



ENHANCING BENEFITS EVALUATION FOR WATER RESOURCES PROJECTS: TOWARDS A MORE COMPREHENSIVE APPROACH FOR NATURE-BASED SOLUTIONS

*Evolution of Benefits Evaluation and Prioritization of Water
Resources Projects*

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers' (USACE) Civil Works Program is responsible for implementing a water resources mission that includes flood risk reduction, navigation, recreation, infrastructure, ecosystem restoration, and emergency response. It is imperative that USACE develop and execute water resources projects in such a way as to ensure that the expenditure of federal funds is reasonable and yields appropriate benefits, consistent with national policy and its legislated authorities. The USACE approach to project evaluation has evolved in tandem with broader public expectations about the role of the federal government in managing water resources for public safety, ecosystem protection, and economic development.

USACE project valuation strategies were originally designed to responsibly guide federal investment to projects that provide benefits to the nation. These valuation methods have been refined through multiple iterations to incorporate additional scientific information and consider a more diverse array of benefits and costs. While this evolution is notable, the guidance and tools necessary to rigorously evaluate the full suite of economic, environmental, and social benefits could be further updated and improved to reflect current mandates and directives from Congress and the President as well as the best available science.

Since the 1980s, USACE review and prioritization of water resources projects have been driven by benefit-cost analysis (BCA). The past and current use of BCA has contributed to under-valuing the environmental and social benefits of potential water resource alternatives and projects. Consequently, this practice has adversely impacted the evaluation of Nature-Based Solutions (NBS) intended to reduce risk and support public safety while also providing environmental and social co-benefits. New methods for valuing environmental and social benefits and innovative planning practices can refine these processes to better account for the full suite of benefits and costs, which in turn can promote wider applications of NBS and the development of more effective and efficient infrastructure systems.

In 2020-2021, Congress and the Biden Administration have directed USACE to advance the practice of comprehensive benefits analysis that addresses economic, environmental, and social goals. USACE continues to invest in technical and policy research which, as this report outlines, represents a continuation of the 100-year evolution of benefits policy within the agency. The goal of this larger study is to ensure that USACE decision-makers can apply the best available science when formulating and evaluating projects to address the nation's water resource challenges.

In order to analyze the use of BCA in USACE project formulation and evaluation, this report examines: 1) the evolution and expansion of USACE's mission and the related authorities, policies, and practices for using BCA; 2) how policies, practices, and challenges in using BCA outside of USACE influence the integration of NBS; and 3) provides an initial assessment on the gaps and obstacles within law and policy to further the implementation of NBS projects.

The evolution of the USACE mission and authorities, combined with newly available valuation and planning methodologies, could support a more comprehensive evaluation of economic, environmental and social benefits and therefore a more complete evaluation of NBS in water resources planning efforts. The



need for more comprehensive evaluation of benefits is underscored by the growing stressors and shifting baselines associated with addressing the impacts of climate change, which necessitates “multiple lines of defense” strategies and other approaches that integrate traditional engineering approaches and NBS. Although technical, legal, and policy challenges remain, recent legislation and executive guidance lays the groundwork for a more holistic consideration of environmental, social, and economic benefits, which in turn could produce federal investments that produce more value, and more diversified value, through infrastructure development. The USACE’s mission and methods have evolved over the last century and is well-positioned to leverage advancements in technical and policy research in support of a comprehensive approach to the nation’s water resources challenges.



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LIST OF ACRONYMS

Acronym	Term
ASACW	Assistant Secretary of the Army for Civil Works
BCA	Benefit Cost Analysis
BCR	Benefit Cost Ratio
EWN	Engineering With Nature
EO	Executive Order
EQ	Environmental Quality
FERC	Federal Energy Regulatory Commission
FIARBC	Federal Interagency River Basin Committee
GAO	Government Accountability Office
NBS	Nature-Based Solutions
NED	National Economic Development
NEPA	National Environmental Policy Act
NNBF	Natural and Nature-Based Features
MRR	Modernizing Regulatory Review
OMB	Office of Management and Budget
P&G	Principles and Guidelines
PR&G	Principles, Regulations and Guidelines
P&S	Principles & Standards
RED	Regional Economic Development
SDG	Sustainable Development Goal
USACE	U.S. Army Corps of Engineers
WRDA	Water Resources Development Act





1.0 INTRODUCTION

1.1 STUDY BACKGROUND

To accelerate progress and delivery of sustainable and resilient infrastructure projects for navigation, flood risk management, water operations, and ecosystem restoration consistent with its Engineering With Nature® (EWN) initiative, the U.S. Army Corps of Engineers (USACE) has engaged in a collaborative effort with The Water Institute of the Gulf (the Institute) and the Network for Engineering With Nature to conduct policy research regarding comprehensive evaluation of the benefits of applying EWN principles and practices in water resources project development, to include Natural Infrastructure, Natural¹ and Nature-Based Features (USACE, 2021a), and other Nature-Based Solutions (NBS). Throughout this document and in subsequent reports, these techniques are referred to as “NBS.”

It has been well-documented that current USACE planning policies undervalue the full suite of benefits provided by NBS (Carter & Lipiec, 2020). Since 1983, USACE has followed the “Principles and Guidelines for Water and Related Land Use Implementation Studies” (P&G) which requires that water resources projects be economically justified with the National Economic Development (NED) plan selected unless the Assistant Secretary of the Army for Civil Works (ASACW) grants a waiver. While environmental and social benefits may be documented, under the P&G, economic analysis is the primary consideration. Consequently, a key policy question for this project is to assess the degree to which NBS have been excluded from the final array of alternatives, or, if included in project recommendations, perform poorly against current budget criteria.

One of the first tasks in this effort is the inventory and review of completed Chief’s Reports (since 2005) so as to identify a subset of six Chief’s Reports that included NBS as part of the plan formulation and evaluation process. These six reports will be reviewed and re-analyzed without the constraints of current procedures and policies to fully consider engineering, economic, environmental, and social benefits.

Based on insights gathered in reanalyzing the selected Chief’s Reports, the study team will perform a policy analysis of the economic, environmental, and social benefits to determine how the additional quantification of benefits impacts the benefit-cost ratio (BCR). This policy research effort is intended to inform the development of an updated Benefit-Cost Analysis (BCA) for each Chief’s Report contributing to a final revised score via the White House Office of Management and Budget (OMB) process. This policy research effort will not result in a formal reevaluation of the examined Chief’s Reports; rather, this effort is aimed at providing USACE and OMB officials with relevant information to support future decision-making.

¹ “[N]atural features are created and evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature... [c]onversely, nature-based features are those that may mimic characteristics of natural features, but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction” (Bridges et al., 2015).



In the Water Resources Development Act (WRDA) of 2020, Congress directed USACE to issue final agency specific procedures to implement the Principles, Regulations and Guidelines (PR&G) within six months. Such procedures will require USACE to develop future water resource projects in accordance with the PR&G and in such a way that “fully identifies and analyzes national economic development benefits, regional economic development benefits, environmental quality (EQ) benefits, and other societal effects (OSE),” (Carter & Stern, 2017). The study team’s applied policy research is intended to support USACE in developing future procedures in considering the full suite of economic, environmental, and social costs and benefits in water resources projects.

1.2 ORGANIZATION OF THIS REPORT

USACE’s mission and relevant authorities related to project evaluation, and the use of BCA, have evolved in tandem with broader national policies and public expectations about the role of the federal government in managing water resources for public safety, ecosystem protection, and economic development. To date, it is hypothesized that USACE’s use of BCA has contributed to under-valuing the benefits of NBS in project formulation and evaluation. However, new methods for valuing environmental and social benefits and innovative planning practices are available that can further refine these processes and methods to better account for a more comprehensive suite of costs and values, which in turn can support application of NBS and development of more sustainable and resilient infrastructure systems.

In order to analyze the current use of BCA in USACE project formulation and evaluation, the following three chapters of this report examine: 1) the evolution and expansion of USACE’s mission and the related authorities, policies, and practices for using BCA; 2) how policies, practices, and challenges in using BCA outside of USACE influence the integration of NBS; and 3) an initial assessment on the gaps and obstacles within law and policy to further implementation of NBS projects.

This report provides preliminary conclusions derived from the cumulative research, review, and analytical efforts. It is anticipated that these initial conclusions will be revised and refined as the research effort proceeds.



2.0 WATER RESOURCES MISSION PROCESS

2.1 OVERVIEW OF THE WATER RESOURCES PLANNING PROCESS

This research effort centers on USACE’s water resources development work, which is under the specific purview of USACE’s Civil Works Program. However, understanding the manner in which USACE’s mission has evolved is critical to identifying the current opportunities for NBS projects. USACE water resources projects include flood control, navigation, recreation, infrastructure, ecosystem restoration, and emergency response. As with all USACE mission areas, it is imperative that USACE execute these projects to ensure that the expenditure of federal funds is reasonable and yields appropriate benefits, as guided by policy.

The responsibility for water resource projects is divided amongst USACE national **headquarters**, which primarily develops the policies and guidance applicable to the program, eight **regional divisions**, and 38 **districts**, which are responsible for planning, engineering, constructing, and managing water resources projects (GAO, 2019a, pp. 9–10). In order to be constructed, a project must first be identified, authorized by Congress through WRDA legislation, studied, and then have funding appropriated through a separate congressional action or have funding allocated under one of USACE’s limited continuing authorities.

Water resources projects begin in consultation with a *nonfederal sponsor*, such as a state, local, tribal, or territorial government, who first identifies a need or a problem necessitating USACE’s involvement. Since 1972, water resource projects have been primarily authorized through a series of WRDA bills. For an authorized project to be constructed, USACE and the nonfederal sponsor must proceed through a planning process known as a “feasibility study process” or “study process” that scopes the potential project, evaluates alternatives, and assesses the feasibility of the project. Although this process is subject to change (identified reasons are detailed below), USACE’s current planning process for water resources projects is guided by the USACE Planning Guidance Notebook (USACE, 2000a). As summarized by the U.S. Government Accountability Office (GAO), “The Corps develops these feasibility studies to inform OMB, Congress, and others whether water resources development projects warrant federal investment” (GAO, 2019b, p. 4).

2.2 WATER RESOURCES STUDY PROCESS

USACE’s study process (Figure 1 below) begins with a scoping phase that specifies the problem, assesses the conditions (including physical, economic, and social) in the project area, and identifies opportunities to address the problem. After this scoping phase, the project team (comprised of USACE engineers, economists, planners, and other specialists) identifies and evaluates potential alternatives. The project team then analyzes the list of alternatives and assesses the feasibility of the options. USACE then prepares a feasibility report (a “Chief’s Report”) that includes findings and recommendations, which is sent to the ASACW for approval (GAO, 2019a). As directed by Executive Order 12322 (46 Fed. Reg. 46561, 1981; also *Executive Order No. 12608*, 52 Fed. Reg. 34617, 1987), USACE submits the reports to OMB prior to submission to Congress. OMB is then directed—per the Executive Order—to examine each report for consistency with (a) “the policy and programs of the President”; (b) the [P&G] “or other such



planning guidelines for water and related land resources planning;” (c) “other applicable laws, regulations, and requirements relevant to the planning process.”

When OMB receives a Chief’s Report, the OMB Water and Power Branch reviews the Report, including the economic analysis from the alternative analysis phase, to ensure the review is consistent with Administration policy. According to a recent audit by the GAO “OMB staff said they consider such criteria as whether the proposed projects’ purposes fall within one of USACE’s three main mission areas and have a benefit-to-cost ratio of 1:1 or higher as a threshold” (GAO, 20-113R, p. 4). OMB then provides the ASACW with a letter stating whether the Chief’s Report is consistent with the policies of the administration (GAO, 20-113R, p. 4).

The Feasibility Study Process:

✓ Key Decision & ■ Product Milestones



Figure 1. The Feasibility Study Process: Key Decision and Product Milestones. From: <https://planning.ercd.dren.mil/toolbox/project.cfm?Step=2> (last accessed September 21, 2021)

Following congressional authorization, USACE obtains federal funds through a separate process. In this process, OMB considers recommended projects whose construction have been authorized by statute for potential inclusion in the President’s Budget. Through this analysis, OMB determines whether the projects meet certain performance-based criteria developed in collaboration with USACE.² Such criteria include the economic analysis in which OMB staff considers whether the proposed project has a benefit cost ratio of **2.5:1** or higher³, using a **seven percent discount rate** that is used to “express expected future benefits and costs in comparable, present value terms” (GAO, 20-113R, p. 5, FN 18).

According to a 2019 GAO audit report, there is often a disconnect between the economic analysis outcome between USACE and OMB due to USACE’s determination that they are required by WRDA 1974 “to use the nominal discount rate for the formulation and evaluation of federal water resources projects rather than the seven percent discount rate that is used for the President’s Budget request” (GAO,

² Criteria established each year and published in USACE’s Program Budget Press Books.

³ In Fiscal Year 2022, the Biden Administration used a 2.0:1 threshold; see: <https://usace.contentdm.oclc.org/utills/getfile/collection/p16021coll6/id/2191>



20-113R, p. 5, FN 18). This discrepancy “commonly causes the projects recommended [for congressional authorization based upon USACE’s economic analysis] to fall below the benefit-to-cost ratio threshold of 2.5:1” used for development of the President’s Budget (GAO, 20-113R, p. 5, FN 18).

When a water resources project successfully reaches this stage in the process—WRDA authorization, USACE feasibility study, Chief’s Report review, OMB review (including the discount rate challenge noted above)—it is then recommended for appropriation, which often occurs through the Energy and Water Development appropriations process and, in certain instances, through supplemental appropriations. Prior to 2011, funding for projects that did not meet the criteria for inclusion in the President’s Budget could be funded via a congressional earmark. Due to concern around the earmarking process, the 112th Congress (2011-2012), imposed an “earmarking moratorium” (Lynch, 2020). Following the imposition of the moratorium, only projects identified in the President’s Budget were funded by Congress. As a result, many projects identified by nonfederal sponsors, that were authorized by Congress and supported by USACE’s internal analysis, remain unfunded. The backlog of authorized projects is currently estimated to exceed \$98 billion (Normand & Carter, 2020). Figure 2 shows an expanded version of the steps in the water resources study process, including final review and recommendations.

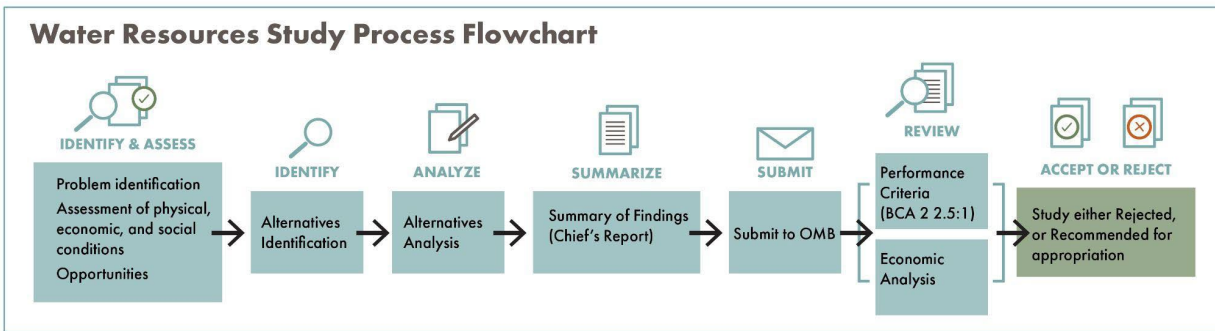


Figure 2. Water Resources Study Process Flowchart.





3.0 HISTORY AND EVOLUTION OF USACE MISSION, BENEFIT-COST ANALYSIS, AND THE ROLE OF NATURE BASED SOLUTIONS

3.1 ORIGIN AND EVOLUTION OF USACE AUTHORITY AND PRIORITIES

USACE has evolved from a limited role in enhancing navigation for military and commercial purposes to a more expansive and complex role at the intersection of commerce, transportation, recreation, environmental protection and restoration, protection of human life, and promotion of ecological and social resilience. A summary of the major steps in USACE evolution is shown in Figure 3.

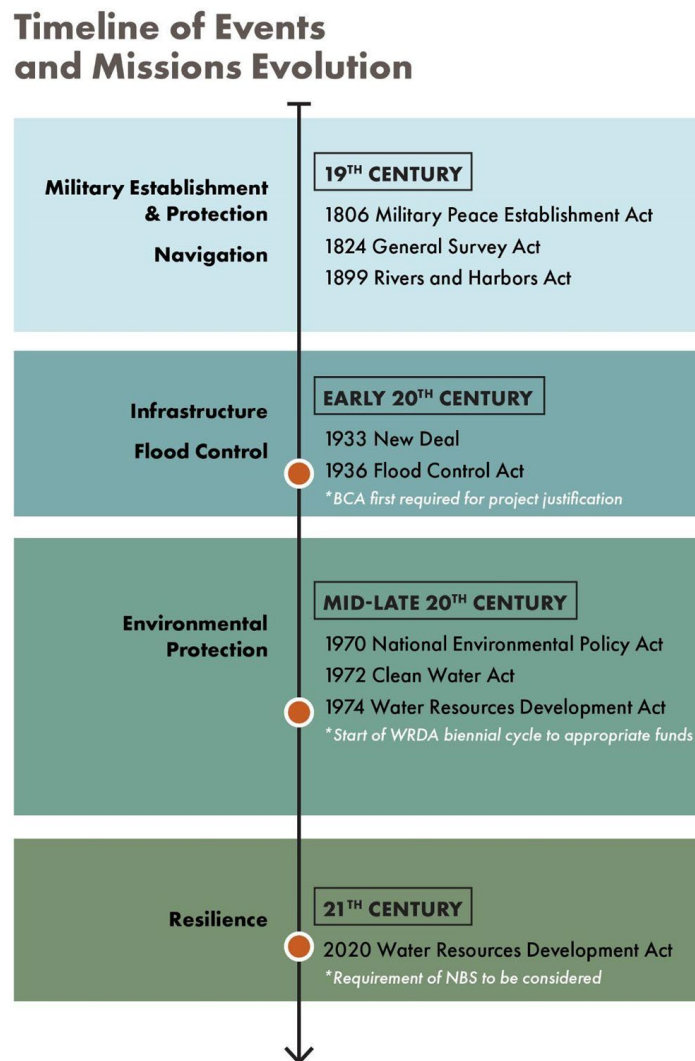


Figure 3. Timeline of Events and USACE Missions Evolution



3.1.1 USACE Origins in National Defense

The history of USACE can be traced back nearly 250 years to General George Washington and chief engineer of the Continental Army Colonel Richard Gridley, and their leadership in the fortifications at storied battlefields such as Bunker Hill and Dorchester Heights (USACE, n.d.). The necessity of engineers to the defense of the United States was formally recognized on March 16, 1802, by the Military Peace Establishment Act, which established USACE as a permanent division of the United States Army (*Military Peace Establishment Act*, Ch. 9, § 26, 1802 Stat. 132, 137).

After the War of 1812, when the British invaded the country from three sides, USACE recognized that “the national defense should rest upon four pillars: a strong Navy at sea; a highly mobile regular Army supported by reserves and National Guard; invincible defenses on the seacoasts; and improved, rivers, harbors, and transportation systems that would permit paid armed concentration against an invading enemy, and swifter, more economical logistical lines” (USACE, 2008). Although still rooted in the defense of the country, the General Survey Act of 1824 formally established USACE’s civil focus on **navigation** and authorized the President to employ engineers to improve the navigation of the Ohio and Mississippi Rivers. Over time, improving navigation on the inland waterways was not only critical to national defense but was deemed critical to the economic viability of the nation. Safe, efficient, and reliable navigation was USACE’s first civil mission and remains a primary focus of USACE and an economic driver for the nation (USACE, 2000b).

3.1.2 19th Century: Navigation and Flood Risk Studies

USACE’s primary focus through the first half of the 19th century was keeping rivers and harbors clear for military and commercial navigation. Typical projects involved clearing snags and sandbars from navigable waters. USACE also employed a trial-and-error methodology using wing dams, wicket dams, and locks to find ways to deepen river channels and enhance commerce (USACE, 2008). These early efforts were followed by an initial expansion of responsibility for **flood control**. In 1850, spurred by the devastating floods along the Mississippi River, USACE was tasked with conducting a comprehensive study of flood control in the Mississippi River Basin. Two officers of the Corps of Topographical Engineers conducted separate surveys; one survey focused solely on the characteristics of the river and the other made recommendations to build reservoirs on the river to reduce flooding. These reports were sent to Congress in January 1852 (USACE, 2008).

3.1.3 Early 20th Century: Expansion to Hydropower and Flood Control

During the first third of the 20th century, two factors induced a significant change in USACE’s mission and priorities. First, the occurrence of major floods in an increasingly urbanized landscape resulted in extensive property loss and hundreds of deaths. These flood events engendered public support for the federal government to play a more significant role in flood risk mitigation (USACE, 2008, p. 60, p. 263). The cost of effective mitigation was too great for local and state governments to bear independently, which further increased support for federal leadership in these areas (USACE, 2008). Second, residents of rural America were falling behind their urban counterparts in the race to electrify homes and businesses. Power producers were investing heavily in densely populated areas but failing to build electric infrastructure in rural parts of the country where the distances between consumers made returns on capital



investment too low for shareholders. Rural Americans saw abundant opportunity for hydropower if the federal government were to make capital investments in dams and related infrastructure. USACE engineering and regulatory expertise supported the expanded federal hydropower investments mandated by Congress. By the middle of the 20th century, USACE was “the largest constructor and operator of federal power facilities” (USACE, 2008, p. 69).

Following the devastating floods of 1927, Congress authorized USACE to conduct comprehensive surveys of the country’s navigable streams and to develop plans for the improvement of flood control in addition to navigation, hydropower, and irrigation (Carter & Lipiec, 2020, p. 66). The 1936 Flood Control Act gave USACE responsibility for federal flood control projects. At this point, flood control became one of USACE’s core responsibilities, and this has resulted in the design, construction, maintenance, and repair of thousands of miles of levees and hundreds of dams, along with floodways, spillways, and other facilities in addition to performing many related studies conducted to protect people, property, and communities.

During this era, USACE faced challenges implementing flood control measures as a larger political debate took place regarding the role of the federal government versus state and local governments in protecting residents (USACE, 2008). The prevailing understanding was that while state and local governments were responsible for public safety, federal expenditures for flood control should be limited to preserving navigability for military and commercial purposes. USACE was, however, still involved in major studies and work on the Mississippi River during this time period. For the next 60 years, USACE expanded its flood control mission with an approach that focused primarily on building levees to protect riparian communities (USACE, 2008, p. 59).

3.1.4 Mid-20th Century: A Multipurpose Mission

After the Great Depression, USACE’s mission and priorities expanded, and as a result USACE became integral in efforts to meet the national need for jobs created and driven by federal spending. When the Roosevelt Administration launched the New Deal to put the country back to work through infrastructure investments, USACE—due to its role in studying river basins around the country—was well-positioned to assist with the development of new dams, reservoirs, and similar projects.

During this time of large federal investment, USACE began to incorporate the concept of “multipurpose” or “multi-objective” planning and construction (USACE, 2008, p. 71). Prior to the New Deal, when USACE sought congressional authorization and appropriations for its projects, it justified those projects based on their capacity to enhance economic development. Flood control projects before the New Deal era—still mainly in the form of levees—were justified by their capacity to protect commercial development in floodplains. As USACE’s involvement in building reservoirs expanded, so too did the purposes and objectives of its flood control mission. Beyond economic development, policymakers began to focus on social effects (particularly job-creation and recreational opportunities) and ecological impacts (with an emphasis on protecting fish and wildlife; USACE, 2008).



The 1936 Flood Control Act established the principle that USACE projects should be justified by some form of BCA. Further discussion of the origins of this principle in the law and how it has been implemented by USACE is provided in Section 3.2.

3.1.5 Late 20th Century: Fiscal and Ecological Emphasis

Three important trends that affected USACE’s mission emerged in the final third of the 20th century. First, as federal spending on entitlement programs and military operations expanded, funding was cut for public works and other discretionary programs. While USACE was a central institution in analyzing and developing solutions to riverine and coastal flooding, congressional appropriations were increasingly directed at ongoing operations and maintenance costs or emergency response rather than new construction. Second, Congress established a practice in the 1970s of using a biennial WRDA cycle as the primary legislative vehicle for separately authorizing and appropriating funds. This cycle has become central to the USACE planning and implementation process. Third, the growing influence of environmental protection policies affected USACE planning and construction. In particular, the 1970 National Environmental Policy Act (NEPA) changed the way USACE approached flood control project planning. NEPA requires federal agencies to assess the environmental impact of any “significant actions” they undertake. NEPA requires agencies to engage the public in the assessment process and the agencies are vulnerable to litigation should they fail to adhere to the statute’s procedural requirements. Together, these three trends represent important changes to USACE’s mission and operations that inform this study.

3.1.6 USACE’s Expanding Environmental Mission

While navigation and flood control were early and straightforward expansions of USACE’s initial mission, the authority to fully assess and address the environmental impact of its civil works has a more complex history. Beginning in the late 19th century, USACE attempted to utilize its existing authorities—specifically, the authority to prevent obstructions to navigation—as a justification for regulating contaminant disposal into navigable waters as well as filling in harbors (Shabman & Scodari, 2014, Appendix A, p. 76).

In one such effort, USACE personnel attempted to use the Rivers and Harbors Act of 1899, which did not provide USACE with explicit environmental protection authority⁴, to stop a company from releasing effluent into a waterway on the basis that the effluent might corrode steamboat boilers (Section 9 of the *Rivers and Harbors Act*, 1899, line 77).

Congress addressed one of these needs with the Oil Pollution Act of 1924, which gave USACE explicit authority to protect harbors from oil discharges. However, the law came without sufficient appropriation and resources to adequately act on the new authority. For the next several decades, USACE continued to

⁴ Section 9 required Corps approval of “any bridge, dam, dike, or causeway over or in any port, roadstead, haven, harbor, canal, navigable river, or other navigable water of the United States. Section 10 stated that, without Corps approval, “it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of any port, roadstead, haven, harbor, canal, lake, harbor or refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States” (*Rivers and Harbors Act*, 1899)



operate without the appropriate authority or funding to establish environmental protection as a primary mission (USACE, 2008).

The Clean Water Act of 1972 (*Federal Water Pollution Control Act*, 1972, 33 U.S.C. § 1151 *et seq*) provided the agency direct and explicit authority for environmental protection. Specifically, the Clean Water Act expanded USACE’s authority to regulate the discharge of dredged and fill materials into federal waters. This authority to review and issue “404 permits” or “wetlands permits” (colloquially named for the section of the Clean Water Act authorizing the regulatory program) remains one of the most visible examples of USACE’s environmental mission (*Federal Water Pollution Control Act*, 1972, line 1344).

USACE’s responsibility to assess the environmental impacts of its own civil works developed on a separate track. Congress authorized USACE to review ways to modify water resource projects to improve EQ through WRDA 1986. It was not until the passage of WRDA 1990 that Congress officially established environmental protection as one of the “primary missions” of USACE “in planning, designing, constructing, operating, and maintain water resource projects” (*WRDA*, 1990, Pub. L. No. 101-640, § 306, 104 Stat. 4604). WRDA 1992 and 1996 expanded that authority to “carry out projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands” (*WRDA*, 1990, Pub. L. No. 101-640, § 306, 104 Stat. 4604). Today, USACE “plays a dominant role in the stewardship of the nation’s ecosystems” (National Research Council, 2014). However, as discussed in Sections 3.2 and 3.3, the effects of USACE civil works projects on ecosystem services do not factor into the primary BCA that drives project formulation and prioritization.

3.1.7 Early 21st Century: Building for Resilience

The continuing, combined impact of extreme weather events and changes to the natural and built environments have prompted an evolution of USACE’s mission in the recent decades. Hurricane Katrina in 2005, the flooding on the Upper Mississippi and Ohio Rivers in 2011 (which prompted the second ever opening of the Birds Point-New Madrid Floodway [Camillo, 2012]), Hurricane Harvey in 2017, and flooding across vast areas of the Upper Midwest in 2019, collectively caused thousands of deaths and billions of dollars in damage. These events, a subset of major flood-related disasters over the first two decades of the 21st century, initiated questions regarding the federal approach to flood-risk management centered on levees and other public works.

Concurrently, the collective understanding of the effects that sea-level rise and coastal erosion have in increasing flood risk and threatening coastal communities has improved. As climate change has increased flood risk, policymakers have begun to focus on resilience as a central theme in flood risk management. USACE defines resilience as the “ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions” (U. S. Army Corps of Engineers, 2020). Resilience practitioners in the U.S. and around the world are increasingly considering how flood risk management activities can be reconsidered to enhance the capacity of people and natural systems to withstand and recover from flooding.



3.1.8 Promotion of NBS through the EWN Initiative

“The overarching need before us is to figure out how to discover, preserve, expand, and apply nature’s value.”

US Army Corps of Engineers. Engineering with Nature, An Atlas, Volume 2, 2021.
<https://ewn.el.erdc.dren.mil/atlasv2.html#Download>

Guided by the goal of developing “socially acceptable, economically viable, and environmentally sustainable [water resources infrastructure] projects,” a team of USACE scientists and engineers established the EWN Initiative in 2010 (USACE, 2018). Engineering With Nature refers to “the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environment, and social benefits through collaboration” (USACE EWN, 2021). Since 2010, the EWN Initiative has and continues to support USACE’s traditional missions, such as Navigation and Flood Risk Management, as well as Ecosystem Restoration (USACE, 2018). The application of the EWN principles to infrastructure projects is rooted in four major elements. First, “using science and engineering to produce operational efficiencies.” Second, “using natural processes to maximize benefit.” Third, “increasing the value provided by projects to include social, environmental, and economic benefits.” And fourth, “using collaborative processes to organize, engage, and focus interests, stakeholders, and partners” (USACE, 2018). The goal of the EWN Initiative is to better integrate and align traditional approaches with nature-based infrastructure approaches to achieve multiple societal co-benefits (termed “triple-win” outcomes; see Figure 4).

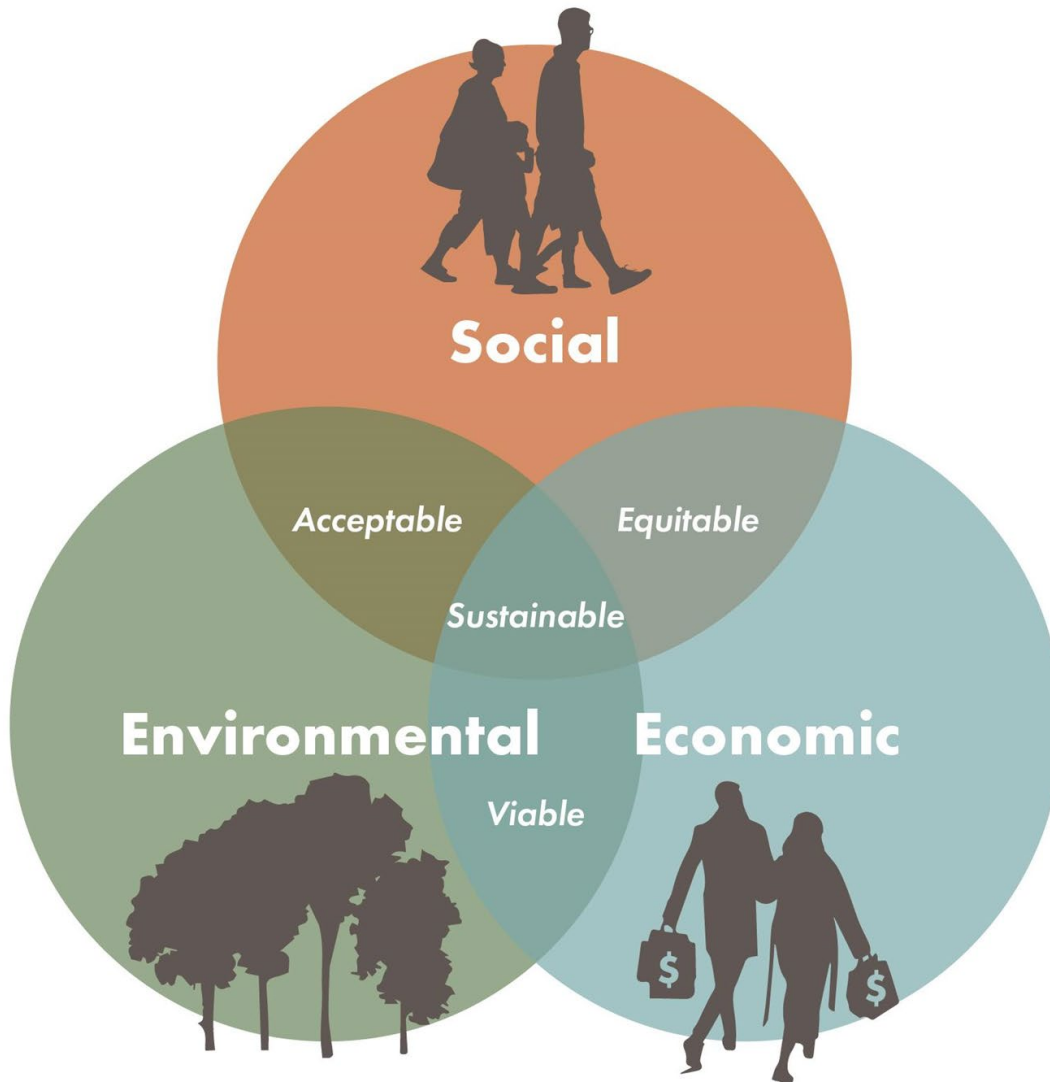


Figure 4. Triple-Win Outcomes Achieved through EWN (Large Text) and Associated Additional Benefits (Small Text) From (USACE, 2018).

Congress has defined Natural and Nature-Based Features (NNBF) as features that are “created by human design, engineering, and construction to provide risk reduction by acting in concert with natural processes” (“33 USC - 2016 - Water Infrastructure Improvements for the Nation” n.d.). NBS can include beaches, dune, island, forest, wetland, and reef features constructed via human engineering.

Using the EWN approach, USACE can approach project formulation and evaluation in a way that combines traditional and natural infrastructure solutions to yield an array of benefits. In this regard, EWN is an outgrowth of USACE’s environmental mission, aligns with USACE’s move towards multipurpose projects, and may serve as a catalyst for a continued evolution. USACE has been required to evaluate “nonstructural alternatives to reduce flood damages” since 1974 (*Water Resources Development Act of 1974*, Pub. L. No. 93-251, § 73(a), 88 Stat. 12), and nonstructural features such as floodproofing,



warning systems, property buyouts, and floodplain management policy improvements have become regular—though not necessarily frequent—features of USACE projects since that time. But it was not until 2016 that Congress specifically required USACE to consider NNBF along with nonstructural and structural measures in studying the feasibility of flood risk management, hurricane and storm damage reduction, and ecosystem restoration projects (*Water Resources Development Act of 2016*; *Water Resources Development Act of 2018*). This requirement was carried forward into USACE’s planning process by a memorandum from the then Acting Assistant Secretary of the Army in 2017 entitled *Implementation Guidance for Section 1184 of the Water Resources Development Act of 2016 (WRDA 2016)*, *Consideration of Measures* (hereafter *USACE, Implementation Guidance for Section 1184 of WRDA 2016*). Furthermore, on January 5, 2021, Assistant Secretary of the Army, Civil Works, R.D. James, issued a Policy Directive related to "Comprehensive Documentation of Benefits in Decision Document" that also reflects USACE's expanding formulation of cost-benefit evaluation" (USACE, 2021b).

Despite this evolution in USACE’s mission towards a broader social-environmental-economic framework, federal project formulation and evaluation processes continue to rely on a narrow economic analysis rooted in the P&G of 1983. This heavy focus economic analysis generates a disconnect between the stated goal of expanding an EWN approach and the implementation of NBS in authorized and constructed USACE projects.

3.2 USACE’S EVOLVING VALUATION POLICIES

The practice of BCA within USACE has evolved in parallel with the agency’s flood-control mission and in conjunction with developments in economic practice and public policy analysis since the New Deal era. This section provides an overview of how USACE’s evaluation policies have evolved over the past century. Broadly speaking, USACE’s evaluation policies have evolved from an initial, limited goal of preventing questionable federal investments to a broader and more nuanced assessment of multiple priorities and value propositions. Over time, valuation policies became increasingly defined by processes and methodologies that reflected a technocratic approach to federal policymaking. Given the stated priorities of the Biden Administration and the evolution of water resources planning practices at the local and state level, the federal government may be reaching an inflection point in which investment decisions might soon be based on criteria that also incorporate historically ignored benefits such as ecosystem services, climate resilience, and equity. While traditional methods of BCA are currently established in USACE policy and practice, and alternative methods are still a developing field in economics, USACE could implement a social-environmental-economic framework that better aligns with EWN principles.

Figure 5 provides a summary of the policy flowchart and BCA evolution.

Policy Flowchart BCA Evolution

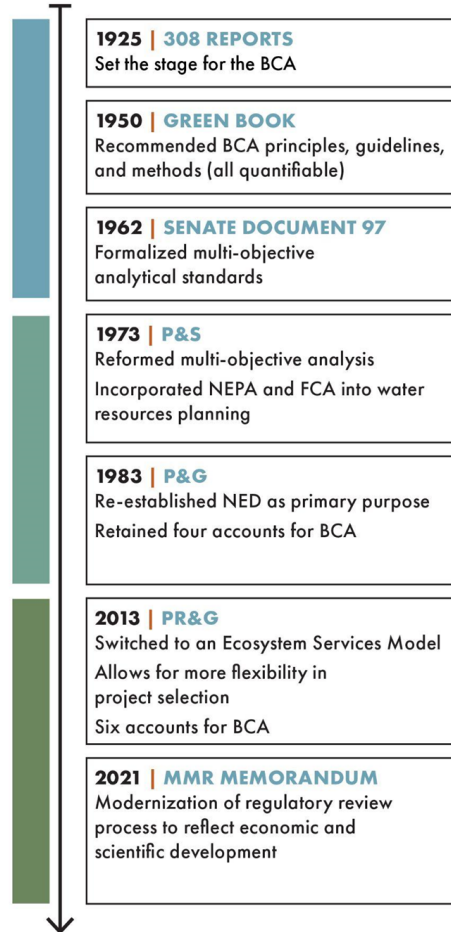


Figure 5. Policy flowchart/BCA evolution

3.2.1 1925 – 1936: “308 Reports”

When Congress passed the River and Harbor Act of 1925, legislators were influenced by two key factors: (1) heightened national demand for federal action to protect an increasingly urbanized population from floods; and (2) a desire to connect rural people and communities with affordable electricity. In the statute, Congress directed USACE, in conjunction with the Federal Energy Regulatory Commission (FERC), to provide cost estimates for a project that would involve surveying rivers and streams across the country to assess their capacity for flood control, hydropower, and irrigation. USACE and FERC delivered these cost estimates in a document that Congress published as H. Doc. 69-308. USACE finalized more than 200 “308 Reports”—the subsequent surveys themselves—for various river basins as it sought authorization and appropriations for dams and other water infrastructure (Major & Stakhiv, 2019).

The 308 Reports are historically important for introducing river basin planning that combined multiple objectives into USACE practice. However, the 308 Reports had limited influence on the specific



methodologies of USACE project valuation policy. According to David Major and Eugene Stakhiv, two preeminent experts on the history of water resources planning at USACE who have reviewed many of the 308 Reports, “costs and benefits for multiple purposes were not, as would later be the case, compared in detail [in the early 308 Reports]; rather, available information was reviewed, and general conclusions were reached as to the desirability of improvements” (2019, pp. 25–26).

3.2.2 1936 – 1950: Flood Control Act

The history of BCA as a widely used tool in policy making—and a strict rule for selecting USACE flood control projects—dates to the Flood Control Act of 1936. The 1936 Act was one element of the New Deal legislative agenda passed by the 74th Congress and signed by President Roosevelt. The legislation has been described as a “confused and confusing piece of legislation,” “ill-conceived and wretchedly drafted,” and marred by “a rather hastily drawn series of implementation features that were a patchwork of compromises thrown together by overworked congressmen on the eve of the presidential and congressional elections of 1936” (Arnold, 1988). The feature of the Flood Control Act of 1936 legislation that prompted USACE benefit-cost considerations states that:

...the Federal Government should improve or participate in the improvements of streams 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 (*Flood Control Act of 1936*, n.d.).

Congress gave no other direction regarding how USACE should engage in this BCA, and the statute's limited guidance could be the result of the contentious political atmosphere surrounding the 1936 Act. In 1935, Maryland Senator Millard Tydings effectively stopped an earlier attempt at federal flood control legislation when he delivered an impassioned speech on the Senate floor against what he viewed as excessive federal spending on public works projects that would have been authorized by that legislation. But major flooding in the mid-Atlantic and Northeast in early 1936 changed his and other key legislators' opinions about the need for federal aid in the form of flood risk reduction projects (Arnold, 1988).

Within months, Congress had passed the 1936 Flood Control Act, including new language regarding the BCA as quoted above. It is unclear where this language in the 1936 Act originated as no similar language existed in the 1935 legislation. Given the historical context, it appears to be a compromise designed to secure votes from legislators who supported federal flood control spending but also favored limitations on the level of federal spending.

In the following years, USACE staff developed standardized practices for evaluating the costs and benefits of water resources development projects, including flood control work. Their efforts inaugurated the modern era of BCA in federal agency activities and set some of the basic parameters for USACE valuation policies that remain today.

One of the defining challenges of water resources management in the early 20th century was the overlapping and adjoining roles of various federal agencies, including USACE, Bureau of Reclamation (Reclamation), Federal Power Commission, and U.S. Department of Agriculture. President Roosevelt



established the Federal Interagency River Basin Committee (FIARBC) in 1943. FIARBC comprised the top presidential appointees from USACE, the Federal Power Commission, and the Departments of Interior, Agriculture, and Commerce. The purpose of FIARBC was to coordinate water management as population increased, particularly in the western U.S. (National Research Council, 1999).

USACE valuation policies during this era promoted infrastructure development for commercial endeavors with minimal consideration of long-term ecological or sociological consequences of flood control projects (National Research Council, 1999). However, two key features of USACE valuation policies from this era are of particular note:

- USACE projects had multiple purposes (e.g., flood control, hydropower, water supply, etc.). The benefit-cost analyses analysis for compliance with the Flood Control Act were assessed in terms of **monetizable, national-scale economic development**. Thus, the benefits of flood control that drove the analyses were prevention of flood damage to property and increased utilization of flood-prone property. Quantitative economic analysis of public benefits was still a field early in its development, so USACE did not consider benefits such as the recreational value of projects, the likelihood that flood control projects would save lives, or ecosystem services. Thus, the full benefits of USACE flood control projects were not evaluated against the costs of construction during this era.
- Projects moved from the study phase to a request for congressional authorization and appropriations if the monetizable benefits exceeded the costs, a purpose it continues to serve today.

3.2.3 1950 – 1962: The Green Book

FIARBC established subcommittees focused on specific geographical regions in which water management was conducted by more than one federal agency. For example, the Missouri Basin Interagency Committee was charged with managing a power-sharing arrangement crafted by Congress whereby USACE managed flood control and navigation while Reclamation oversaw irrigation. Another development that influenced project valuation at USACE is FIARBC's establishment of a Subcommittee on Benefits and Costs in 1946. The subcommittee's remit was to establish a common set of principles, guidelines, and methods for conducting BCAs in federal water resources management projects across FIARBC's constituent agencies. By 1950, the Subcommittee had reviewed current agency practices and developed a recommended set of principles, guidelines, and methods for FIARBC approval. They were published in a report, *Proposed Practices for Economic Analysis of River Basin Projects*, which—with a green cover—became known by the colloquial name, the “Green Book” (FIARBC Subcommittee on Benefits and Costs, 1950). In summary:

- The Green Book explicitly recognized the limits of BCA as a tool for setting water resource management policy, recommending that the analyses be used (1) to ensure that a particular project scope and design are justifiable in simplistic economic terms and (2) to make recommendations as to the order in which individually justified projects should be undertaken. The Green Book recommends principles and methods for developing quantitative estimates of



project costs and benefits using market-based valuation, but provides numerous examples of benefits that could not be quantified using those methods, including the value of resource conservation to future generations, effects on health and welfare (including lives saved by flood control projects), effects on national security, and “improvement of underdeveloped areas” (FIARBC Subcommittee on Benefits and Costs, 1950, rev. 1958, p. 6).

- The Green Book proposed a specific decision framework in which policymakers could utilize benefit-cost analyses first to justify a particular project design and scope, and then to choose among justifiable projects. First, each project should be designed to maximize net benefits (1950, p. 5). Then, to prioritize among the projects competing for limited funds, they should be compared based on their benefit-to-cost ratios (1950, p. 14).
- The Green Book indicated that applying discount rates to benefits and costs can improve the final analysis in two ways. First, discount rates make benefit and cost calculations comparable over time (especially important where construction costs occur over years but operations and maintenance costs, as well as benefits, accrue over many decades). Second, discount rates provide an element of accounting for risk in inaccurate initial estimates (1950, p. 21). The Green Book also made specific recommendations for the rates that agencies should use: at least four percent for benefits, and two-and-a-half percent for costs. The discount rate for project costs was based on the average cost of long-term U.S. Treasury bonds. The discount rate for benefits was based on the costs to private borrowers for mortgage loans secured by real property at the time, on the theory that it best represented “the values attached to deferred benefits by beneficiaries” (1950, p. 23).
- The Green Book provided for a more modern, multi-objective approach to analyzing the benefits and costs of water resources management projects. The Green Book lays out six categories of “project purposes” common to federal water management projects. These categories were irrigation, flood control, watershed treatment, navigation, electric power, and “recreation, fish and wildlife” (1950, pp. 39–52).

The FIARBC recognized these six different purposes and encouraged agencies to assess benefits and costs under each where relevant, acknowledging the ways in which multiple objectives promote a more comprehensive approach to planning than had been used historically (FIARBC Subcommittee on Benefits and Costs, 1950). **However, the Green Book took a more limited approach and implemented a policy that entailed analyzing the benefits and costs for all project purposes from “a comprehensive national perspective”:** ultimately, all benefits and costs were to be reduced to quantifiable monetary effects on NED. NED relies on quantifiable monetary effects rather than enabling planners to estimate benefits and costs in both quantifiable and nonquantifiable terms and allowing for benefits and costs to be linked to different objectives. Figure 6 depicts how the Federal discount rate for USACE water resources projects has changed from 1957 through present day.

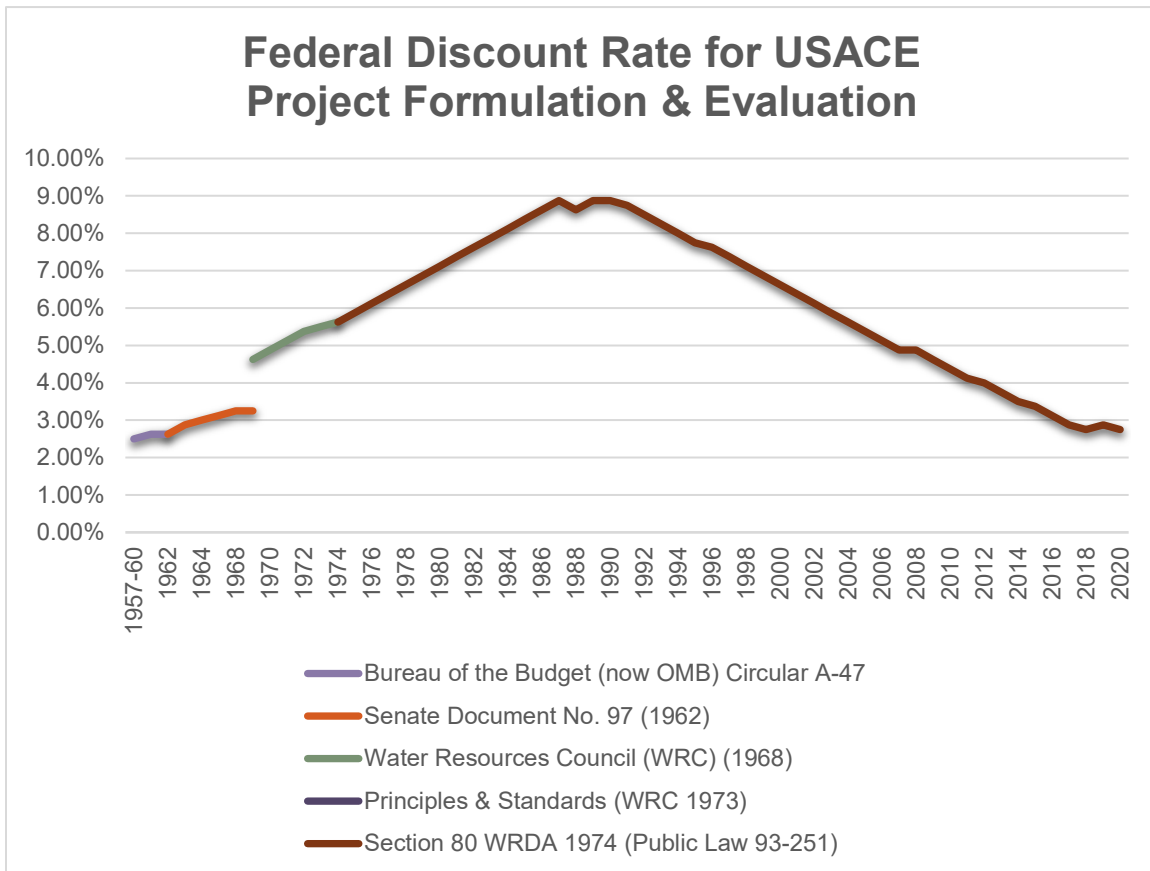


Figure 6. The Federal Discount Rates for USACE Project Formulation & Evaluation from 1957-2020

3.2.4 1962 – 1973: Senate Document 97

In the mid-1950s, congressional Democrats (with then-Senator John F. Kennedy among them) were becoming frustrated by an apparent “no new starts policy” for water resources management projects in the Eisenhower administration (Major & Stakhiv, 2019, p. 103, citing Caulfield [2000], p.15). Economic methods for estimating certain classes of benefits (e.g., protecting human lives or enhancing ecological services) had changed little since the Green Book was published. President Eisenhower’s Bureau of the Budget (the precursor to today’s OMB) published “Circular A-47,” which established a requirement that the administration would only present to Congress for authorization and funding projects with a benefit-to-cost ratio greater than 1:1. Senate Democrats passed a resolution challenging the administration’s practice, conducting a year’s worth of hearings and studies, and then passed another resolution (S. Res. 148, 85th Cong.) to propose standards and criteria for land and water resource project authorization.

After winning the 1960 presidential election,⁵ President Kennedy created an interagency workgroup to develop standards in accordance with S. Res. 148. The workgroup comprised the Secretaries of the Army,

⁵ As a candidate for President, Senator Kennedy campaigned in western states on a platform that included enhanced investment in projects that would increase water supplies and greater conservation and protection of water quality. He saw these issues as essential to promoting development in those states and improving the well-being of the American people over the long run (Kennedy, 1960).



Agriculture, Interior, and Health, Education & Welfare. By 1962, the workgroup had developed an interagency agreement that was approved by President Kennedy, and that Senator Clinton P. Anderson of New Mexico presented to Congress in May of that year as being consistent with the principles that the Senate had outlined in S. Res. 148. The interagency workgroup’s “Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources” was subsequently published as Senate Document 87-97 (and is known colloquially as “Senate Document 97”). The purpose of the Kennedy Administration’s workgroup and Senate Document 97 was to solidify an approach to identifying projects for congressional authorization and funding—an approach that involved increased federal spending and greater emphasis on what were, at the time, considered “intangible” benefits (37th Congress, 2nd Session, 1962).

Senate Document 97 is notable for formalizing multi-objective analytical standards for project evaluation. Again, the Green Book had recognized multiple purposes that could be measured in BCAs, but ultimately recommended that those purposes be reduced to their quantifiable effects on NED. Senate Document 97 and the “Policies, Standards, and Procedures” described therein further formalized the methods by which those additional objectives would be accounted for in project formulation. Table 1 summarizes three co-equal objectives from Senate Document 97 for water resource planning and underlying BCA.

Table 1. Key Features of Senate Document 97, from S. Doc. No. 97-87 at 1-2 (1962).

Three co-equal objectives for water resources planning and underlying benefit-cost analysis:		
<p><i>National Economic Development</i> Among other contributors to “economic growth and development,” includes “flood control or prevention measures to protect people, property, and productive lands from flood losses where such measures are justified and the best means of avoiding flood damage.”</p>	<p><i>Preservation</i> The ways a project preserved or enhanced natural resources for subsequent exploitation according to their “best use,” for recreation, and “for the inspiration, enjoyment and education of the people.”</p>	<p><i>Well-being of “all people”</i> Declared to be the “overriding determinant in considering the best of water and related land resources” and this objective was intended to ensure consideration of “hardship and basic needs of particular groups within the general population.”</p>

Senate Document 97 was the first federal water resources planning policy statement to incorporate the multi-objective approach officially to planning. It provided some instruction for analyzing benefits and costs for each objective (S. Doc 97-87, "Policies, Standards, and Procedures," 1962, pp. 9–11). While Senate Document 97 removed the Green Book requirement that all benefits and costs be reduced to quantifiable effects on NED, it provided limited guidance or principles for making “reasoned choices ... between [the multiple objectives of development, preservation, and the well-being of people] when they conflict” (1962, p. 1). Importantly, it allowed for projects to be presented to Congress even where monetized costs exceed monetized benefits, in cases where (1) “intangible benefits” (e.g., saving lives) warrants more costly projects; or (2) agencies might want to build for more water or power needs in the future (1962, p. 8).



3.2.5 1973 – 1983: Principles & Standards

Three years after publishing Senate Document 97, and “as part of a continuing effort by the administrations of John F. Kennedy and Lyndon Johnson to coordinate and centralize federal water resources planning and policy formulation,” Congress passed the Water Resources Planning Act of 1965 (National Research Council, 1999). The law set up interagency/interstate commissions for water resources management planning and established the U.S. Water Resources Council, comprising seven Cabinet-level agencies including the Army. A primary purpose of the Water Resources Council was to develop a set of uniform federal standards and criteria for planning and evaluating water resources projects (Major & Stakhiv, 2019, p. 139; *Principles, standards, and procedures for Federal projects*, 42 U.S.C. 1962a-2).

The Water Resources Council began its work on principles and standards for water resources planning and evaluation while natural resource and environmental economics was developing, and multipurpose water resource planning was also evolving. The principles and standards were developed to reflect a different way of thinking—that optimal allocation of federal resources should not be determined solely by an analysis of individual preferences revealed in market transactions, but rather by a combination of formal economic analysis and multivariate political analysis (Major & Stakhiv, 2019, p. 139, *et seq*). The Council delegated work on this project to a Special Task Force of staff from the constituent federal agencies, who received assistance “from many more agency personnel and outside reviewers” as it developed its draft “Principles and Standards for Planning Water and Related Land Resources” (Major & Stakhiv, 2019, p. 142). Known colloquially as the “Principles & Standards” or “P&S,” the final document was approved by President Nixon and published in the *Federal Register* on September 10, 1973 (*Principles and Standards for Planning Water and Related Land Resources*, 38 Fed. Reg. 24778, 1973). The key features from this document are summarized in Table 2.

The P&S represented three major advances in project evaluation. First, the P&S added rigor to the methods for presenting multi-objective analysis. Second, the P&S begin to incorporate ecosystem services as a factor in evaluating project effects on the EQ objective. And third, the P&S begin incorporating elements of early Public Interest Era legislation into water resources planning, including NEPA of 1970 and the Flood Control Act of 1970. NEPA initiated a new era in environmental impact analysis of federal activities, as well as increased public involvement in planning and impact assessment. The Flood Control Act of 1970 established a statutory obligation to account for social well-being in flood control planning (*River and Harbor Act of 1970*, Pub. L. No. 91-611, § 122, 84 Stat. 1818).



Table 2. Key features of the 1973 Principles and Standards for Planning Water and Related Land Resources

Key Features of the 1973 P&S: FOUR OBJECTIVES FOR WATER RESOURCES PLANNING AND EVALUATION		
System of Accounts		
<p>REQUIRED “Design” Objectives Central to “society’s preferences” for “promot[ing] the quality of life.”</p>	<p>1. National Economic Development (NED) Evaluated a project’s ability to quantitatively “[increase] the value of the nation’s output of goods and services and [improve] national economic efficiency.”</p>	<p>2. Environmental Quality (EQ) Focused on a project’s capacity to “enhance the quality of the environment by management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.”</p>
<p>OPTIONAL “Display” Objectives to be considered “display” objectives that would provide a basis for comparing alternative plans.</p>	<p>3. Regional Economic Development Addressed local impacts on employment, population distribution, the environment, and the value of economic outputs.</p>	<p>4. Social Well-being Included effects on income distribution; life, health, and safety; educational, cultural, and recreational values; emergency preparedness; and other concerns.</p>

The P&S built on the multi-objective approach of Senate Document 97 by defining four objectives for water resources planning and evaluation: NED, EQ, RED, and social well-being (*Principles and Standards for Planning Water and Related Land Resources*, 38 Fed. Reg. 24778, 1973, pp. 6–10, 17). While these accounts were greater in number and different in character from the three identified in Senate Document 97, the P&S four-objective approach was not an explicit expansion of Senate Document 97. Rather, the P&S introduced the concept of a “system of accounts” in which planners would present their analysis of benefits and costs differently for “design” and “display” objectives “in such manner that the different levels of achievement in each account can be readily discerned and compared, indicating the tradeoffs among alternative plans” (*Principles and Standards for Planning Water and Related Land Resources*, 1973). NED and EQ were considered “design” objectives, meaning that they were central to “society’s preferences” for “promot[ing] the quality of life” (1973, p.17). However, RED and social well-being were to be considered “display” objectives that would provide a basis for comparing alternative plans (1973, p. 17). Thus, in water resources planning under the P&S, the objective of social well-being was no longer considered to be of equal importance to NED and environmental concerns.

The P&S included more extensive benefit and cost accounting than prior policy statements. It required “a complete display or accounting of relevant beneficial or adverse effects” for NED and EQ, “measured in monetary or nonmonetary terms” (*Principles and Standards for Planning Water and Related Land Resources*, 38 Fed. Reg. 24778, 1973, p. 6). Furthermore, while the P&S required documentation of RED



and social well-being accounts that “include display of the distribution of effects to regions, income classes, and interest groups relevant to the particular plan” this analysis was considered optional whereas the NED analysis was required (1973, p. 17). This P&S also requires that during the planning process at least one alternative plan be formulated which “emphasizes the contributions to the environmental quality objective” (1973, p. 15).

In addition, the P&S adopted a framework for “alternatives analysis.” Under the Clean Water Act and NEPA, USACE must evaluate alternatives to a proposed project. The principles for analyzing alternatives stated that the “tradeoffs among alternative plans should be displayed as fully as possible for the components of all objectives and where appropriate for effects on regional development and social well-being to facilitate administrative and legislative review and decision” (*Principles and Standards for Planning Water and Related Land Resources*, 38 Fed. Reg. 24778, 1973, p. 16). Furthermore, the recommended alternative was intended to (1) reflect “the priorities and preferences expressed by the public at all levels to be affected by the plan;” and (2) have “net national economic development benefits unless the deficiency in net benefits for the national economic development objective is the result of benefits foregone or additional costs incurred to serve the EQ objective” (*Principles and Standards for Planning Water and Related Land Resources*, 1973). In the case of a recommended plan where net NED benefits are negative due to environmental concerns, it was required that proposals be approved by the head of a Department and/or Independent Agency.

After the P&S were finalized in 1973, the next year, Congress required that the document be revised (*Water Resources Development Act of 1974*, Pub. L. No. 93-251, § 80, 88 Stat. 12). Congress was concerned with two features of the P&S: (1) that the EQ, RED, and social well-being objectives were not given enough consideration, and (2) that the discount rate was too high. The Ford administration did not act on the congressional directive, but President Carter initiated a review of water resource management policies upon assuming office in 1977 and put the Water Resources Council in charge of the project. President Carter then proposed a set of policy changes in 1978, including a rewrite of the P&S. The revised P&S were transformed from guidance to a codified federal rule over several ensuing years (*See* 18 C.F.R. pts. 711, 713, 714, and 716, 1981).

3.2.6 1983 – 2007: Principles & Guidelines (P&G)

The Reagan administration took a different approach beginning in 1981. In September of that year, the Water Resources Council, under the chairmanship of Interior Secretary James Watt, proposed repealing the procedures codified by the Carter administration (Water Resources Council, 1981). In March 1982, the Council published draft replacement guidelines, which were modified before being approved by President Reagan and finalized a year later (Water Resources Council, 1982; Water Resources Council, 1983). The final replacement policy, formally titled the “Principles and Guidelines for Water and Related Land Use Implementation Studies,” is colloquially known as the “P&G.”

Consistent with the Reagan administration’s overarching goals of limiting federal spending and reducing procedural requirements in federal policymaking, the P&G re-established NED as the primary purpose of water resources management (*White House Report on the Program for Economic Recovery*, 1981). A summary of the key features and objectives of the 1983 P&G are shown in Table 3. The P&G, and the



subsequent dissolution of the Water Resources Council due to lack of federal funding, halted development of more sophisticated multi-objective analytical guidelines until 2007 (*Water Resources Development Act of 2007*, 2007); discussed in more detail below in Section 3.3).

Table 3. Key features of the 1983 Principles and Guidelines

1983 P&G: FOUR OBJECTIVES FOR WATER RESOURCES PLANNING AND EVALUATION			
System of Accounts			
REQUIRED	<p>1. National Economic Development (NED) The NED account covers “changes in the economic value of the national output of goods and services” and is generally expressed in monetary units. NED benefits relevant to flood-control projects include quantifiable benefits such as protecting crops and other developed land, enhancing recreational opportunities, and protecting commercial fisheries (1983a, p. 9).</p>		
OPTIONAL	<p>2. Environmental Quality (EQ) The EQ account covers “non-monetary effects on significant natural and cultural resources.” Examples include functional aspects of the environment such as nutrient cycling and erosion, structural aspects of the environment such as plant or animal populations and chemical/physical properties of water or air, and cultural attributes that provide evidence of human lifeways (1983a, p. 103).</p>	<p>3. Regional Economic Development (RED) The RED account “registers changes in the distribution of regional economic activity that result from each alternative plan” (1983a, p. 11). It reflects an interest among policymakers in understanding how public works projects can provide sizeable income and employment benefits to local communities.</p>	<p>4. Other Social Effects (OSE) The OSE account “registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.” It includes “urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation” (1983a, p. 12).</p>

- To “facilitate evaluation and display of the effects of alternative plans,” the P&G retained four accounts for BCA: NED, EQ, RED, and OSE (Water Resources Council, 1983, p. 9). A singular federal objective is defined as contributing to NED, consistent with protecting the nation’s



environment under national environmental statutes, applicable executive orders, and other federal planning requirements (1983, p. iv). The project alternative with the greatest NED is the only option that planners are required to present under the P&G, although other alternatives may be considered as well.

- The P&G lowered EQ to a second order consideration, rather than an equal and required account in the project alternatives analysis as it was in the P&S. The P&G also shifted the emphasis of the EQ from assessing and valuing the environmental impacts of a project to reporting and describing them, this reduced the impact that natural infrastructure enhancements may have on a project.

Unlike the earlier policy statements highlighted above, the P&G includes an extensive discussion of the processes by which agencies should evaluate project benefits. While the P&G provide extensive discussion of processes for evaluating NED and EQ benefits, it provides no procedural standards for evaluating the RED or OSE accounts. The P&G's limited emphasis on RED and OSE accounts reflects that Secretary Watt and others on President Reagan's Water Resources Council did not anticipate that those accounts would have significant impact on the ultimate decisionmakers who would propose projects for congressional authorization and funding.⁶

3.3 RECENT DEVELOPMENTS IN PROJECT VALUATION

Since 2007, there has been a series of efforts to update the federal valuation of project benefits.

3.3.1 Principles, Requirements, & Guidelines (PR&G)

In 2007, Congress instructed the Secretary of the Army to revise the P&G consistent with a new set of priorities, which include *sustainable* economic development, minimizing “unwise” land use in floodplains, and protecting and restoring “the functions of natural systems” (WRDA, 2007). Congress set a two-year deadline for the administration to accomplish the task. The Secretary of the Army under President George W. Bush issued proposed revisions applicable only to USACE in September 2008 (*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: Availability of Proposed Principles and Request for Comments*, 73 Fed. Reg. 52960, 2008). President Obama subsequently tasked the White House Council on Environmental Quality (CEQ) with developing draft principles and standards applicable to multiple agencies in December 2009 (*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: Initiation of Revision and Request for Comments*, 74 Fed. Reg. 65102, 2009).

Congress established a National Academies of Science panel to review the draft principles and standards. The panel found that the draft lacked clarity and consistency in several respects, including not providing meaningful distinctions between “objectives, principles, and standards” (Carter & Stern, 2017; see also: National Research Council, 2012). In response, CEQ revised the initial draft and published new policies

⁶ See Water Resources Council, Water and Related Land Resources Planning Principles, Standards, and Procedures; Repeal of Regulations, 48 Fed. Reg. 10250, 10254 (March 10, 1983). In response to a commenter who stated that the administration's proposed approach to accounting for OSE “dilute this section to the point of ineffectiveness,” the administration does not disagree but rather states that “Flexibility has been added in order to focus the evaluation on the effects that have a material bearing on the decision-making process.”



in two parts: first, reframing and revising the “Principles and Requirements” in March 2013, and separately developing “Interagency Guidelines” in December 2014 (78 Fed. Reg. 18562, 2013; 79 Fed. Reg. 77460, 2014). Collectively, the Principles, Requirements, and Interagency Guidelines are colloquially known as the updated “PR&G.”

Key features of the PR&G include:

- The PR&G encourages agencies to return to multi-objective analysis. Citing Congress’s statement of national priorities in WRDA 2007, the PR&G lists three federal objectives for water resource planning:
 - “seeking to maximize sustainable economic development;”
 - “seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used;” and
 - “protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems” (CEQ, 2013).
- The PR&G established a new model for project evaluation using an ecosystem services model and mandating agencies no longer use the economic performance assessment model of traditional BCA that had been in use since the publication of the Green Book in 1950. The ecosystem services approach is presented as “a way to organize all the potential effects of an action (economic, environmental and social) within a framework that explicitly recognizes their interconnected nature” (CEQ, 2013). While CEQ recognized the methodological limitations in the practice of ecosystem service valuation, it emphasized the new approach as the optimum way to capture “the values that ecosystems or watersheds contribute to our economy and well-being”(CEQ, 2013). By contrast, traditional benefit-cost analyses, according to CEQ, “involve an unduly narrow benefit-cost comparison of the monetized effects,” are “unnecessarily biased towards those economic effects that are generally more easily quantified and monetized,” and are “no longer reflective of our national needs” (CEQ, 2013, p. 7)
- The PR&G altered how BCAs are used in project selection. While the PR&G provided agencies with the leeway to select a project plan according to a decision framework that is less constrained than the frameworks found in earlier policy statements, there remained a lack of clear guidance on what methodological approach(es) should be used. Where prior policies required plan selection to maximize net national economic benefits (or allowed for exceptions only in limited circumstances), the PR&G proposed a more flexible BCA:

“Any recommendation for Federal investments in water resources to address identified water resources needs must be justified by the public benefits when compared to costs” (CEQ, 2013, p. 13).

The PR&G acknowledges the challenge in quantifying all relevant benefits and recognizes that subjective judgement is often required. “It is recognized that most of the activities pursued by the



Federal government will require an assessment of tradeoffs by decision makers and that in many cases the final decision will require judgment that considers the extent of both monetized and non-monetized effects” (CEQ, 2013, p. 13).

- The PR&G established a new set of accounts in identifying six co-equal principles for water resources planning. These accounts elevate various environmental and social effects to the same level as economic factors” (CEQ, 2014, p. 12). The six principles (accounts) are:
 - “Healthy and resilient ecosystems,” which includes an explicit objective of protecting and restoring ecosystem function;
 - “Sustainable economic development,” which emphasizes “the creation and maintenance of conditions under which humans and nature can coexist in the present and into the future;”
 - “Floodplains,” especially avoiding unwise uses that have “an unreasonable adverse effect on public health and safety, or ... [are] incompatible with or adversely affects one or more floodplain functions that leads to a floodplain that is no longer self-sustaining;”
 - “Public safety,” or avoiding, reducing, and mitigating risks of death and injury;
 - “Environmental justice,” which includes both fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies; and
 - “Watershed approach,” by which policies “facilitate evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed” (CEQ, 2013, pp. 4–6).
- The PR&G are less detailed, allowing for more agency discretion, which can result in agencies continuing to apply the same approaches employed prior to the PR&G. In contrast to the 1983 P&G, the PR&G take a less prescriptive approach to defining how an agency should undertake benefit-cost analyses in support of water resources planning. The PR&G does provide opportunities for agencies to utilize existing “pathways” to achieve the analytical work necessary to meet the principles and requirements stated therein (CEQ, 2013).
- The PR&G put greater emphasis on nonstructural alternatives than earlier policies by recognizing that nonstructural approaches to water resources management “can often be the most cost-effective and environmentally protective alternative” and that they are “particularly effective in minimizing adverse effects on floodplain functions and the aquatic environment” (CEQ, 2013, p. 11). The PR&G state that “full consideration and reporting on nonstructural alternative actions or plans should be an integral part in the evaluation of Federal investments in water resources” (CEQ, 2013, p. 11).

The multi-objective approach of the PR&G could be perceived as another shift between valuation policies that target projects that deliver easily quantified economic development benefits and those policies that seek to promote environmental and social progress through public works. While there was a focus during the middle and late parts of the 20th century on a technocratic approach to policymaking, there has been a



growing recognition of the inherent limitations of overly quantification-based approaches and bipartisan support to change the traditional approach. During the final days of the Trump Administration, Assistant Secretary of the Army R.D. James noted in a Policy Directive Memorandum that, “[c]oncerns about an over-reliance on national economic benefits as a required decision metric with secondary consideration of other important benefit categories in part led to the development of the [PR&G].” Assistant Secretary James further noted that “[t]he availability of data, tools, and methodologies may limit the [Project Delivery Team]’s ability to quantify benefits. As a result, new or expanded procedures may be required to support complete and commensurate evaluation of all benefit types and enable an assessment of the total benefits...” (*Policy Directive Memo*, 2021). Just a few weeks later, President Biden issued an Executive Order which acknowledged that “[e]ntrenched disparities in our laws and public policies, and in our public and private institutions, have often denied that equal opportunity to individuals and communities,” which have been exacerbated by “converging economic, health, and climate crises,” and established that the policy of the federal government would be to “pursue a comprehensive approach to advancing equity for all, including people of color and others who have been historically marginalized” (e.g., *Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*, 2021).

The PR&G’s impact on USACE evaluation policies is presently undetermined, as Congress only recently lifted restrictions that prevented USACE from developing agency-specific procedures for implementing the PR&G (*Water Resources Development Act of 2020*, 2020). Some Members of Congress objected to the way the PR&G placed all three objectives listed in WRDA 2007 on co-equal footing, arguing instead that the law should have been interpreted as insisting that sustainable economic development was the primary objective, with limiting development in floodplains and ecosystem restoration/protection as secondary and tertiary objectives, respectively (see: 111th Cong. 27-28, 2010, opening remarks of Rep. Boozman). These objections led to annual riders in USACE’s appropriations (GAO, 2019a, p. 24). By federal fiscal year 2020, however, Congress had removed the budget rider (*Consolidated Appropriations Act*, Pub. L. 116-260, 2021).

3.3.2 WRDA 2014

WRDA 2014 codified into law the “3x3x3 Rule” which was established in February 2012, by M. G. Walsh, Deputy Commander, Civil Works and Emergency Operations (USACE, 2012). The 3x3x3 rule states that all planning studies must be completed in three years, cost no more than \$3 million, and include three levels of coordination within USACE. Initially the 3x3x3 rule was established to facilitate the implementation of “SMART” planning⁷, a USACE-driven planning process improvement initiative intended to transform the traditional process to a more focused, time sensitive, risk-informed planning process. Additionally, Congress established an upper cost limit of \$3 million for planning studies. To date, USACE has maintained a policy that no study can exceed \$3 million total without ASACW approval (USACE, 2012). As noted in Section 3.3.3, USACE must now comply with the PR&G which

⁷ USACE defines “SMART” planning refers to a process in which the objectives developed are “Specific, Measurable, Attainable, Risk-informed, and Timely.”



will require analysis of the full suite of economic, environmental, and social benefits of project alternatives.

3.3.3 WRDA 2020

WRDA 2020, which was included as a component of the 2020 Consolidated Appropriations Act, contained new provisions relevant to this report.

In Section 110, titled “Implementation of Water Resources Principles and Requirements,” Congress directed USACE to issue final agency specific procedures to implement the PR&G within six months and to update the policy every five years, as necessary. According to Section 110, the newly developed procedures will require USACE to develop future water resource projects in accordance with the PR&G and in such a way that “fully identifies and analyzes NED benefits, regional economic development benefits, environmental quality benefits, and other societal effects.”

Section 116 reiterated the importance of considering NNBF⁸ in feasibility studies. “To the maximum extent practicable, the Secretary shall include in each feasibility report developed under section 905 of the Water Resources Development Act of 1986 (33 U.S.C. 2282) for a project that contains a flood risk management or hurricane and storm damage risk reduction element, a summary of the natural feature or nature-based feature alternatives, along with their long-term costs and benefits, that were evaluated in the development of the feasibility report, and, if such alternatives were not included in the recommended plan, an explanation of why such alternatives were not included in the recommended plan.” Section 115 also set the local, nonfederal cost share portion for such projects at 35 percent.

With the inclusion of these provisions, WRDA 2020 presents direction for USACE to modernize its approach to assessing the full range of benefits and costs.

3.3.4 Recent Executive Action from the Biden Administration

Within the first week of taking office, President Biden took three executive actions relevant to changing the valuation of water resource project costs and benefits.

On January 20, 2021, President Biden issued Executive Order 13990, “Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis” (86 Fed. Reg. 7037, 2021), which requires the review of regulations and other actions within the prior four years that may have been inconsistent with the Administration’s focus on confronting the “climate crisis.” The Executive Order outlines the Administration’s policy to:

“listen to the science; to improve public health and protect our environment; to ensure access to clean air and water; to limit exposure to dangerous chemicals and pesticides; to

⁸ *Natural Features* are created and evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature. Conversely, *Nature-based Features* are those that may mimic characteristics of natural features, but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction. Overall, Natural and Nature-Based Features (NNBF) are a type of NBS specifically applied to flood risk management and/or hurricane and storm damage risk reduction projects. See Bridges et al., (2015)..



hold polluters accountable, including those who disproportionately harm communities of color and low-income communities; to reduce greenhouse gas emissions; to bolster resilience to the impacts of climate change; to restore and expand our national treasures and monuments; and to prioritize both environmental justice and the creation of the well-paying union jobs necessary to deliver on these goals” (2021, Sec. 1).

While not all these goals fall directly within USACE’s mission, there is an emphasis on multiple benefits. Also, Executive Order 13990 simultaneously directs federal agencies to “listen to the science,” to quantify the “social costs” of emissions, and “accurately determine the social benefits of reducing greenhouse gas emissions when conducting cost-benefit analyses of regulatory and other actions” (86 Fed. Reg. 7037, 2021, Sec. 5). The Executive Order places the Director of OMB on a newly established Interagency Working Group of the Social Cost of Greenhouse Gases to use the best available economics and science to update the federal estimate of the “social cost of carbon (SCC), social cost of nitrous oxide (SCN), and social cost of methane (SCM)”.

On January 21, 2021, President Biden issued an Executive Memorandum titled, “Modernizing Regulatory Review” (“MRR”; 86 Fed. Reg. 7223, 2021). MRR begins by “reaffirm[ing] the basic principles set forth in [Executive Order 12866 of September 1993 (Regulatory Planning and Review)] and in Executive Order 13563 of January 18, 2011 (Improving Regulation and Regulatory Review), which took important steps towards modernizing the regulatory review process” and notes that “[w]hen carried out properly, that process can help to advance regulatory policies that improve the lives of American people” (86 Fed. Reg. 7223, 2021). MRR then directs the Director of OMB, in consultation with other agencies, to develop a set of recommendations for improving and modernizing regulatory review. “These recommendations should provide specific suggestions on how the regulatory review process can promote public health and safety, economic growth, social welfare, racial justice, environmental stewardship, human dignity, equity, and the interests of future generations” (86 Fed. Reg. 7223, Sec. 2, 2021) According to MRR, the recommendations should also:

- (i) “identify ways to modernize and improve the regulatory review process...to ensure that the review process promotes policies that reflect new developments in scientific and economic understanding, fully accounts for regulatory benefits that are difficult or impossible to quantify, and does not have harmful or anti-regulatory or deregulatory effects;”
- (ii) “propose procedures that take into account the distributional consequences of regulations, including as part of any quantitative or qualitative analysis of the costs and benefits of regulations, to ensure that regulatory initiatives appropriately benefit and do not inappropriately burden disadvantaged, vulnerable, or marginalized communities;”
- (iii) “Consider ways that [the Office of Information and Regulatory Affairs] OIRA can play a more proactive role in partnering with agencies to explore, promote, and undertake regulatory initiatives that are likely to yield significant benefits; and”
- (iv) “Identify reforms that will promote the efficiency, transparency, and inclusiveness of the interagency review process, and determine an appropriate approach with respect to the review of guidance documents.”



While these regulatory concerns are distinct from USACE project formulation and evaluation, addressing the disconnects between USACE’s and OMB’s discount rates as well as the differing BCAs could be consistent with the overall objectives of the MRR. According to a 2019 GAO report, USACE officials stated that they are required by the WRDA 1974 to use the nominal discount rate for the formulation and evaluation of federal water resources projects, rather than the seven percent discount rate that is used by OMB to develop the President’s Budget (GAO, 2019b). This causes the projects recommended based on economic analyses to fall below the benefit-to-cost ratio threshold of 2.5:1 that is used for the President’s budget request (GAO, 2019b).

On January 27, 2021, President Biden issued Executive Order 14008 entitled, “Tackling the Climate Crisis at Home and Abroad,” which seeks to “put the climate crisis at the center of United States foreign policy and national security” and take a “government-wide approach to the climate crisis” (*Executive Order No. 14008*, 2021). In a memorandum to the force on March 4, 2021, Secretary of Defense Lloyd Austin made clear that the President’s climate approach would be put into practice right away by the Department of Defense (DOD; *Message to the Force*, 2021). It states: “We face a growing climate crisis that is impacting our missions, plans and capabilities and must be met by ambitious, immediate action. In line with the President’s direction, we will elevate climate as a national security priority integrating climate considerations into the Department’s policies, strategies, and partner engagements.” This initiative resulted in the creation of DOD’s Climate Working Group, to coordinate the response to EO 14008. This group is being led primarily by USACE personnel due to the agency’s experience in climate preparation and resilience (Vergun, 2021).

EO 14008 includes the Justice40 Initiative which aims to ensure that at least 40 percent of the benefits of certain federal investments related to climate resilience are directed to “disadvantaged communities.” (Administration of Joseph R. Biden, Jr., 2021). The Initiative also covers federal flood-risk mitigation programs and programs that reduce the likelihood of displacement. USACE Civil Works is listed in the EO as an agency or department expected to participate in the Initiative. EO 14008 also underscores the importance of resilient coastal communities to taking climate action. “Coastal communities have an essential role to play in mitigating climate change and strengthening resilience by protecting and restoring coastal ecosystems, such as wetlands, seagrass, coral and oyster reefs, and mangrove and kelp forests, to protect vulnerable coastlines, sequester carbon, and support biodiversity and fisheries” (*Executive Order No. 14008*, 86 Fed. Reg. 7619, 7627, 2021).

Finally, on April 22, 2022, President Biden issued EO 14072, “Strengthening the Nation’s Forests, Communities and Local Economies,” (*Executive Order No. 14072*, 2022) which addresses the role of NBS in addressing climate change and enhancing resilience. The EO directs OMB to “issue guidance related to the valuation of ecosystem and environmental services and natural assets in Federal regulatory decision-making...” It further notes that OMB guidance be “...consistent with the efforts to modernize regulatory review required by my Presidential Memorandum of January 20, 2021 (Modernizing Regulatory Review)” discussed above. Thus, this latest Executive Order builds on the requirements of EO 13990, the MMR, and EO 14008 in clearly directing the modernization of how economic, environmental, and social factors are considered and evaluated for federal water resources projects.



These recent legislative (WRDA, 2020) and executive actions are consistent with the policy trends noted above and suggest alignment in modernizing the way water resource projects are analyzed—the importance of considering alternatives, weighing pros and cons, and selecting a solution that provides the greatest benefit for the lowest cost.



4.0 GAPS AND IMPEDIMENTS TO FURTHER IMPLEMENTATION OF NBS

During the summer of 2021, the study team developed and administered a survey to a targeted selection of senior USACE planning personnel. The survey was designed to identify what these expert practitioners see as the key gaps and impediments in implementing NBS. The survey was distributed to the eight Regional Division Planning Chiefs and requested that each Chief (a) identify whether, in their judgment, technical, policy and legal gaps/impediments exist in formulating and evaluating NBS alternatives; and (b) offer thoughts regarding how any identified gaps/impediments could be addressed.

4.1 SUMMARY OF SURVEY FEEDBACK: KEY GAPS AND IMPEDIMENTS IN IMPLEMENTING NBS

The USACE Planning Chiefs provided feedback related to the challenges in implementing NBS that can be broken down into three core areas: technical, policy, and legal.

1. **Technical:** There were several technical impediments identified by USACE planners. The planners cited gaps associated with data and modeling, such as a lack of accepted engineering performance data for NBS. Respondents further cited the lack of clear and consistent guidance on economic evaluation of NBS, including methods for quantifying and monetizing benefits beyond NED. In the absence of consistent guidance and methods for monetized valuation, planners noted that including alternatives with NBS can add to the cost side of the BCA calculation without fully accounting for the corresponding benefits, leading to arbitrarily low BCRs.
2. **Policy:** While USACE planners identified a number of challenges related to developing strong NBS alternatives, a fundamental challenge stems from the fact that the “Federal Objective” for water resource projects dating from the 1983 P&G is “to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements” (*Water and Related Land Resources Planning Principles, Standards, and Procedures; Repeal of Regulations*, 48 Fed. Reg. 10250, 10254, 1983b). The planning experts noted that this effectively means that economic costs and benefits (e.g., flood property damages avoided) drive the selection of the preferred alternative and thus limit the inclusion of ecosystem services, equity, social justice and other outcomes/benefits that may not be readily monetized in the context of NED.

A related and more specific challenge is found in the definition of the “Federal Standard” used in assessing Beneficial Use of Dredge Material alternatives—an important source or means for developing, constructing and maintaining NBS. In that context, the “least costly” disposal alternative consistent with sound engineering practice that meets federal environmental requirements is considered the “base plan” or default solution for navigation dredging (*Federal Water Pollution Control Act*, 33 U.S.C. § 1151, 1972; *Marine Protection, Research, and Sanctuaries Act*, 33 U.S.C. § 1401 *et seq.*, 1972). USACE planning personnel noted that this policy often eliminates NBS alternatives from further consideration as they rarely represent the least costly alternative, and it is often difficult to find a willing nonfederal sponsor to pay the



cost-share for such additional features, following traditional engineering, operational, and business practices.

USACE planning experts noted that this policy preference for the “NED alternative” is well-understood and enforced (through policy review) within the agency and likely causes planning and feasibility study teams to favor traditional engineering solutions that are more familiar and yield clearer economic benefits.

3. **Legal:** The survey respondents identified several legal impediments. The project scope of a feasibility study is constrained by the relevant USACE authority, which the planning experts noted effectively precludes the agency from focusing on more holistic solutions for water resources problems. Specifically, USACE planners observed that this constrained authority results in a “business line” approach to the generation of alternatives rather than a focus on solving the actual water resource challenge. When USACE characterizes a solution as a “Flood Damage Reduction” (FDR) alternative, the formulation and subsequent evaluation of the relevant alternative is typically conducted with a focus on the economic costs and benefits of avoiding flood damage to property.

4.2 POTENTIAL STRATEGIES TO ADDRESS IDENTIFIED GAPS AND IMPEDIMENTS TO IMPLEMENTING NBS SOLUTIONS

Assessing the feedback from USACE planning experts provides a valuable perspective to understand why NBS are not typically found in completed feasibility studies and recommended projects for Congressional authorization and appropriation.⁹ However, as noted below, there are pathways to addressing these technical, policy, and legal impediments.

1. **Technical:** Many of the technical challenges noted by USACE planning experts are being actively addressed. On September 16, 2021, USACE’s EWN program released the *International Guidelines on Natural and Nature-Based Features for Flood Risk Management* which provide practitioners with the best available information concerning the conceptualization, planning, design, engineering, construction, and maintenance of NNBF to support resilience and flood risk reduction for coastlines, bays, and estuaries, as well as river and freshwater systems (Bridges et al., 2021). These guidelines directly address a fundamental, identified gap: specifically, the lack of information and evidence related to NBS. Furthermore, the science surrounding the quantification of environmental and social benefits has advanced in recent years. Thus, significant progress has been made in addressing the identified technical impediments to implementing NBS (Olander et al., 2018). USACE has the opportunity to implement and institutionalize this progress into relevant policy and practice.
2. **Policy:** The passage of WRDA 2020 addressed a fundamental policy challenge identified by USACE planning experts. Specifically, Section 110 directed USACE to implement the updated

⁹ As part of this study, for example, the study team reviewed 150 feasibility studies completed from 2005-2020 and found that alternatives with NBS were considered in only a minority of studies outside of the Environmental Restoration mission area. These results are described in detail in a forthcoming report (Windhoffer et al., forthcoming).



PR&G in such a way that it “fully identifies and analyzes national economic development benefits, regional economic development benefits, environmental quality benefits, and other societal effects.” In addition, Section 116 requires USACE “to the maximum extent practicable” to consider NBS in feasibility reports. Furthermore, recent executive direction provided by President Biden, including “Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis” (EO 13990, issued on January 20, 2021) and “Modernizing Regulatory Review” (Executive Memorandum issued on January 20, 2021), further support the consideration of environmental and social benefits. Thus, current policy direction from both the executive and legislative branches indicates alignment in implementing NBS, and USACE has the opportunity to implement and institutionalize into relevant policy and practice.

3. **Legal:** A legal impediment identified by USACE planning experts—perceived lack of authority to holistically address modern water resource challenges—can be addressed as USACE comes into compliance with the relevant provisions of WRDA 2020 and the executive orders issued by the Biden administration. Specifically, by implementing the updated PR&G, USACE can require holistic consideration of water resource challenges via a thorough evaluation of NBS alternatives and quantification of their respective environmental and social benefits. The legal impediment to fully considering NBS alternatives in feasibility studies—USACE’s inability to implement the PR&G—was removed in WRDA 2020. The implementation of the PR&G will allow USACE to consider the full range of economic, environmental, and social benefits and costs of water resources projects.

4.3 CONCLUSION

Over the past two centuries, USACE has evolved from enhancing navigation for military and commercial purposes to being charged with developing solutions to some of the nation’s most challenging environmental and water-related issues. The evolution of USACE’s mission, authorities, and available valuation methodologies have aligned such that significant changes in how water resource projects are evaluated could occur in the near-term. The growing stressors associated with climate change—more frequent and intense storms, greater and more regular flooding, heat, drought, wildfires etc.—reveal the need for a 21st century approach to the formulation and evaluation of water resource projects. When conventional engineering approaches and NBS are designed to work together, the results provide a wide range of economic, environmental, and social benefits.

With the publication of the *International Guidelines on Natural and Nature-Based Features for Flood Risk Management*, USACE has addressed a persistent barrier to the technical implementation of NBS (Bridges et al., 2021). Similarly, the highlighted provisions of WRDA 2020 along with recent executive action from President Biden address challenging legal and policy issues. Therefore, the research presented herein indicates the use of NBS is consistent with USACE’s modern mission and relevant authorities.

Future funded phases of this study examine some the remaining structural impediments to transforming the BCA; for example, outlining a potential practical approach to documenting environmental and social costs and benefits. While this study is focused on implementation of NBS, the development of a sound



method of demonstrating the full suite of project benefits and costs allows for the potential to better evaluate multiple project alternative approaches—conventional, natural, and blended. Subsequent reports in this study will provide information about the application of methods for capturing, describing, and comparing a comprehensive array of economic, environmental, and social benefits to be expected from project alternatives.

The study team will next select six completed feasibility studies that considered NBS alternatives suitable for analysis, but did not select and recommend the NBS alternatives. The study team will review updated valuation methods and planning frameworks that incorporate environmental and social benefits and offer options for practical implementation of the methodologies. The six completed studies will then be revisited using the updated evaluation methods to perform a comprehensive benefits analysis to gain insight on: 1) the range of methods available; 2) the degree to which the methods are practical and can be broadly implemented; 3) the nature and diversity of benefits that can be produced by projects that combine conventional and NBS; and 4) how project alternatives can be compared with respect to different types of benefits. Ultimately, the results of the study will help inform future practice.

Congress and the Biden Administration have directed USACE to advance the practice of comprehensive benefits analysis that addresses economic, environmental, and social goals. USACE continues to invest in technical and policy research which, as this report outlines, represents a continuation of the 100-year evolution of benefits policy within the agency. The goal of this larger study is to ensure that USACE decision-makers can apply the best available science when formulating and evaluating water resources projects. Moving forward, USACE is well-positioned to leverage advancements in technical and policy research in support of a comprehensive approach to the nation’s water resources challenges.



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