (e.g., floodplains, wetlands, and coasts), if those alternatives reduce flood risk. In practice, the program continues to predominantly repair the damaged flood control works. That is, there remain a limited number of nonfederal entities pursuing nonstructural alternatives under this program.

Identifying Challenges and Opportunities for NNBFs as Flood Risk Reduction Measures

Quantifying the effectiveness and reliability of NNBFs as flood risk reduction measures in different environmental conditions and for different floods and storms is an area of ongoing research. In some

circumstances, NNBFs may provide flood risk reduction and a suite of environmental and social benefits. In other applications, NNBFs may be unable to replicate the level of flood risk reduction provided by traditional structural and nonstructural measures. Congress may consider the following issues for NNBFs in USACE flood risk reduction activities: knowledge gaps in measuring the benefits and limitations of NNBFs and the research to fill these gaps; how USACE processes account for NNBFs' benefits, costs, and performance; and effects of agency practice, Administration guidance, and statutory authority on the consideration and adoption of NNBFs for flood risk reduction. Congress has requested two reports related to NNBFs from USACE. These reports, when available, may inform congressional deliberations on whether—and, if so, how—to support the use of NNBFs as part of USACE flood risk reduction efforts.

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Introduction

Significant recent coastal and riverine flood events, as well as concerns about changing hydrologic conditions, have prompted interest in using a suite of approaches to reduce flood risk and improve *flood resilience*, which is the ability to adapt to, withstand, and rapidly recover from floods. Traditional options to reduce flood risk include constructing levees and dams. Some stakeholders and Members of Congress support protecting, restoring, and enhancing natural features and processes to reduce flood and storm damages. Examples include floodplains that can store excess water and coastal wetlands that may attenuate storm surge.[1]

Congress has directed the U.S. Army Corps of Engineers (USACE)—the primary federal agency constructing projects to reduce flood risks—to evaluate the use of natural and nature-based features (NNBFs) when conducting its flood risk reduction activities along the nation's rivers and coasts. As part of a USACE authority, Congress defined a *nature-based feature* as "a feature that is created by human design, engineering, and construction to provide risk reduction by acting in concert with natural processes."[2] It defined a *natural feature* as a feature "created through the action of physical, geological, biological, and chemical processes over time."[3]

Although NNBFs may provide flood risk reduction and resilience benefits in some circumstances, they may be unable to replicate the risk reduction provided by traditional structural and nonstructural measures for some communities. How to effectively incorporate natural features and processes into planning of and investments in reliable flood risk management is an area of evolving policy and research. Part of the challenge is to identify where to use NNBFs and to determine how much flood risk reduction NNBFs can provided either on their own or in combination with structural and nonstructural measures.

Whether to adjust—and, if so, how—USACE's consideration and use of NNBFs for flood risk reduction is an ongoing policy issue. Although Congress has authorized consideration of NNBFs, examples of USACE using NNBFs in its flood risk reduction activities remain limited.[4] In November 2019, the Subcommittee on Water Resources and Environment of the House Transportation and Infrastructure (T&I) Committee held a hearing as part of preparations for developing water resource authorization legislation.[5] At the hearing, multiple witnesses referenced interest in facilitating the use of NNBFs for managing flood risks and improving resilience. Congress has requested various reports related to NNBFs, but the reports have not

[1] For example, see Testimony of Rear Admiral A.C. Phillips, Special Assistant to the Governor of Virginia for Coastal Adaptation and Protections, in U.S. Congress, House Committee on Transportation and Infrastructure (T&I), Subcommittee on Water Resources and Environment, *Concepts for the Next Water Resources Development Act: Promoting Resiliency of our Nation's Water Resources Infrastructure*, 116th Cong., 1st sess., November 19, 2019 (hereinafter referred as a House T&I Subcommittee hearing on November 19, 2019); and U.S. Army Corps of Engineers (USACE), "Landmark guidelines on natural and nature-based features is an international effort," press release, February 13, 2020.

[2] Section 1184 of the Water Infrastructure Improvements for the Nation Act (WIIN Act, P.L. 114-322), 33 U.S.C. §2289a(a)(2).

[3] Section 1184 of the WIIN Act, 33 U.S.C. §2289a(a)(1).

[4] In this report, the term *flood risk reduction* is applied to projects both riverine and coastal contexts. Some USACE authorities differentiate between coastal projects and other flood risk reduction projects. In those instances (e.g., see **Table 1**), the distinctions are presented.

[5] House T&I Subcommittee hearing on November 19, 2019.

been delivered to the authorizing committees.[6] When available, these reports may inform congressional deliberations on NNBFs as part of authorization and appropriations legislation.[7]

USACE considers NNBFs to include wetlands, such as salt marshes and certain submerged aquatic vegetation; oyster, mussel, and coral reefs; maritime forests/shrubs; and the combination of these natural features with engineered components, such as rock gabions (i.e., a basket or other container filled with rocks or other hard materials), stone toes (i.e., stones placed on the lower portion of an eroding streambank), and concrete reef balls (which are shown in **Figure 1** along with other NNBFs).[8] In some contexts, NNBFs that stabilize banks and shores also may be referred to as *living shorelines*.[9] Efforts to enhance natural management of floodwaters often include attempts to restore disturbed natural features. For example, the ability of coastal mangroves, wetlands, and reefs to function as buffers of erosion or storm surge may be reduced if these features are degraded or improved if they are protected or restored.

This report introduces NNBFs in the context of USACE flood risk reduction activities. It first discusses how NNBFs relate to USACE authorities for structural and nonstructural measures. It next discusses the primary flood-related activities for which USACE has NNBF-related authority: (1) federal flood risk reduction projects and (2) a program for the repair of damaged nonfederal flood control works. The report then addresses challenges and opportunities for use and incorporation of NNBFs within USACE's flood risk reduction and resilience efforts. It concludes with questions pertinent to the future of use of NNBFs as part of USACE's flood risk reduction activities.

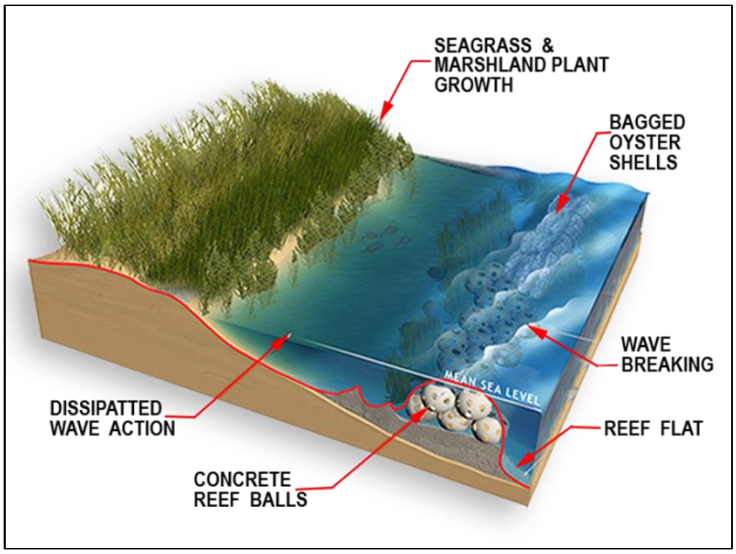
[6] For more on these reports, see the "Congressionally Directed Reports Related to NNBFs" section.

[7] Congress guides USACE flood risk management and resilience activities through the congressional appropriations process, oversight actions, and authorization legislation, which is typically titled as a Water Resources Development Act (WRDA) and often considered biennially. For more on WRDAs, see CRS In Focus IF11322, *Water Resources Development Act: Primer*, by Nicole T. Carter and Anna E. Normand.

[8] Systems Approach to Geomorphic Engineering (SAGE), *Natural and Structural Measures for Shoreline Stabilization*, February 2015. Hereinafter referred to as SAGE, *Natural and Structural Measures for Shoreline Stabilization*; USACE, *Coastal Risk Reduction and Resilience: Using the Full Array of Measures*, September 2013; and USACE, Engineer Research and Development Center (ERDC), *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience*, January 2015 (hereinafter referred to as ERDC, *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience*).

[9] SAGE, *Natural and Structural Measures for Shoreline Stabilization*.

Figure 1. Examples of Coastal Natural and Nature-Based Features



Source: U.S. Army Corps of Engineers, Engineering With Nature, "Natural and Nature-Based Features," at https://ewn.el.erdc.dren.mil/nnbf.html.

Natural and Nature-Based Features (NNBFs) in the USACE Flood Risk Reduction Context

Evolution of the USACE Authorities

USACE has been involved in efforts to reduce the nation's flood risk for over a century. The agency's early efforts involved building dams and levees along rivers. In the mid-20th century, Congress began directing USACE involvement in coastal storm risk reduction projects, which have primarily consisted of engineered dunes and beaches, and in some instances, storm surge gates and levees. Congressional direction on USACE flood risk reduction activities has evolved to include authorities to use other means to reduce flood risk. Congress expanded USACE authorities related to nonstructural alternatives; then, starting in the mid-2010s, it directed the consideration of NNBFs.

Since 1974, Congress has required that USACE evaluate nonstructural alternatives, such as elevation of structures and acquisition of floodplain lands, during its planning of flood risk reduction projects.[10] Following widespread flooding in the Midwest in 1993, many experts

[10] Section 73 of P.L. 93-251, codified at 33 U.S.C. §701b-11, which states in (a)

> In the survey, planning, or design by any Federal agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages including, but not limited to, flood-proofing of structures; flood plain regulation; acquisition of flood plain lands for recreational, fish and wildlife, and other public purposes; and relocation with a view toward formulating the most economically, socially, and environmentally acceptable means of reducing or preventing flood damages.

In 1986, in P.L. 99-662, Congress also established requirements for USACE feasibility reports for all types of projects, requiring that a feasibility report shall include "a description of a nonstructural alternative to the recommended plan when such plan does not have significant nonstructural features" (33 U.S.C. 2282(a)(2)).

encouraged USACE, other agencies, and policy decisionmakers to support greater use of nonstructural approaches to mitigate flooding.[11] In 1996, Congress amended USACE's authority to repair damage to certain nonfederal flood control works to allow use of nonstructural alternatives in lieu of repairs.[12] In 2016, in the Water Infrastructure Improvements for the Nation Act (WIIN Act; P.L. 114-322), Congress defined such *nonstructural alternatives* to the repair of nonfederal flood control works to include restoring and protecting natural resources (e.g., floodplains, wetlands, and coasts), if those alternatives reduce flood risk.[13]

Although nonstructural measures (including natural features as part of nonstructural measures) have been part of the discussion of and authorities for USACE flood risk reduction for decades, the focus on natural processes and use of terms such as *NNBF* or *natural infrastructure* are more recent developments. USACE began its Engineering With Nature initiative in 2010 to explore ways to align natural and engineering processes in USACE project planning.[14] In 2015, USACE incorporated NNBF concepts into its *North Atlantic Coast Comprehensive Study*, which Congress required as part of the agency's response to Hurricane Sandy.[15] In 2016 in the WIIN Act, Congress altered USACE authorities to specifically direct the agency to consider NNBFs in its planning of water resource projects. This was Congress's first use of the terms *natural feature* and *nature-based features* in USACE authorities.

In the WIIN Act, Congress directed USACE to evaluate NNBFs as part of the agency's planning of flood risk reduction and ecosystem restoration projects.[16] Congress required that USACE consider each of the following: natural features; nature-based features; nonstructural measures; and structural measures. In 2018, Congress also required that USACE feasibility reports for flood risk reduction projects "consider the use of both traditional and natural infrastructure alternatives, alone or in conjunction with each other, if those alternatives are practicable."[17]

[11] Interagency Floodplain Management Review Committee, *Sharing the Challenge: Floodplain Management into the 21st Century*, June 1994, https://fas.org/irp/agency/dhs/fema/sharing.pdf.

[12] Section 202(e) of P.L. 104-303, 33 U.S.C. §701n(a)(1)).

[13] Section 3029(a) of the WIIN Act (33 U.S.C. §701n(a)(4)).

[14] Todd S. Bridges et al., *Engineering With Nature: An Atlas*, ERDC, 2018, p. 2, at https://ewn.el.erdc.dren.mil/img/atlas/ERDC-EL_SR-18-8_Ebook_file.pdf. Hereinafter referred to as Bridges, *EWN: An Atlas*, 2018.

[15] "Investigations" account, Chapter 4, Title X of P.L. 113-2.

[16] 33 U.S.C. §2289a directs USACE to consider natural and nature-based features (NNBFs) in flood risk management, hurricane and storm damage reduction, and ecosystem restoration. For purposes of this report, the term *flood risk reduction project* covers both flood risk management projects, which are usually focused on river flooding, and hurricane and storm damage reduction projects, which are usually associated with coastal flood hazards. This report does not address the role of NNBFs in USACE ecosystem restoration projects. In 2014, Congress authorized USACE to perform watershed assessment to identify actions that would "help to rehabilitate and improve the resilience of damaged and natural resources to rescue risks to human life and property from natural disasters" (33 U.S.C. §2267b), and to carry out the projects pursuant to USACE continuing authorities programs.

[17] Section 1149 of P.L. 115-270, 33 U.S.C. §2282 note. Neither *natural infrastructure* nor *traditional* infrastructure were defined in Section 1149 of P.L. 115-270. Based on the implementation guidance for Section 1149 of WRDA 2018, USACE indicates that it is addressing the natural infrastructure reference in Section 1149 as part of its efforts to implement Section 1184 of the WIIN Act (P.L. 114-322) (USACE, CECW-CE Memorandum for Commanders, Major Subordinate Commands, *Revised Implementation Guidance for Section 1149 of the Water Resources Development Act (WRDA) of 2018, Inclusion of Alternative Measures for Aquatic Ecosystem Restoration*, April 17, 2019; hereinafter referred to as USACE, Revised Implementation Guidance for Section 1149 of WRDA 2018). The term *green infrastructure* is sometimes used interchangeably with NNBF. To date, Congress has not used the term *green infrastructure* in USACE authorities.

NNBFs in the Context of Nonstructural and Structural Authorities

Congress has included references to nonstructural alternatives and measures in USACE authorities since at least 1974. *Nonstructural measures* generally are those that alter the human exposure or vulnerability to flooding with little effect on the characteristics of the flood (e.g., elevating a structure, floodproofing the lowest floor of a structure, or purchasing a structure for purposes of removing it which is referred to as a *buyout*).[18] *Structural measures* are those that alter a flood's characteristics and reduce the probability of flooding at the location (e.g., a levee or berm that diverts flood water away from a community).[19]

Congress has not identified NNBFs as structural or nonstructural features for purposes of USACE planning of federal water resources projects and federal and nonfederal sharing of project costs. Current USACE practice considers measures that change the character of the flood as structural measures, which may include most NNBFs.[20] However, in the agency's role in repairing nonfederally operated flood control works damaged by floods, Congress has included the following definition:

> Nonstructural alternatives defined. - In this subsection, the term 'nonstructural alternatives' includes efforts to restore or protect natural resources, including streams, rivers, floodplains, wetlands, or coasts, if those efforts will reduce flood risk.[21]

Therefore, some NNBFs may fall within Congress's definition of nonstructural alternatives for the repair program.

It is unclear if the classifications of NNBFs as structural or nonstructural are consistent across the two sets of USACE activities that may use NNBFs for flood risk reduction—the USACE repair program and USACE's planning of projects. For purposes of planning a USACE flood risk reduction project, an NNBF may be structural or nonstructural, depending on whether the NNBF affects the character of the flood. USACE considers most NNBFs to be structural measures because the NNBFs alter the flood hazard and are cost shared as structural measures (see "Cost Sharing of USACE Flood Risk Reduction Measures"). Nonstructural NNBFs could include the restoration or expansion of a floodplain through acquisition of structures and lands, especially when combined with an aquatic ecosystem restoration project.[22]

Engineered dunes and beaches also have a role in NNBF discussions. USACE considers engineered dunes and beaches as NNBFs.[23] However, traditional engineered dunes and beaches and other types of NNBFs may not face the same challenges when it comes to being incorporated

[18] USACE, Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Damage Reduction Measures, Planning Bulletin (PB) 2016-01, December 22, 2015, at https://planning.erdc.dren.mil/toolbox/library/pb/PB2016_01.pdf. Hereinafter referred to as USACE, PB 2016-01.

[19] USACE, PB 2016-01.

[20] Personal communication (email) with USACE and CRS on April 16, 2020. USACE's PB 2016-01 provides the following definition "Nonstructural measures reduce human exposure or vulnerability to a flood hazard without altering the nature or extent of that hazard," as well as a definition for *hazard*, *exposure*, and *vulnerability*. It does include a definition for structural measures.

[21] 33 U.S.C. 701n(a)(4). This definition was added in 2016 by P.L. 114-322.

[22] Personal communication (email) with USACE and CRS on April 16, 2020.

[23] Personal communication (email) with USACE and CRS on April 16, 2020. Various USACE-related products reference engineered dunes and beaches as NNBFs: USACE, *Coastal Risk Reduction and Resilience: Using the Full Array of Measures*, September 2013; Bridges, *EWN: An Atlas*, 2018; and SAGE, *Natural and Structural Measures for Shoreline Stabilization*.

into USACE planning and construction as more novel NNBFs, such as living shorelines.[24] USACE has more than half a century of involvement in constructing engineered dunes and beaches (sometimes referred to as *dune-and-berm beach nourishment systems*) as components of coastal storm risk reduction projects. The agency has long-standing approaches for calculating the flood risk reduction benefits of engineered dunes and beaches, which is not the case for other NNBFs (see section entitled "Evaluation of NNBFs' Benefits"). In addition, unlike other NNBFs, engineered dunes and beaches often are not designed to rely primarily on natural processes (e.g., engineered dunes and beaches often require regular renourishment of sand to maintain storm damage reduction benefits). Additionally, while engineered dunes and beaches may support habitat for certain species, some researchers and stakeholders have raised concerns about the potential for environmental harm associated with some engineered dune and beach projects (see "Incorporating More Natural Processes in Engineered Dunes and Beaches" for further discussion).[25] Where appropriate, this report differentiates between the more novel applications of NNBFs and the more traditional engineered dunes and beaches.

Levee setbacks are an example of combining a structural element—the levee—with natural features—a wider floodplain—to reduce flood risk.[26] USACE considers levee setbacks as structural alternatives for purposes of its projects and its repairs to certain damaged nonfederal levees because levees alter the extent of the flood hazard.[27] The extent to which USACE would classify some levee setbacks as NNBFs (e.g., levee setbacks that augment natural storage and reduce peak flows) is unclear. Where appropriate, this report discusses levee setbacks activities that would include natural features and processes to reduce flood risks.

USACE Projects and NNBFs

Through the Engineering With Nature initiative and comprehensive studies such as the post-Hurricane Sandy *North Atlantic Coast Comprehensive Study*, USACE has identified ways in which NNBFs could be incorporated into flood risk reduction and resilience efforts. Incorporating NNBFs into USACE feasibility reports and their recommended plans for flood risk reduction is a step that would move NNBFs from concepts into potential USACE project features. Statutory direction in 2016 and 2018 requires that NNBFs be considered as part of feasibility studies and their reports. The discussion below provides examples of how USACE has incorporated NNBFs

[24] Personal communication (phone) with USACE and CRS on April 16, 2020.

[25] National Research Council (NRC), *Reducing Coastal Risk on the East and Gulf Coasts*, Washington, DC, 2014, pp. 90-91. Hereinafter referred to as NRC, *Reducing Coastal Risk on the East and Gulf Coasts*.

[26] Levees constructed close to a river's channel can reduce the river's access to its natural floodplain and increase peak flood flows in the river. Some stakeholders suggest that moving levees or segments of levees further from the river in some locations can provide for natural flood storage in the floodplain. Levee setbacks consist of replacing existing levees or constructing new levees to allow for a wider floodplain within the confines of the levees. By having a levee further from the river channel, the natural floodplain's ability to store water lowers the risk of levee failure by reducing the frequency and height of floodwater reaching the levee. Levee setbacks also may provide environmental benefits in addition to their flood risk reduction benefits. For a discussion of other considerations and potential complications in using levee setbacks, see USACE, Engineer Research and Development Center (ERDC), *Overview of Levee Setback Projects and Benefits*, July 2017, pp. 7-8. Levee setbacks may require some relocation of utilities. Levee setbacks in populated areas or areas with development near the existing levee may be particularly challenging. Lands that have existing conservation easements or other types of development and use restriction may be easier locations for pursuing levee setbacks. (Personal communication (phone) with USACE and CRS on April 16, 2020).

[27] Personal communication (email) with USACE and CRS on April 16, 2020.

into completed feasibility reports and how NNBFs are evaluated and cost shared as part of USACE flood risk reduction projects.[28]

Evaluation of NNBFs in USACE Project Planning

USACE has an extensive planning process for its flood risk reduction projects; part of the process consists of an evaluation of whether the project is economically justified as a federal investment. Generally, federal involvement in flood risk reduction projects is limited to projects that are determined to have national economic benefits exceeding their costs or to projects that address a public safety concern.[29] As previously noted, Congress has required the evaluation of NNBFs as part of USACE flood risk reduction project planning. Under current Administration guidance, USACE's evaluation of NNBFs as part of a feasibility study is tailored to each project (i.e., it is not standardized but case-by-case).[30]

Economic Justification for Flood Risk Reduction Investments

The Principles and Guidelines (P&G) broadly guide the planning process and the decision criteria for identifying the recommended plan in a USACE feasibility report. The P&G indicate that USACE is to select the plan with the greatest net economic benefit consistent with protecting the environment (referred to as the *national economic development plan,* or NED plan), unless the Assistant Secretary of the Army for Civil Works (ASACW) grants an exception. The P&G have been in effect for USACE since 1983. For a discussion of the status of the P&G and a set of guidelines developed to replace the P&G, see the box titled "Planning Guidance for Federal Water Resource Studies and Investments."

Planning Guidance for Federal Water Resource Studies and Investments

In 1983, the Reagan Administration released the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, which are known as the Principles and Guidelines (P&G), pursuant to the authority from the Water Resources Planning Act of 1965 (P.L. 89-80). The act directed that the Water Resources Council establish principles, standards, and procedures for evaluations of federal water resource projects (42 U.S.C. §1962a-2). The P&G applied to USACE and other federal water resource agencies. The P&G indicate that USACE is to select the plan with the greatest net economic benefit consistent with protecting the environment (referred to as the *national economic development plan,* or NED plan), unless the Secretary of a department or head of an independent agency grants an exception to this rule. The P&G state that the exceptions to the NED plan can be granted if there are "overriding reasons for recommending another plan, based on other Federal, State, local and international concerns." For USACE, it is the Assistant Secretary of the Army for Civil Works (ASACW) who may grant the exception.

[28] Nonfederal entities and other federal agencies also may pursue NNBFs or levee setbacks at an existing USACE projects; this work would be performed independently from USACE (i.e., no cost sharing by USACE). To make modification to existing USACE projects, the entity wanting to make the modification would need to obtain a Section 408 permission from USACE, as well as the appropriate real estate interest from USACE (e.g., easement). Information on how to obtain a Section 408 permission is available at https://www.usace.army.mil/Missions/Civil-Works/Section408/. This report does not further address nonfederal entities pursuing NNBFs at USACE projects.

[29] Congress established a cost-benefit justification as policy in the Flood Control Act of 1936 (49 Stat. 1470), which states "that the Federal Government should improve or participate in the improvement of navigable waters or their tributaries including watersheds thereof, for flood control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected."

[30] USACE, Chief of Engineering and Construction Division, Civil Works Directorate (CECW-CE) Memorandum for Commanders, Major Subordinate Commands, *Implementation Guidance for Section 1184 of the Water Resources Development Act of 2016 (WRDA 2016), Consideration of Measures*, September 28, 2017 (hereinafter referred to as USACE, Implementation Guidance for Section 1184 of WRDA 2016); and USACE, Revised Implementation Guidance for Section 1149 of WRDA 2018; Personal communication (email) with USACE and CRS on April 16, 2020.

The P&G were replaced by the Principles, Requirements, and Guidelines (PR&G) for federal water resource investments on June 15, 2015. The PR&G consists of two documents published by the Council on Environmental Quality: *Principles and Requirements for Federal Investments in Water Resources* (March 2013) and the more detailed *Interagency Guidelines* (December 2014). Under the PR&G, agencies are to strive to maximize public benefits relative to public costs, using applicable selection criteria identified in agency-specific procedures. Public benefits encompass environmental, economic, and social goals and include monetary and nonmonetary effects and quantified and unquantified measures. No hierarchy exists among these three goals and, as a result, trade-offs among alternatives are assessed as part of the evaluation. For more on the P&G and PR&G, see CRS In Focus IF10221, *Principles, Requirements, and Guidelines (PR&G) for Federal Investments in Water Resources*, by Nicole T. Carter and Charles V. Stern.

Until FY2020, Congress, through an annual appropriations restriction, had prohibited USACE to implement the PR&G. Other federal agencies were not subject to PR&G implementation restrictions. The explanatory statement accompanying the Further Consolidated Appropriations Act, 2020 (P.L. 116-94), included direction on USACE resuming efforts to develop implementation guidance for the PR&G. The explanatory statement directed that within 60 days of enactment, USACE was to "brief the Committees on Appropriations of both Houses of Congress on the efforts necessary to develop implementation rules and guidelines" for the PR&G. The briefing was to include "a timeline for completion of the implementation rules and guidelines, how the Corps' ongoing planning efforts would be impacted by implementation, impacts to funding prioritization, and any challenges associated with the development and implementation of such rules and guidelines." According to a memorandum by the ASACW in April 2020, the ASACW anticipates the Administration completing USACE's agency-specific procedures for PR&G implementation by October 1, 2020, and revised internal policy guidance by the end of 2020. The memorandum provided guidance on how USACE in the interim is to document project benefits; the guidance focused predominantly on documenting other social benefits and regional economic benefits. Until the full implementation of PR&G, USACE continues to plan projects pursuant to the P&G.

Sources: U.S. Congress, House Committee on Appropriations, *H.R. 1865 / Public Law 116–94*, committee print, 116th Cong., 2nd sess., January 2020, 38-697, p. 402; ASACW, Memorandum for the Commanding General U.S. Army Corps of Engineers, *Comprehensive Documentation of Benefits in Feasibility Studies*, April 3, 2020. PR&G are available at https://obamawhitehouse.archives.gov/administration/eop/ceq/initiatives/PandG. The P&G are available at https://planning.erdc.dren.mil/toolbox/library/Guidance/Principles_Guidelines.pdf.

According to the U.S. Government Accountability Office (GAO), the flood damage reduction of structures continues to dominate the evaluation of economics and the NED plan remains the main means for identifying the recommended plan for flood risk reduction alternatives.[31] The effect is that most flood risk reduction projects are subject to a benefit-cost analysis. This means that for an NNBF to be found economically justified as a stand-alone flood risk reduction feature, the NNBF's effect on economic benefits (which for flood risk reduction projects is principally quantified as reduced flood damages to structures) would have to be quantified and found to exceed the cost of the NNBF.

Part of the attraction of NNBFs is that they may provide some risk reduction benefits without some of the costs of traditional structures. NNBFs, compared with structures such as storm surge gates, levees, or dams, may not require as much investment in long-term maintenance in order to continue their flood risk reduction functions. In addition, NNBFs generally would not require replacement or removal at the end of their use. The consistency with which USACE is incorporating these reduced costs into the comparison of NNBFs with other alternatives in feasibility reports is unclear.

Environmental and Social Benefits of NNBFs

Another attraction of NNBFs is that they may support species habitat, water quality, or recreation, among other environmental and social benefits. Statute requires and the P&G and USACE

[31] U.S. Government Accountability Office (GAO), *Army Corps of Engineers: Evaluations of Flood Risk Management Projects Could Benefit from Increased Transparency*, GAO 20-43, November 26, 2019.

planning guidance allow the agency's feasibility reports for flood risk reduction projects to include information on the environmental and other social benefits of NNBFs.[32] Nonetheless, under the P&G, unless an exception is granted by the ASACW, USACE is directed to select the plan with the greatest net economic benefit consistent with protecting the environment (the NED plan) in its feasibility reports for flood risk reduction projects. For a discussion of how this approach to identifying recommended plans and evaluating the benefits of alternatives may be shaping the adoption of NNBFs, see the discussion under "Evaluation of NNBFs' Benefits."

The P&G have been the primary document guiding USACE planning and plan recommendations since 1983. In April 2020, the Administration described its plans to replace USACE's use of the P&G with new planning guidance.[33] The new guidance is referred to as the Principles, Requirements, and Guidelines (PR&G) for federal water resource investments.[34] Under the PR&G, USACE would strive to maximize public benefits relative to public costs. Public benefits encompass environmental, economic, and social goals, with no hierarchy among the three goals. In the interim, USACE continues to implement the P&G. For more details on the evolution of water resource planning guidance, see the text box titled "Planning Guidance for Federal Water Resource Studies and Investments."

Examples of NNBFs in USACE Flood Risk Reduction Projects

USACE is proposing using NNBFs (other than engineered dunes and beaches) often in combination with traditional structural measures. For example, the following USACE projects incorporate NNBFs as elements of broader flood risk reduction projects using structural elements.

- **New York's East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Project.** The recommended plan includes NNBFs consisting of stones and larger rocks with associated vegetative planting to attenuate wave action and reduce erosion (**Figure 2**) as part of traditional structural measures. The feasibility report indicates that the NNBF was evaluated based on its cost effectiveness, rather than a benefit-cost analysis.[35] That is, the cost of the NNBF per linear foot was compared to the cost per linear foot of a floodwall. The entire recommended plan, which consists of various components in addition to the NNBFs, was subject to a benefit-cost analysis and was found to be economically justified.[36]

[32] 33 U.S.C. §2281. Regarding environmental and other social benefits, USACE planning guidance related to nonstructural measures indicates that the agency planners should evaluate life safety and other safety concerns, as well as the social and environmental benefits and cost, in formulating and selecting nonstructural measures (USACE, PB 2016-01; USACE, *Further Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Risk Management Measures*, PB 2019-03, December 13, 2019).

[33] Assistant Secretary of the Army for Civil Works, Memorandum for the Commanding General U.S. Army Corps of Engineers, *Comprehensive Documentation of Benefits in Feasibility Studies*, April 3, 2020.

[34] The PR&G consist of two documents published by the Council on Environmental Quality for the Water Resources Council; the documents are the *Principles and Requirements for Federal Investments in Water Resources*, Council on Environmental Quality Washington, DC (March 2013) and *Interagency Guidelines* (December 2014).

[35] USACE, Final Report Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, May 2019, p. 135, at https://www.nan.usace.army.mil/Portals/37/docs/civilworks/projects/ny/coast/Rockaway/Rockaway%20Final%20Report/Rock%20Jam%20Bay%20Final%20Report%20HSGRR%205-9-19.pdf?ver=2019-05-29-124532-717. Hereinafter referred to as USACE, Final East Rockaway to Jamaica Bay, 2019.

[36] The cost-sharing information provided for the project did not specify whether the NNBF would be cost shared as structural or nonstructural. USACE, *Final East Rockaway to Jamaica Bay*, 2019, p. 255.

- **Virginia's Norfolk Coastal Storm Risk Management Project.** The feasibility report recommends NNBFs in combination with traditional structural measures, such as storm surge barriers and pump stations, and nonstructural features, such as elevation, floodproofing, and buyout of structures (**Figure 3**). The NNBFs include "living shorelines to increase resiliency."[37] According to the feasibility report, the recommended NNBFs are "economically justified by their ability to reduce maintenance costs associated with structural features of the [recommended plan]," as well as other benefits, such as recreation and education identified.[38] A benefit-cost analysis was performed on the combined NNBFs and structural features, and the investment was found to be economically justified.

The above projects use NNBFs as support for traditional structural features or in combination with traditional structural features. USACE has proposed several projects where the key components are traditional engineered dunes and beaches, which USACE considers to be NNBFs. The Congressional Research Service (CRS) has not identified a final USACE feasibility report in which NNBFs other than engineered dunes and beaches are the dominant means to reduce flood risk.[39]

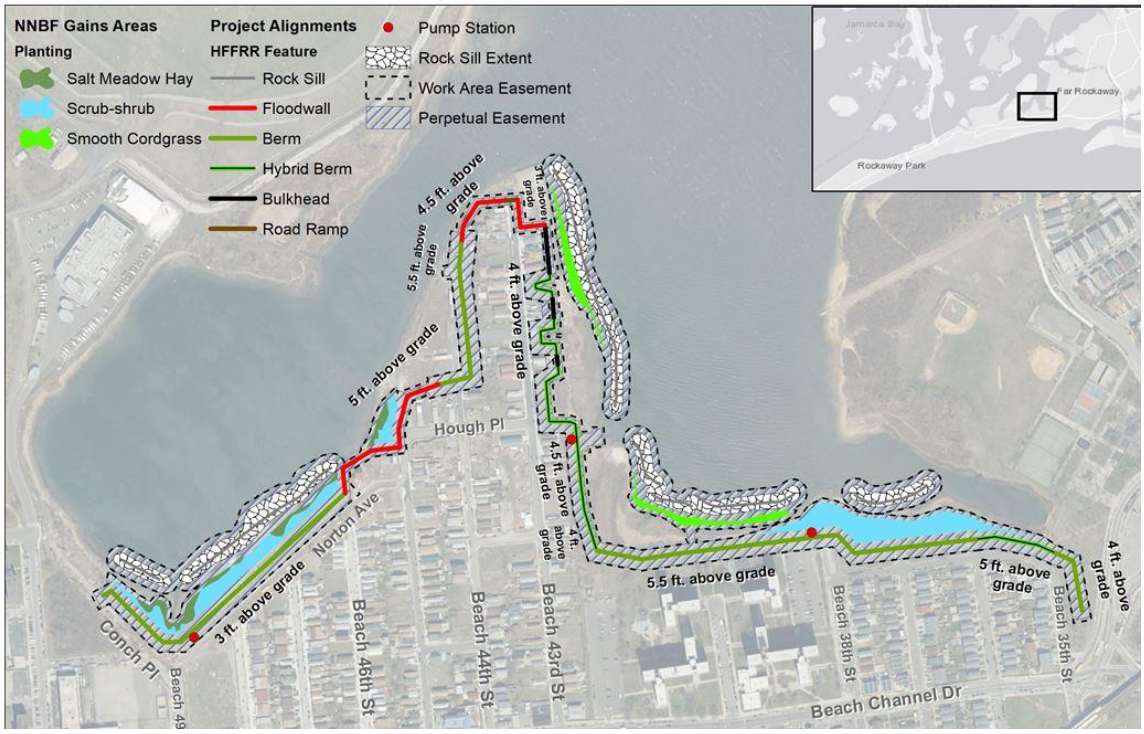
[37] USACE describes the living shoreline as "fringing wetlands with a nearshore oyster reef." USACE, *Final Integrated City of Norfolk Coastal Storm Risk Management Feasibility Study/Environmental Impact Statement*, September 2018, p. 331, at https://usace.contentdm.oclc.org/digital/collection/p16021coll7/id/5490/. Hereinafter referred to as USACE, *Final Norfolk Coastal Storm Risk Management*).

[38] USACE, *Norfolk Coastal Storm Risk Management*, p. 128.

[39] In contrast, USACE has developed some flood risk reduction projects that rely heavily on nonstructural features, such as buyouts and removal of structures and elevation of structures. Examples of dominant or significant use of nonstructural measures in a USACE flood risk reduction project include a riverine project for Mill Creek, TN, to remove 80 frequently flood-damaged residential structures and elevate 9 others and a proposed coastal project for Pawcatuck River, RI, to elevate 247 structures and floodproof 21 commercial structures. In 2016, Congress authorized the Southwest Louisiana project to raise 3,462 residential structures and floodproof 342 nonresidential structures.

Figure 2. East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Recommended Plan: Structural Features and NNBFs

(Edgemere Area of The Rockaways, NY)

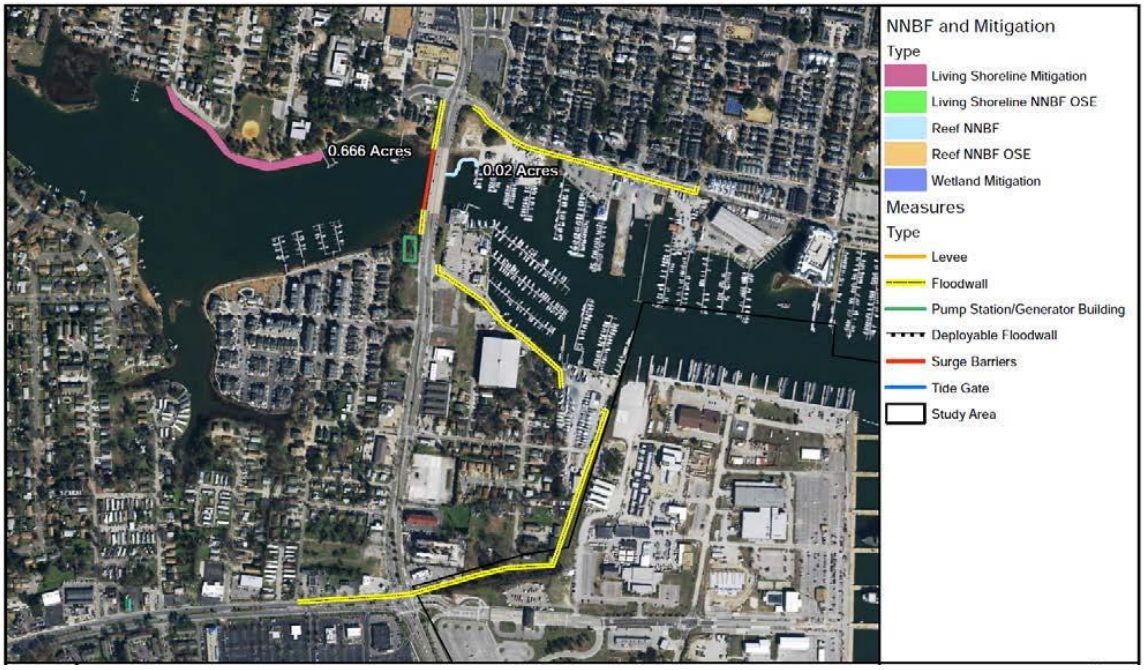


Source: U.S. Army Corps of Engineers (USACE), *Final Report Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay*, May 2019, p. xvi.

Notes: NNBF = natural and nature-based feature; Gains Areas = areas where USACE is proposing to place certain types of vegetation; HFFRR = high frequency flooding risk reduction.

Figure 3. City of Norfolk Recommended Plan: Structural Features and NNBFs

(Pretty Lake, Norfolk, VA)



Source: U.S. Army Corps of Engineers (USACE), *Final Integrated City of Norfolk Coastal Storm Risk Management Feasibility Study/Environmental Impact Statement*, September 2018, p. 404.

Notes: OSE = other social effects; NNBF = natural and nature-based feature.

Cost Sharing of USACE Flood Risk Reduction Measures

Congress has established that USACE involvement in a flood risk reduction project generally requires both congressional study authorization and congressional construction authorization. Congress also has established that the planning and construction costs for most USACE projects are shared with a nonfederal sponsor, such as a municipality or levee district for flood risk reduction projects. **Table 1** provides information on the nonfederal cost shares for USACE flood risk reduction, coastal storm damage reduction, and ecosystem restoration projects. Information about ecosystem restoration projects is included in **Table 1** because some USACE projects may have dual purposes of flood risk reduction and ecosystem restoration.[40]

Nonfederal project sponsors are generally required to provide all real estate interests needed for a flood risk reduction project, such as the land, easements, rights-of-way, relocations, and disposal (LERRD). The value of the LERRDs are applied toward the nonfederal cost share. At times, these real estate costs may exceed the standard minimum nonfederal cost share established by Congress for the USACE project type. As shown in **Table 1**, Congress has established different means for addressing LERRD costs that exceed the required nonfederal contribution for structural features and for nonstructural features.

[40] The ecosystem restoration feature would have to be justified based on the ecosystem benefits achieved rather than the flood risk reduction benefits. See discussion under "NNBFs as Structural Measures in USACE Planning" for more information.

For some types of projects, Congress also has required that part of the nonfederal cost share must include a cash contribution, as shown in **Table 1**. That is, the nonfederal share must consist of more than LERRDs and in-kind contributions.

For structural measures, Congress has generally established that the maximum nonfederal construction cost share is 50% if the nonfederal LEERDs exceed the 35% minimum. For nonstructural projects, if the nonfederal costs exceed 35%, the remainder of the costs are federal. Although Congress has established how costs of structural and nonstructural measures are to be shared, Congress has not enacted cost sharing that applies specifically to NNBFs. USACE considers most NNBFs to alter the flood hazard and treats those features as structural measures in its planning processes. Therefore, the cost-sharing requirements for structural measures apply to the use of most NNBFs, like those in the coastal storm risk reduction projects in Norfolk, VA, and East Rockaway Inlet to Rockaway Inlet and Jamaica Bay. Some stakeholders have expressed interest in having NNBFs be eligible for nonstructural cost sharing.[41]

Congress has authorized numerous coastal storm damage reduction projects that use engineered dunes and beaches and the periodic renourishment of these features, which consists of multiple cycles of sand placement on beaches, dunes, or both. Statute allows for periodic nourishment over 50 years, with possibilities for extension,[42] to be cost shared as shown in **Table 1**.

Table 1. Statutory Nonfederal Cost Shares for Selected Types of USACE Projects

(cash contribution requirements shown in parentheses)

Project Purpose		Construction		
(Cost Share in U.S. Code)	**Study**	**First Costs**	**Periodic Nourishment**	**OMRR&R**
Flood Risk Reduction				
Structural Measures 33 U.S.C. §2213(a)	50%	Minimum of 35%, up to 50% if nonfederal LERRDs are higher than 30%. (5% cash contribution)	NA	100%
Nonstructural Measures 33 U.S.C. §2213(b)	50%	Maximum of 35%. LERRDs above 35% are federal cost. (No cash contribution)	NA	100%
Coastal Storm Damage Reduction 33 U.S.C. 2213(c)(5); 33 U.S.C. §2213(d)[a]	50%	35%, with the possibility of LERRDs above 35% at a federal cost.[b]	50%[c]	100%
Ecosystem Restoration 33 U.S.C. 2213(c)(7)	50%	35%	NA	100%

Source: CRS using 33 U.S.C. §2213;

Notes: LERRDs = lands, easements, rights-of-way, relocations, and disposal; NA = not applicable; OMRR&R = operations, maintenance, repair, replacement, and rehabilitation.

a. Costs are 100% nonfederal for private shores.

[41] See for example, testimony by Melissa Samet, National Wildlife Federation, in House T&I Subcommittee hearing on November 19, 2019.

[42] 42 U.S.C. §1962d-5f.

b. USACE, *Model Agreement for Specifically Authorized Coastal Storm Risk Management Projects (with periodic nourishment) May 26, 2016 (with updates as of October 2, 2019)*, at https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll11/id/4100.

c. The federal 50% cost share applies to projects authorized starting CY2000. Projects authorized before that date may have higher federal cost shares. 33 U.S.C. §2213(d)(2).

NNBFs in Program to Repair Damaged Nonfederal Flood Control Works

USACE is authorized to fund the repair of certain nonfederal flood control works (e.g., levees, dams) and federally constructed hurricane or shore protection projects that are damaged by factors other than ordinary water, wind, or wave action (e.g., storm surge rather than high tide). To receive this assistance, damaged flood control works must be eligible for and active in the agency's Rehabilitation and Inspection Program (often referred to as the USACE P.L. 84-99 program or RIP) and have been in an acceptable condition at the time of damage, as determined by regular USACE inspections.[43] The P.L. 84-99 program does not fund repairs associated with regular operation, maintenance, repair, and rehabilitation. As of 2018, around 1,200 nonfederal entities operating roughly 2,000 levee systems participate in the P.L. 84-99 program,[44] and the nonfederal levees in the P.L. 84-99 program cumulatively span nearly 10,000 miles. Congress funds the P.L. 84-99 program and USACE's flood-fighting efforts through the agency's Flood Control and Coastal Emergencies (FCCE) account.

In 1996, Congress amended the P.L. 84-99 program to authorize USACE to implement nonstructural alternatives for reducing flood risk—previously the authority was limited to the repair or restoration of the flood control structures.[45] Congress made the nonstructural alternative authority available only if a nonfederal entity requests the nonstructural alternative.[46] That is, USACE does not include nonstructural alternatives in its evaluation of repair alternatives unless requested to do so by the nonfederal sponsor.[47]

In 2014, Congress extended the nonstructural alternative option to authorized coastal storm damage reduction projects.[48] In 2016, Congress defined the nonstructural alternative for the P.L. 84-99 program authority as including "efforts to restore or protect natural resources, including

[43] In Section 3013 of P.L. 113-121 (33 U.S.C. §701n note) Congress directed the Secretary of the Army to review guidelines relevant to USACE's levee vegetation policy and to revise the guidelines based on the findings of the review. Levee vegetation policy may be an avenue for enhancing environment conditions at levees in the P.L. 84-99 program, and the review of these policies could consider options for incorporating NNBFs into levees. This report does not further address efforts to review and revise levee vegetation guidelines.

[44] USACE, U.S, Army Corps of Engineers: Levee Portfolio Report: A Summary of Risks and Benefits Associated With the USACE Levee Safety Portfolio, March 2018, at https://www.mvk.usace.army.mil/Portals/58/docs/LSAC/USACE_Levee_Safety_Report2018.pdf. The systems consist of both riverine flood risk reduction and authorized coastal storm damage protection projects; roughly 30 dams are part of the program.

[45] Section 202(e) of the Water Resources Development Act of 1996 (WRDA 1996; P.L. 104-303).

[46] 33 U.S.C. §701n(a)(1).

[47] Personal communication (email) with USACE and CRS on April 16, 2020. Another federal agency also may act as the entity requesting and supporting the nonstructural alternative (USACE, *Emergency Employment of Army and Other Resources*, ER 500-1-1, Washington, DC, September 30, 2001, pp. 5-19 to 5-20 at https://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_500-1-1.pdf; hereinafter referred to as ER 500-1-1).

[48] 33 U.S.C. §701n(a)(1). This extension was in Section 3029 of P.L. 113-121.

streams, rivers, floodplains, wetlands, or coasts, if those efforts will reduce flood risk."[49] Congress also required USACE to notify and consult with the nonfederal sponsor about "the opportunity to request implementation of nonstructural alternatives to the repair or restoration of a flood control work" under P.L. 84-99 program. **Table 2** provides information on how USACE shares the costs for the program.[50] Under the P.L. 84-99 program, the costs for all LERRDs are 100% nonfederal. Most repairs would require few or no new LERRDs. Nonstructural alternatives may require significant new LERRD acquisition by the nonfederal sponsor. Also, if a nonstructural alternative is pursued, USACE will provide no further flood-related assistance anywhere within the formerly protected area, except for rescue operations, with some exceptions.[51]

Table 2. Nonfederal Cost Share for the P.L. 84-99 Program

Cost	Nonfederal Cost Share
Repair of Damage	
Real estate interests—land, easements, rights-of-way, relocations, and disposal interests (LERRDs)	100%
Repair of damaged federally constructed flood control work	0%
Repair of damaged nonfederally constructed flood control work	20%
Repair of damaged federally authorized coastal storm damage reduction project	0%
Nonstructural Alternative in Lieu of Repair	
LERRDs[a]	100%
Nonstructural alternative up to the lesser of what would have been the repair costs or the benefits of the repair[a]	0%
Nonstructural alternatives in excess of what would have been the repair costs or the benefits of the repair	100%

Source: CRS, using 33 C.F.R. §203.82(f) and §203.50, Engineer Regulation 500-1-1.

a. Although USACE is responsible for making the repairs, the nonfederal sponsor implements the nonstructural alternative. These sponsors may use the USACE payment for the nonstructural alternative to pay for LERRD-related costs.

For repairs under the P.L. 84-99 program, USACE primarily follows Engineer Regulation (ER) 500-1-1 from 2001,[52] and updated agency policies for how to return coastal storm damage reduction projects to design levels of protection (e.g., how to reconstruct and renourish with sand and engineered dune and beach to the design level of protection). ER 500-1-1 includes nonstructural alternatives to repair, pursuant to the 1996 amendment to the repair authority, but, in practice, the P.L. 84-99 program appears to remain a "repair-in-place" program or for minor adjustments in levee alignments to avoid repeated erosive damage to a levee segment often

[49] 33 U.S.C. §701n(a)(4). This definition was added in Section 1176 of P.L. 114-322.

[50] 33 U.S.C. §701n is the authority for the program; the statute does not specify the cost sharing.

[51] ER 500-1-1, p. 5-21

[52] See footnote 47.

referred to as *scour*.[53] Repair-in-place planning often is more expeditious for USACE than the planning required for a nonstructural alternative.[54] USACE does not appear to track the use of the nonstructural alternative authority within the P.L. 84-99 program. Selected uses of the nonstructural alternative authority include examples following the 1997 floods in California and the 2008 floods in the upper portion of the Mississippi River.[55]

In the P.L. 84-99 program, USACE may setback a damaged levee segment; USACE considers the setback a structural realignment of the levee to restore the damaged levee system.[56] USACE does not consider levee setbacks as nonstructural alternatives.[57] Because levee setbacks are considered as structural realignments for the repair of the damaged levee, the levee setbacks as part of the P.L. 84-99 program are designed for purposes of the levee's functioning and integrity (e.g., to decrease scour) rather than to enhance floodplain capacity or reduce peak flows.[58] If a nonfederal entity pursues a nonstructural alternative, such as the acquisition of floodplain lands, the nonfederal sponsor also may choose to setback the levee. It appears that USACE would consider the setback of the levee not as part of the nonstructural alternative but as a complementary investment by the nonfederal entity.

USACE and other federal agencies also may own and operate levees and other flood control projects. USACE is responsible for rebuilding flood-damaged levees that it operates. USACE has no authority to evaluate and implement nonstructural alternatives (or NNBFs) for congressionally authorized USACE-operated infrastructure.[59]

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[53] USACE, ERDC, *Levee Setbacks: An Innovative, Cost-Effective and Sustainable Solution for Improved Flood Risk Management*, June 2017, at https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/4239/ (hereinafter referred to as ERDC, *Levee Setbacks*, 2017); Personal communication (email) with USACE and CRS on April 16, 2020. There are a few instances of more significant levee setbacks to repair damage along a more extended length of a levee. For example, see the L536 levee repairs on the Missouri River to address damage from flooding in 2019 (USACE Omaha District, *Omaha District System Restoration Team / L536*, at https://www.nwo.usace.army.mil/Omaha-District-System-Restoration-Team/L536/).

[54] ERDC, *Levee Setbacks*, 2017, p. 3.

[55] Personal communication (email) with USACE and CRS on April 16, 2020.

[56] Personal communication (email) with USACE and CRS on April 16, 2020. Under the P.L. 84-99 program, USACE does not have authority to setback a levee that has not been damaged (Personal communication (email) with USACE and CRS on April 16, 2020). The text of the P.L. 84-99 program authority at 33 U.S.C. §701n(a)(1) begins as follows:

> There is authorized an emergency fund to be expended in preparation for emergency response to any natural disaster, in flood fighting and rescue operations, or in the repair or restoration of any flood control work threatened or destroyed by flood, including the strengthening, raising, extending, realigning, or other modification thereof as may be necessary in the discretion of the Chief of Engineers for the adequate functioning of the work for flood control and subject to the condition that the Chief of Engineers may include modifications to the structure or project, or in implementation of nonstructural alternatives to the repair or restoration of such flood control work if requested by the non-Federal sponsor;

The above text includes realigning language for flood control works; 33 U.S.C. §701n(a)(1) does not include realigning language for coastal storm damage reduction projects.

[57] Personal communication (email) with USACE and CRS on April 16, 2020.

[58] Personal communication (phone) with USACE and CRS on April 16, 2020.

[59] Personal communication (email) with USACE and CRS on April 16, 2020.

Challenges and Opportunities for NNBFs as Flood Risk Reduction Measures

Some contend that traditional structural measures are institutionally easier for USACE to implement, which disadvantages use of NNBFs, especially in situations and contexts that favor expediency or are time-constrained.[60] Although USACE has decades of experience planning and constructing structural levees and dams, and the authorities and policies to guide those measures, the agency's guidance and experience with NNBFs are less well-developed. For example, implementing NNBFs may require USACE to work with more federal and nonfederal agencies, landowners, and other stakeholders than the agency would with structural measures.[61] Two factors that may shape the further adoption of NNBFs as part of USACE flood risk reduction activities are (1) the availability of information and evaluation procedures for using NNBFs as flood risk reduction measures and (2) the classification of some NNBFs as structural measures for flood risk management. Identifying whether and, if so, how to incorporate NNBF concepts more fully into USACE's engineered dunes and beaches presents another challenge.

Evaluation of NNBFs' Benefits

USACE's actions pursuant to congressional modifications to its NNBF authorities since the mid-2000s have led to the development of new procedures to evaluate the flood risk reduction benefits of NNBFs and to questions about what USACE is able to count as benefits. An attraction of NNBFs as flood risk reduction measures is that by using natural processes, NNBFs also may support species habitat, water quality, or pubic enjoyment, among other environmental and social benefits. Whether—and if so, how—to incorporate the environmental and social benefits of NNBFs into USACE decisionmaking remains an ongoing question. The discussion below first reviews the challenges related to evaluating the flood risk reduction benefits and then discusses the role of environmental and other social benefits in evaluating investments in NNBFs as flood risk reduction measures under the P&G.[62]

Under the P&G, which USACE has followed since 1983, flood risk reduction projects—whether they use traditional structural measures, nonstructural measures, or NNBFs—are to be economically justified based on the NED benefits from the reduced flood risk. The P&G requires the selection of the NED plan for USACE flood risk reduction projects, unless a waiver is provided by the ASACW. The P&G allows for USACE to document the environmental and social

[60] ERDC, *Levee Setbacks*, p. 3. Expediency is often a concern for the functionality of flood control works after a flood, and most USACE feasibility study efforts are time-limited to three years, pursuant to 33 U.S.C. §2282c.

[61] For example, in order to accomplish one levee setback, USACE worked with a state department of natural resources, a state department of transportation, U.S. Fish and Wildlife Service of the Department of the Interior, and the Natural Resources Conservation Service of the U.S. Department of Agriculture (ERDC, *Levee Setbacks*, 2017, p. 30).

[62] These benefits at times are referred to as *ecosystem services* or *ecosystems goods and services*. ERDC in *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience* (p. 97) states

> Ecosystem goods and services are tangible items or intangible commodities generated by self-regulating or managed ecosystems whose composition, structure, and function are comprised of natural, nature-based and/or structural features that produce socially valued benefits that can be utilized either directly or indirectly to promote human well-being.

The PR&G, which are discussed in the box titled "Planning Guidance for Federal Water Resource Studies and Investments," incorporates ecosystem services into the evaluation framework for federal water resource investments. Congressional spending limitations on USACE implementing the PR&G through FY2019 postponed USACE work on quantifying the economic benefits of ecosystem services for the planning of federal water resource investments.

benefits; however, these benefits are not explicitly included in the agency's identification of the recommended plan for a project. In April 2020, the Administration indicated that during 2020 it plans to develop documents required for USACE to replace its use of the P&G with the PR&G. Unlike the NED-focused decision criteria of the P&G, the PR&G would direct USACE to strive to maximize public benefits toward environmental, economic, and social goals relative to public costs.[63]

Economic Benefits of NNBFs' Flood Risk Reduction

In some circumstances, NNBFs may not be effective as flood risk reduction measures or provide the level of protection sought by a community. In circumstances where NNBFs may be able to reduce flood risk, NNBFs may be effective alone or in combination with traditional flood risk reduction measures. They also may assist with adjustments to changing hydrologic conditions (e.g., coastal wetlands adjustment to sea level rise) and provide a suite of environmental and social benefits (e.g., additional species habitat, water quality improvements, and recreation opportunities).

Stakeholders and others have noted that knowledge gaps may affect USACE's ability to support federal NNBF investments. For example, in 2019, GAO found

> The Corps faces challenges in developing cost and benefit information for some types of natural infrastructure and has initiated some steps to address this. For example, a 2015 Corps report identified knowledge gaps in understanding how natural coastal infrastructure, such as wetlands may perform during coastal storms. These knowledge gaps make it challenging for the Corps to develop cost and benefit information for some natural infrastructure alternatives and compare them to other alternatives, such as those that use hard infrastructure.[64]

For USACE, the procedures to evaluate the potential benefits, limitations, and economic costs of traditional flood risk reduction structures are developed and standardized through various procedures and models. As GAO identified, this is not the case for NNBFs. GAO's report indicated that USACE was developing a research strategy to address some of the knowledge gaps.[65] Although USACE has not finalized the strategic research plan referenced by GAO, USACE has research activities directed toward improving understanding of NNBF performance, directly or indirectly.[66] Several of these research programs are developing numerical and analytical tools that can estimate performance (e.g., reduced erosion, wave impacts, and flood/storm surge inundation) for NNBF so trade-offs can be estimated in the planning, design, and maintenance process in the future. In addition to USACE, other researchers are attempting to document NNBFs' flood risk reduction benefits, limitations, and costs.[67]

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[63] For more on the PR&G, see the text box titled "Planning Guidance for Federal Water Resource Studies and Investments."

[64] GAO, *Army Corps of Engineers: Consideration of Project Costs and Benefits in Using Natural Coastal Infrastructure and Associated Challenges*, March 2019, p. 2. Hereinafter GAO, *Army Corps of Engineers.*

[65] GAO, *Army Corps of Engineers.*

[66] Personal communication (email) with USACE and CRS on April 16, 2020. Types of NNBFs being researched include coastal beaches and dunes, vegetated dune and levee systems, living shorelines (including coastal, estuarine, and riverine applications), wetlands including mangroves, oyster and coral reefs, barrier islands and island features, and others.

[67] NRC, *Reducing Coastal Risk on the East and Gulf Coasts*, p. 79. USACE, ERDC, *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience*, January 2015, p. 239. For an example of this research, see the estimated economic value of the protection provided by coastal wetlands across the United States rather than in one specific

Under the Administration's current guidance for the NNBF authority, the identification, evaluation, and justification of NNBF alternatives (other than engineered dunes and beaches) appears to remain a case-by-case process.[68] Part of the challenge is how a feature's location may affect an NNBF's performance, which consequently may influence the NNBF's benefits and costs. Congress may consider how USACE's case-by-case approach to evaluating NNBFs may shape consideration and adoption of the features (e.g., adapting the NNBFs to local conditions) in a planning process that is constrained by time and funding.[69]

Another challenge to valuing the flood risk reduction benefits of NNBFs may be NNBFs' dynamic nature as the result of their use of natural processes, as compared to traditional flood control structures. For example, NNBFs consisting of mangroves or other wetlands may shift their extent and location in response to changing conditions.[70] Other NNBFs may change over time as the living components—such as vegetation or oyster reefs—mature or their area expands or contracts. Floods or storms may temporarily or permanently damage some NNBFs and lessen their role in reducing flood risks.

International and Interagency Efforts on Natural and Nature-Based Features

The U.S. Army Corps of Engineers (USACE) has participated in multiple efforts to develop best practices and concepts for NNBFs and to understand their benefits and limitations. In 2016, USACE initiated an international collaborative project to develop and publish guidelines on NNBF development and implementation. The international guidelines aim to address developing, constructing, and maintaining NNBFs and are expected to be released in 2020.

Separately, USACE and the National Oceanic and Atmosphere Administration lead the Systems Approach to Geomorphic Engineering (SAGE) working group, which has participants from federal and state agencies, academic and research institutes, nongovernmental organizations, and the private sector. SAGE provides a platform to share information and work collaboratively on pilot NNBF projects. USACE was also a part of the National Science and Technology Council's (NSTC's) Coastal Green Infrastructure and Ecosystem Services Task Force established in response to the *Hurricane Sandy Rebuilding Strategy*.

Sources: USACE, Engineer Research and Development Center, *International NNBF Guideline Project*; NSTC, Committee on Environment, Natural Resources, and Sustainability, *Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure,* 2015; SAGE, "Systems Approach to Geomorphic Engineering," at http://sagecoast.org/.

USACE is participating in interagency and international efforts aiming to fill knowledge gaps and develop best practices and concepts for NNBFs and to understand their benefits and limitations. For example, USACE is leading an international effort to develop and publish international guidelines on NNBFs, as discussed in the box titled "International and Interagency Efforts on Natural and Nature-Based Features." The extent to which the agency may be able to incorporate into its own planning some of the international guidance remains to be seen and may depend on the extent to which the guidance helps address questions of performance and economic benefits in various environmental and flood/storm conditions.

location as provided in Fanglin Sun and Richard T. Carson, *Coastal wetlands reduce property damage during tropical cyclones*, Proceedings of the National Academy of Sciences of the United States of America, February 2020, at https://doi.org/10.1073/pnas.1915169117.

[68] See USACE guidance referenced in footnote 30.

[69] P.L. 113-121 established that USACE studies are generally limited to $3 million and three years, unless the Secretary of the Army grants an extension (33 U.S.C. §2282c).

[70] NRC, *Reducing Coastal Risk on the East and Gulf Coasts*, p. 72.

Environmental and Social Benefits of NNBFs

As previously noted, USACE may document environmental and social benefits of NNBFs, but its decision criteria under the P&G for flood risk reduction project remains the NED plan. The PR&G-based planning process may require greater consideration of environmental and social benefits; the impact of those additional considerations on USACE's development and selection of plans that use NNBFs is unknown. The question of whether to incorporate, in the planning process and related decisions, certain environmental and social benefits and costs of flood risk reduction measures is a recent development in a long-standing debate on federal water resource investments.[71]

USACE has adapted its project planning process before to meet changes in the agency's authorities. In the late 1990s, following Congress's enactment of various authorities for USACE ecosystem restoration projects, the agency developed procedures to evaluate ecosystem restoration investments (see box titled "Evaluation of an Ecosystem Restoration Project"). Whether and to what extent consideration of environmental and social benefits and costs of NNBFs, or for flood risk reduction projects more broadly, may be considered in the USACE planning and decision process is unclear.

Evaluation of an Ecosystem Restoration Project

USACE ecosystem restoration projects are not evaluated the same way as flood risk reduction projects. In the 1990s and 2000s, Congress expanded the authorities of the U.S. Army Corps of Engineers (USACE) to allow the agency to plan and construct aquatic ecosystem restoration projects to produce environmental improvements.

A USACE restoration project must be justified based on its net ecosystem restoration benefits and evaluated on the significance of the ecosystem restoration outputs, among other factors. The significance of restoration outputs rests on the institutional (e.g., recognition in federal or state law), public, or technical importance of restoring or protecting the ecosystem.

For the economic evaluation in the planning of restoration projects, USACE evaluates alternatives based on how effectively funds are used to produce an environmental output (e.g., cost per unit of habitat created). That is, flood risk reduction projects that include NNBFs are subject to a benefit-cost analysis, whereas ecosystem restoration projects that include NNBFs are evaluated based on how cost effectively they produce environmental outputs.

Sources: USACE, *Civil Works Restoration Policy*, Engineer Regulation (ER) 1165-2-501, September 30, 1999; USACE, *Ecosystem Restoration–Supporting Policy Information,* Engineer Pamphlet 1165-2-502, September 30, 1999; and USACE, *Planning Guidance Notebook*, ER 1105-2-100, April 22, 2000.

In addition to the use of NNBFs as part of USACE flood risk reduction activities, the agency, through its regulatory program, has authorized a general permit for the use of one NNBF type—coastal living shorelines. The permitted activities are not performed or funded by USACE; they are performed by the entities that apply for the permit, such as a town or a landowner. As more nonfederal entities use NNBFs such as living shorelines, USACE may draw additional knowledge, data, and experience from these nonfederal and non-USACE projects. For information on the living shoreline general permit, see the box titled "Facilitating Approval of Natural and Nature-Based Features: Living Shoreline Nationwide Permit."

[71] The debate has its roots in disagreement in the 1970s and 1980s about the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) and preceding guidance. In September 1973, the Water Resources Council published the *Principles and Standards for Planning Water and Related Land Resources* (Principles & Standards or P&S) which used the national economic development and environmental quality as the two overall purposes of federal water resources planning. Some stakeholders supported a focus on national economic benefits (as the P&G adopted in 1983), while other stakeholders wanted to keep the wider array of benefits used for decisionmaking under the P&S. For more on evolution of federal water resource planning, see CRS Report R40573, *Thirty-Five Years of Water Policy: The 1973 National Water Commission and Present Challenges*.

Facilitating Approval of Natural and Nature-Based Features: Living Shoreline Nationwide Permit

In addition to its efforts to incorporate natural and nature-based features (NNBFs) into its planning efforts, the U.S. Army Corps of Engineers (USACE) has facilitated nonfederal efforts to use *living shorelines* in certain coastal areas by issuing a general permit for the period from 2017 to 2022. The permit is referred to as Nationwide Permit (NWP) 54 – Living Shorelines and is for the construction and maintenance of living shorelines to stabilize banks and shores in coastal waters. A general permit allows a project developer to proceed with a project without the need to obtain standard individual permits in advance, which is a longer process that requires more documentation and effort. Living shorelines provide nature-based erosion control by incorporating vegetation or other natural elements alone or in combination with some type of harder shoreline structure (e.g., oyster reefs) for added stability. Even narrow marshes—a common component of living shoreline designs—have been shown to slow waves and reduce shoreline erosion. Living shorelines are not practical or feasible in all coastal environments; however, they may be effective in managing erosion along sheltered coastlines (typically found in some parts of estuaries, bays, lagoons, and coastal deltas) that are not subject to the high-energy erosive forces that occur along open coasts. Constructing living shorelines often requires substantial amounts of fill to be discharged into waters and wetlands to achieve appropriate grades to dissipate wave energy. USACE developed the living shoreline NWP because the structures, work, and fills associated with constructing living shorelines often did not fall within the terms and conditions of existing NWPs and often required individual USACE permits. The extent to which other types of NNBFs may be incorporated into other NWPs in the future is unknown. Research that USACE and others are conducting on understanding how and where NNBFs can be beneficially constructed may inform future efforts. This research also may inform efforts to adapt other federal, state, and local approvals that may be necessary for constructing NNBFs.

Living Shoreline: Oyster Reef Breakwater, Bon Secour National Wildlife Refuge in Alabama

Source: Photo used with permission and provided to CRS by USACE, Engineering With Nature.

NNBFs as Structural Measures in USACE Planning

As previously noted, current USACE practice in the planning of flood risk reduction projects is to consider measures that change the character of the flood as structural measures, which may include most NNBFs. NNBFs classified as structural measures are cost shared differently than those classified as nonstructural measures. Some stakeholders have proposed that legislation require NNBFs to be cost shared as nonstructural measures regardless of the NNBFs' effect on the flood hazard.[72] This would cap the nonfederal construction costs at 35% rather than up to 50% for structural measures, thereby shifting more of the NNBF costs to the federal government.

Levee setbacks, although not generally categorized as NNBFs by USACE, illustrate some of the challenges for NNBFs that are classified as structural measures.[73] Examples of USACE's use of setback levees as part of the agency's flood risk reduction projects remain limited. Many potential levee setback projects do not have a sufficient benefit-cost ratio to be an economically justified investment as a structural measure for flood risk reduction,[74] in part because of the costs associated with the additional land and other real estate interests that would need to be acquired.[75] Nonfederal project sponsors generally would be responsible for 100% of these LERRD costs.

The designation of an NNBF as a structural measure could require the nonfederal sponsor to pay a greater share of the cost than if the NNBF were considered nonstructural (as shown in **Table 1**). Classification of an NNBF as a structural measure also results in a difference between the cost sharing for the NNBF and the cost sharing for nonstructural measures (e.g., elevating structure in the floodplain).

Incorporating More Natural Processes in Engineered Dunes and Beaches

As discussed above, USACE has long-standing approaches for calculating the flood risk reduction benefits of engineered dunes and beaches. Traditional USACE engineered dunes and beaches may not face the same challenges of being incorporated into USACE planning and construction as other features that USACE classifies as NNBFs. Although traditional engineered dunes and beaches may have social benefits and provide habitats for some species, engineered dunes and beaches have been shown in some circumstances to have some negative effects. For example, the construction and replenishment of these features can disrupt existing biological communities, such as benthic, fish, and shorebird communities,[76] at the project site and where the sand is sourced.[77] The cumulative effect of the projects and resulting environmental changes remains poorly understood.[78] USACE has taken some steps to address these effects (e.g., the

[72] For example, see written and oral testimony from House T&I Subcommittee hearing on November 19, 2019.

[73] ERDC, *Levee Setbacks*, 2017.

[74] ERDC, *Overview of Levee Setback Projects and Benefits*, 2017, p. 7.

[75] For a discussion of other considerations and potential complications in using levee setbacks, see footnote 26 ERDC, *Overview of Levee Setback Projects and Benefits*, 2017, pp. 7-8.

[76] Karen Greene, *Beach Nourishment: A Review of the Biological and Physical Impacts*, Atlantic States Marine Fisheries Commission (ASMFC), ASMFC Habitat Management Series #7, November 2002; and Lisa M. Manning, Charles H. Peterson, and Stephen R. Fegley, "Degradation of Surf-Fish Foraging Habitat Driven By Persistent Sedimentological Modifications Caused by Beach Nourishment," *Bulletin of Marine Science*, vol. 89, no. 1 (2013).

[77] NRC, *Beach Nourishment and Protection*, 1995, p. 107; and Chapter 5, https://www.nap.edu/download/4984.

[78] Randall W. Parkinson and Danielle E. Ogurcak, "Beach nourishment is not a sustainable strategy to mitigation climate change," *Estuarine, Coastal and Shelf Science*, vol. 212 (November 15, 2018); and Tyler Woodbridge, Heather

agency considers the compatibility of some sand characteristics, and for some projects, it avoids nourishing during ecologically significant periods), but some suggest that engineered dunes and beaches could incorporate natural processes or elements with more environmental benefits.[79] For example, some researchers have suggested leaving gaps in sand placement or nourishing smaller areas at a time to allow species to recolonize from the edges of the nourishment area.[80]

Efforts to integrate resilience into approaches to flood risk reduction can raise questions about the role of traditional engineered dunes and beaches that rely heavily on regular renourishment through the engineered placement of sand on the beaches and dunes. NNBFs generally are intended to be developed by or to use natural processes.[81] NNBFs are meant to be as self-sustaining as possible;[82] that is, they are expected to recover, often without or with minimal human intervention, following a flood event. For example, natural dune and beach systems may experience large waves during storm events, which move sediment from the front of the beach (the foreshore) to the back of the beach system, effectively maintaining or raising the elevation behind the dune over time. The foreshore is built up by normal wave activity over time,[83] thereby maintaining through natural processes the dune system, including its potential flood risk reduction benefits. Some dune and beach systems may recover quickly after a damaging storm; however, others may take decades to rebuild to previous heights and widths through natural processes. Conversely, engineered dunes are often built to not be overtopped and moved. Some engineered dunes also have cores or components that provide stability (e.g., synthetic membranes or clay) and may not allow for dune migration.[84] To allow this natural movement to continue, some stakeholders have suggested that USACE consider constructing lower dunes and providing space behind dunes to accommodate sand movement.[85] Other options may include designing dunes to be naturally shaped by the wind while decreasing overall sand loss by using features such as vegetation, screens made of natural materials, and variations in terrain elevation. Furthermore, dunes could be designed to specifically include habitat features, such as those that enable wetland development.[86]

Some stakeholders argue that USACE and its nonfederal partners could consider other ways to promote natural processes and their benefits into USACE coastal storm risk reduction projects, such as by allowing dune systems to spread out, limiting the raking or grading of incipient dunes, and restricting driving on the beach.[87] These measures would allow dunes to widen or for additional dunes to form in front or behind the primary dune, providing some environmental and social benefits (e.g., greater protection for structures behind dunes and greater variety in available habitats) but could limit other social benefits (e.g., space for beach recreation).

J. Henter, and Joshua R. Kohn, "Effects of beach nourishment on intertidal invertebrates: A 15-month, eight beach study," *Estuarine, Coastal and Shelf Science*, vol. 175 (June 20, 2016).

[79] For examples of incorporating more natural processes and features into engineered dunes and beaches, see Bridges, *EWN: An Atlas*, 2018.

[80] NRC, *Reducing Coastal Risk on the East and Gulf Coasts*, p. 91.

[81] See the definitions for natural features and nature-based features in 33 U.S.C. §2289a(a)(1) and 33 U.S.C. §2289a(a)(2), respectively.

[82] ERDC, *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience*, p. xvii.

[83] NRC, *Reducing Coastal Risk on the East and Gulf Coasts*, p. 93.

[84] Karl F. Nordstrom, "Coastal dunes with resistant cores," *Journal of Coastal Conservation*, vol. 23 (2019).

[85] NRC, *Reducing Coastal Risk on the East and Gulf Coasts*, p. 93.

[86] For examples regarding the use of some of these approaches, see Bridges, *EWN: An Atlas*, 2018.

[87] NRC, *Reducing Coastal Risk on the East and Gulf Coasts*, p. 96.

Although USACE has long-standing approaches for calculating the flood risk reduction benefits of engineered dunes and beaches, the agency's procedures for incorporating more natural processes and features (e.g., vegetation) into engineered dunes and beaches are being reconsidered in the context of the additional NNBF considerations.[88] Incorporating more natural processes into engineered dunes and beaches may require additional efforts to secure the LERRDs for a dune that shifts.

Statute not only allows for federally cost-shared periodic nourishment of USACE-constructed dunes and beaches over 50 years but also provides for the possibility of extending renourishment for an additional 15 years.[89] It is unclear if USACE's evaluations for extending a project's federally cost-shared renourishment timeframe consider the role of more natural processes and elements (e.g., vegetation) in future renourishments. It also remains unknown whether more natural processes would be considered a reformulation, requiring congressional authorization, rather than an administrative extension.[90] Similarly, the extent to which P.L. 84-99 program-funded repairs of coastal storm protection projects have been used to incorporate more natural processes into the designs of engineered dunes and beaches remains unknown.

Congressionally Directed Reports Related to NNBFs

Congress has directed that the Administration produce two reports that may provide information on NNBFs to decisionmakers and planners. One report relates to how USACE complies with the WIIN Act requirement to evaluate NNBFs as part of USACE flood risk reduction projects. The other report focuses on USACE's authorities related to repair of nonfederal flood control works, including the use of the authority to support a nonstructural alternative in lieu of repairing the damage.

Report on NNBFs in USACE Projects

In 2016, Congress directed the Secretary of the Army to evaluate NNBFs, nonstructural features, and structural features in its planning of flood risk reduction projects and ecosystem restoration projects. At that time, Congress also required the Secretary of the Army to report on the statute's implementation to the House T&I Committee and Senate Committee on Environment and Public Works (Senate EPW) by February 1, 2020 (and 5 and 10 years thereafter).[91] At a minimum, the report was to include

- a description of the guidance or instructions issued, and other measures taken, by the Secretary and the Chief of Engineers to implement the requirement to evaluate NNBFs, nonstructural features, and structural features in the planning of flood risk reduction and ecosystem restoration projects;

[88] USACE is researching the use of more NNBFs into its evaluation and consideration of dune features; the review includes investigating the effects of vegetation on dune reliability and resilience (Personal communication (email) with USACE and CRS on April 16, 2020).

[89] 42 U.S.C. §1962d-5f.

[90] USACE has published guidance on how to review the extension of renourishment and indicated that only an extension of periodic nourishment will be considered and does not require a reexamination of the existing project. USACE, *Implementation Guidance for Section 1037(a)of the Water Resources Reform and Development Act (WRRDA) of 2014, Hurricane and Storm Damage Reduction*, July 16, 2015, at http://cdm16021.contentdm.oclc.org/utils/getfile/collection/p16021coll5/id/309.

[91] Section 1184(c) of P.L. 114-322 (33 U.S.C. §2289a(c)).

- an assessment of the costs, benefits, impacts, and trade-offs associated with measures recommended by the Secretary for coastal risk reduction and the effectiveness of those measures; and
- a description of any statutory, fiscal, or regulatory barriers to the appropriate consideration and use of a full array of measures for coastal risk reduction.

The committees have not received the report as of April 2020; however, USACE indicates that it has initiated development of the report.[92] USACE implementation guidance from 2017 and 2018 indicates that the agency was making efforts at that time to collect data for the report.

Report on NNBFs in Program to Repair Nonfederal Flood Control Works

In June 2014, Congress required that the Secretary of the Army review the use and performance of the emergency authority for repairs of nonfederal flood control works.[93] Congress required that a report on the findings of the review be delivered within 18 months to the House T&I Committee and Senate EPW Committee and for the report to be publicly available.[94] USACE implementation guidance for the provision indicates that the agency would undertake the review when Congress provided funding for it.[95] Congress has not yet funded the review. The Secretary is to, among other actions,

> review and evaluate the historic and potential uses, and economic feasibility for the life of the project, of nonstructural alternatives, including natural features such as dunes, coastal wetlands, floodplains, marshes, and mangroves, to reduce the damage caused by floods, storm surges, winds, and other aspects of extreme weather events, and to increase the resiliency and long-term cost-effectiveness of water resources development projects.[96]

Conclusion

In 2010, USACE ramped up its efforts to identify opportunities to incorporate natural processes into its flood risk reduction activities with its Engineering With Nature initiative. Starting in the mid-2010s, Congress has authorized the consideration of NNBF alternatives in circumstances where NNBFs can reduce flood risk. The reliance on natural processes in NNBFs may provide flood resilience advantages compared with traditional structural measures or when used in combination with traditional structural measures. However, various challenges to the adoption of NNBFs as part of USACE projects remain.

Among recently completed feasibility reports, USACE has recommended a few flood risk reduction projects that use NNBFs. Typically, the recommendation is to use the NNBFs in combination with structural measures if the combined alternative can be economically justified.

[92] Personal communication (email) with USACE and CRS on April 16, 2020.

[93] Section 3029(b) of P.L. 113-121.

[94] Section 3029(c)(2) of P.L. 113-121.

[95] The guidance states: "Section 3029 (b) of WRRDA 2014, Emergency Response Authorities, directs the Secretary to undertake a comprehensive review of the implementation of Section 5 of the Act of August 18, 1941. This review will be undertaken at such time that funds are provided by Congress. Funding of this review will be considered during the normal budgetary process." The untitled guidance is available at http://cdm16021.contentdm.oclc.org/utils/getfile/collection/p16021coll5/id/741.

[96] Section 3029(b)(2)(C) of P.L. 113-121.

The limited use of NNBFs in USACE flood risk reduction activities to date is shaped by various factors ranging from what is known about NNBF performance to how NNBFs are evaluated. In some circumstances, NNBFs may not be able to provide levels of flood risk reduction similar to traditional structural and nonstructural measures. In other circumstances, NNBFs may be able to reduce flood risks, but the ability to quantify the effectiveness and reliability of NNBFs as flood risk reduction measures in different environmental conditions and for different flood and storm conditions remains limited. In circumstances where NNBFs may be effective alone or in combination with traditional flood risk reduction measures, they can provide a suite of environmental and social benefits. The extent to which USACE considers NNBFs' environmental and social benefits, as well as their flood risk reduction potential, in agency feasibility reports and their recommendations and in decisions on repairing damaged flood control works remains unclear. USACE's evaluations and recent applications of NNBFs have raised questions about how environmental and social benefits are considered in USACE planning and the potential opportunities and limitations for USACE's use of NNBFs.

Some questions related to NNBFs relevant to decisions about USACE authorities and policies include the following:

- What are the remaining knowledge gaps regarding the benefits and limitations of NNBFs in flood risk reduction? What are the options for decisionmakers to direct USACE or other federal agencies to address these gaps or otherwise support research that addresses these gaps?
- What is the impact of current decisionmaking processes on the accounting of NNBFs' benefits, costs, and performance over time?
- How do statutes, Administration guidance, and agency practice create disincentives and incentives for NNBF adoption for USACE and nonfederal project sponsors?

The congressionally directed reports discussed in the previous section may inform USACE decisionmakers' and planners' understanding of the circumstances in which use of NNBFs may be beneficial. They also may inform congressional deliberations on whether—and, if so, how—to support use of NNBFs as part of USACE flood risk reduction and resilience efforts.

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