

Leveraging the US Army Corps of Engineers Public-Private Partnerships (P3) Pilot Program to Promote Equitable Outcomes from Local Climate Mitigation and Adaptation Projects

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Abstract

As the negative impacts of a rapidly changing climate continue to exacerbate structural inequities across all sectors and scales, U.S. communities and citizens are increasingly at risk of physical, economic, and environmental harms. Directed federal investment in climate mitigation can reduce disproportionate burdens on at-risk populations, while also providing substantial economic benefits to those individuals and communities. The US Army Corps of Engineers has been the nation's premier flood management agency since the mid-19th century and is uniquely equipped to provide technical and financial support to such communities.

In this client-based thesis, I worked with Aaron Snyder, Lead of the Corps' Water Infrastructure Financing Program and Director of the Corp's Public-Private-Partnership (P3) program, to evaluate the Corps' role in developing and stewarding resilient civil works and public infrastructure. We focused on the Corp's role of providing flood protection infrastructure in response to the stressors of increasingly frequent and intense natural disasters. Our goal was to assess how the Corp's recently introduced P3 program can be improved to alleviate disproportionate cost-burdens on at-risk communities. Illustrated through case studies of weather and water disasters in Nashville, TN; New Bern, NC; Richwood, WV; and Fargo, ND; we find that the theoretical foundations of the cost-benefit analyses currently employed at the onset of the Corp's water resource management projects substantially limits availability and access of federal aid to communities who need it most. We conclude that the new P3 program, if directed to promote equitable outcomes from local climate mitigation and adaptation projects, would allow the Corps to more accurately assess project feasibility, prioritize projects sponsored by non-federal partners, leverage progressive local funding mechanisms, and ultimately reduce climate risks in vulnerable communities while meeting USACE's mission of protecting U.S. Citizens, reducing disaster risk, and providing vital infrastructure needs and solutions.

Thesis Advisor: Lawrence Susskind

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Acronyms

BCA - Benefit-Cost Analysis

CBA - Cost-Benefit Analysis

DOT - Department of Transportation

EPA - Environmental Protection Agency

FEMA - Federal Emergency Management Agency

GI - General Investigations

HUD - Department of Housing and Urban Development

LCA - Local Cooperation Agreement

NOAA - National Oceanic and Atmospheric Administration

O&M - Operations and Maintenance

P3 - Public-Private Partnership

RCP - Representative Concentration Pathway

ROFI - Return on Federal Investment

SBA - Small Business Administration

USACE - United States Army Corps of Engineers

WIFIA - Water Infrastructure Finance and Innovation Act

WRDA - Water Resources Development Act

WRRDA - Water Resources Reform and Development Act

Background

The effects of climate change threaten the economic, social, and personal security of U.S. Citizens across the United States. Cities, towns, and communities bear some of the greatest risks – as impacts from climate disasters such as flooding and hurricanes place already vulnerable communities at further risk, it is essential that the federal government provide support to communities that otherwise do not have it. The Biden Administration has prioritized supporting communities as they face these challenges. The *Justice40 Initiative* and the *American Jobs Plan* both prioritize supporting communities that are most vulnerable to the effects of climate change.

However, climate preparation and impact mitigation in the United States relies upon a complex political and bureaucratic process that in recent decades has not met the growing need for infrastructure deployment. The United States Army Corps of Engineers is responsible for the deployment of water resources infrastructure, which will be pivotal as the impacts of climate change manifest in increased hurricane frequency, flash-flooding due to increased precipitation, and storm surge impacts become more commonplace. Decades of disinvestment, an increasingly polarized political climate, and crumbling legacy infrastructures have hamstrung the Corps' ability to achieve their existing critical missions, much less incorporate new directives intended to fundamentally change the Corp's operating procedures. In 2018, USACE introduced the Revolutionize Civil Works Initiative to help address some of the obstacles facing the Corp's attempts to deliver new civil works projects. This initiative aims to expedite project delivery to a three-year timeframe and offer new financing flexibility to localities that would otherwise not be able to finance a project. One way in which the Revolutionize Civil Works Initiative aims to achieve this is through its new Public-Private Partnerships (P3) program, which is designed to help expedite the delivery of civil works projects by piloting new project financing mechanisms.

Upon learning about this initiative, I reached out to the USACE Civil Works Infrastructure team and connected with Aaron Snyder, who oversees the Public-Private Partnerships (P3) program. We discussed the history, purpose, and background of the Revolutionize Civil Works Initiative alongside the P3 program. We agreed to work together to answer the following questions: 1) What factors of the program's current feasibility assessment process limits the Corp's ability to address the socioeconomic and socio-environmental impacts of climate change?; and 2) How can the Corp, through its Revolutionize Civil Works Initiative and the P3 Initiative, better assess project feasibility, effectiveness, and equity by taking into account the plethora of costs and benefits currently excluded from the feasibility process? Through this assessment, we hope to illuminate how the P3 initiative can be leveraged so that the Corps better meets the goals set by the Biden Administration and uproot decades of project valuation practice that ultimately harm our most vulnerable communities.

I. Introduction

I Believe(d) in Nashville

Heavy rainfall and storms began in the Nashville area on May 1, 2010. Over the next two days, 13.6 inches of rain would fall in the city, causing the Cumberland River, which runs through the center of the downtown area, to crest at 51.86 feet for the first time since 1937¹. When the rain and flooding finally stopped on May 7, the flood had caused nearly \$2.3 Billion in damages affecting 31%² of Tennessee's surface area.

Flooding was so significant that some parts of the city became inaccessible, such that water and supplies had to be ferried to stranded residents without power. In some places, the flood surge was so rapid that people commuting to work were caught in the current. Interstate 24 was covered in seconds, engulfing and submerging commuters and their cars. LP Field, Bridgestone Arena, the Grand Ole Opry, and other major Nashville establishments reported major flooding and damage. The Schermerhorn Symphony Center's basement flooded as well, destroying two Steinway grand concert pianos and an organ that was valued at \$2.5 million³. In Nashville alone, the flood caused \$2 Billion in damages⁴ to public and private property as well as \$120 million in damages to public infrastructure⁵.

Although water disasters like the 2010 flood is uncommon in Nashville, floods themselves are not. The US Department of Energy in 2015 indicated that floods occur every ten days in Tennessee on average⁶. In Nashville specifically, the communities that bear the harshest impacts of flood risk are typically Black, Hispanic and communities of color such as Thompson Lane, Bordeaux-Whites Creek, Metro Center, North Nashville, Fisk-Meharry, and "The Nations." Unfortunately, flood risk in Nashville and in Tennessee is only increasing. The First Street Foundation Risk Assessment indicates that in 2020, 383,200 Tennessee properties are at substantial riskⁱ for flood damage, with 395,600 properties projected to be at risk by 2050⁷. Similarly, the Foundation indicates that of the 15.1% of individual

ⁱ Substantial risk here has the same meaning as the FEMA definition.

properties in the state that there at risk of flooding through 2050, 80% of which are at major to extreme risk of flooding.

During the recovery response in 2010, the people who lived in these communities said in interviews with the Associated Press that they felt neglected⁸ and left without resources. Despite the myriad flood management surveys, projects and plans created by the US Army Corps of Engineers, Davidson County, and the City of Nashville in the wake of the 2010 flood; seven years later, the impacts of Hurricane Harvey resulted in a nine-inch rainfall that left Bordeaux-Whites Creek, a predominantly lower-income community,⁹ distressed by a 13 foot water level rise. This time, however, there were no inspiring advertising or branding campaigns for the recovery and relief effort, and there was no emergency declaration that funneled emergency funding from the state or federal agencies.

Bordeaux-Whites Creek is only one example of a wider trend in US post-disaster outcomes. Low-income neighborhoods disproportionately suffer damage from urban and peri-urban flooding¹⁰. After Hurricane Florence in 2018, downtown New Bern (NC) had been reopened and cleaned within two weeks; weeks later it was unclear when lower-income and historically Black neighborhoods, such as Sunnyside and Duffy Field, would receive aid.¹¹ Because many affected areas were not technically classified as residing in a floodplain, such as the City of New Bern, NC, which received roughly \$75 million of damages to residential property, many residences did not have flood insurance. Similarly, when FEMA arrived in New Bern for aid, only homeowners were able to apply for reparative grants or loans, whereas no forms of aid were offered to renters. 108 of designated low-income units were eventually declared by federal officials to be too costly to repair and were subsequently slated for demolition.¹²

Penny Loeb highlights the people of Richwood, West Virginia's decades-long struggle with extreme flooding and minimal flood protection: aptly characterizing the community's status as "too poor to protect" in the eyes of federal decision-makers.¹³ Despite the preventability of significant damage and suffering caused by floods in Richwood, federal agencies responsible for responding to these circumstances have not acted to meet these undeniable and intergenerational threats. The USDA Soil

Conservation Services and the US Army Corps of Engineers alike denied Richwood flood mitigation project funding on the grounds that the projects' costs outweighed their benefits. Including Richwood, areas that are experiencing economic hardship, have modest property values, and have lower population densities are institutionally and structurally marginalized in federal funding allocations, and therefore are significantly less likely to receive the help they need to protect their disproportionately vulnerable communities.

The reality is that while federal flood risk and relief programs exist, many communities are not protected by such programs intended to provide aid or emergency services. Moreover, because the floods and extreme weather events causing so much damage in Bordeaux-Whites Creek, Richwood, and Sunnyside did not occur on Capitol Hill, government representatives and bodies who are responsible for setting budgets, appropriations, and legislative priorities are inherently disconnected from these impacts and communities. Fundamentally, the pecuniary approach through which federal flood management agencies and programs assess and evaluate their own effectiveness continues to perpetuate cycles¹⁴ of poverty and insecurityⁱⁱ for the nation's most vulnerable communities.

Federal Responsibility and the American Jobs Plan

Flood risk is an exponentially increasing reality for more and more communities, both coastal and inland¹⁵. According to the National Oceanographic and Atmospheric Administration (NOAA), the U.S. has sustained 285 weather and climate-related disasters since 1980 wherein the subsequent damages and costs have exceeded \$1 billion (adjusted to 2020 dollars).¹⁶ Throughout this timeframe, damages have totaled over \$1.875 trillion.¹⁷ 2020 was the sixth consecutive year in which there were 10 or more billion-dollar disaster events, totaling \$95 billion.¹⁸ From 1980-2020, flooding events from

ⁱⁱ Fothergill and Peek (2004) illustrate the psychological and physical stress and turmoil that disaster plays across varying socio-economic groups. They conclude that folks with lower socioeconomic status are more vulnerable during a climate event -- due to factors such as housing type, housing locations, building materials, and access to resources -- and are also more vulnerable after a climate event due to the unequal allocation of relief efforts and resources by local and federal institutions.

this category alone accounted for roughly \$303 billion in damages -- roughly one-third of which can be directly attributed to the worsening effects of climate change.¹⁹

These destabilizing impacts have already been felt at the federal level: according to the U.S. Government Accountability Office (GAO) from 2005-2019, the federal government allocated at least \$450 billion in supplemental appropriations to disaster assistance, a number which does not include existing annual appropriations to Departments and agencies that typically manage disaster relief; federal fiscal exposure to climate disasters has now been classified by GAO as High-Risk.²⁰ Moreover, the existing infrastructure network in the United States is not sufficient to withstand these pressures.²¹ There is no single agency, local or federal entity that is responsible for climate action alone. In fact, U.S. climate action and infrastructure management relies upon shared responsibility and risk across federal, state, and local scales. The U.S.'s decentralized system creates an environment wherein there are simply more agencies and priorities than Congress is willing to fund. Moreover, the enabling legislation that establishes federal authority in local flood and environmental risk mitigation²² is rooted in the post-Depression principle that the federal government should be responsible for managing natural disasters and floods on the grounds that it promotes national economic development.

Because of this circuitous approach to the advancement of public welfare, federal funding for localized environmental action is typically justified through the lens of economic benefit. The cost-benefit paradigm that emerged from this act gave rise to a political culture that only reacts to climate-related costsⁱⁱⁱ rather than trying to anticipate them. Moreover, national attention and aid is predominantly awarded to communities with more economic power, rather than the most categorically vulnerable areas. As such, political will for new projects typically follows large disasters in high-density areas, after which funds can be earmarked through emergency appropriations.

Directed federal investment in climate mitigation can reduce disproportionate burdens on at-risk populations while simultaneously providing substantial economic benefits to individuals and communities. Fortunately, contemporary federal leadership has designated federal agencies to better

consider communities that are typically excluded from climate and natural disaster programming. In April of 2021, the Biden Administration released its first infrastructure bill, dubbed the American Jobs Plan, which acknowledges the historical disinvestment in climate resilient infrastructure across the United States, as well as the harm it has caused to the nation’s most vulnerable communities. The plan states that “public domestic investment as a share of the economy has fallen by more than 40%”²³ since the 1960’s. Through increased allocations to various FEMA, HUD, and DOT climate resilience programs, as well as other economic relief funds, the Biden Administration proposes to invest in resilient infrastructure in areas that are most vulnerable to and/or disproportionately affected by flooding. While these directives provide important thought-leadership and acknowledgment of a need for fundamental change, the direction provided by the Biden Administration does little to address demonstrably unjust processes, metrics, and values within fundamental federal procedures.

Climate action in the United States has historically been reactive rather than proactive,²⁴ and therefore relying upon extant funding mechanisms and processes undermines the federal government’s ability to help deliver critical civil works and services to communities most vulnerable to our rapidly changing environment. For instance, Biden’s infrastructure plan – the American Jobs Plan -- allocates more funding to FEMA and SBA disaster relief and community development programs; however, as illuminated by the disaster relief effort in New Bern, NC, both FEMA and SBA approaches to relief²⁵ led to disproportionately worse outcomes for already marginalized vulnerable communities. A reevaluation of federal directives is particularly important given the relatively recent preponderance of scientific evidence of the effects of climate and other anthropogenic environmental changes, such as the RCP (Representative Concentration Pathways) climate scenarios used by the Intergovernmental Panel on Climate Change (IPCC). The multi-agency funding allocations proposed in the American Jobs Plan illuminates the hyper-decentralized and undirected nature of climate adaptation^{iv} planning in the United States, wherein multiple agencies with the same goals and directives must jockey for

ⁱⁱⁱ Direct federal assistance in response to flood-related disasters began in 1968 when the National Flood Insurance Act established the National Flood Insurance Program (NFIP) to help curb the economic losses and distress caused by flooding.

^{iv} Adaptation is defined as adjustments to both natural and human systems in response to the present or future challenges and risks posed by climate change.

funding during an appropriations process that prefers to give fiscal relief post-disaster, rather than to reduce the risk of extreme weather events through concerted and equitable adaptation and mitigation efforts.

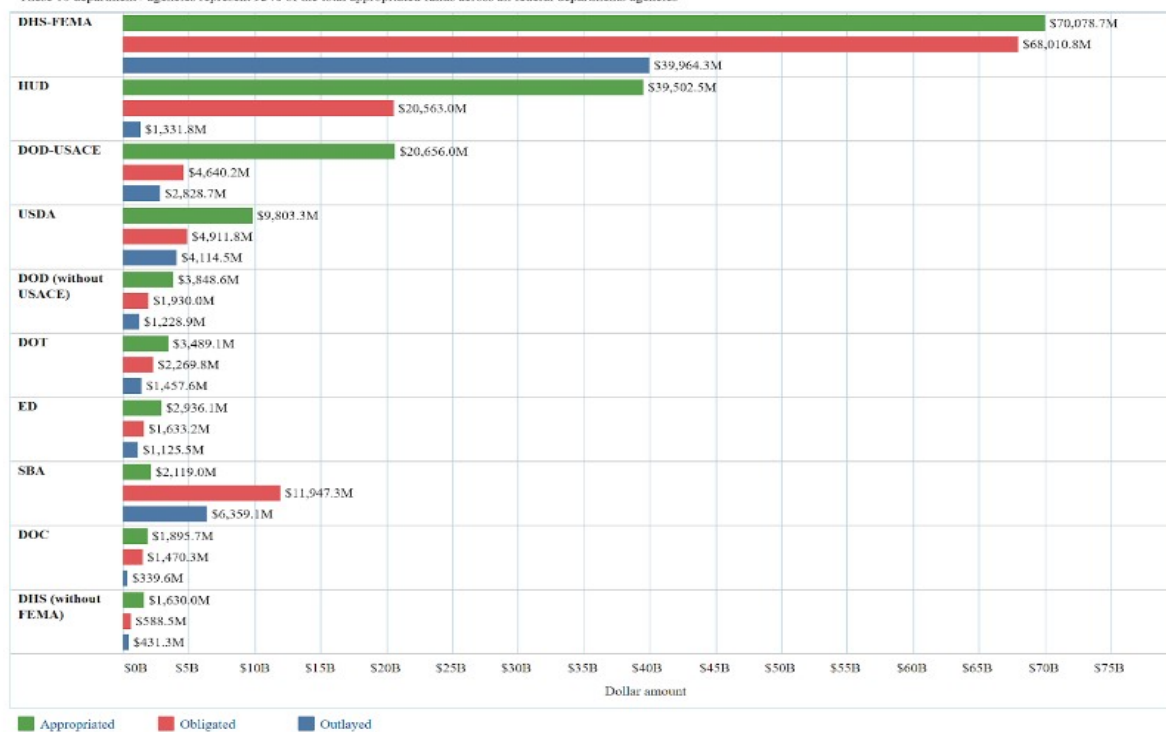
In collaboration with 35 states and municipalities, the GAO undertook a 2019 study²⁶ that analyzed the existing network through which the federal government engages in climate adaptation. The study ultimately recommends that Congress create a federal body to lead the response effort to address high-priority projects and initiatives. This body would apply interdisciplinary expertise to address systemic and large-scale challenges that climate change poses. The GAO recommended that due to its unique approach, the body should be granted its own budgetary allowance. Nevertheless, this recommendation would do little to alleviate the existing challenge of coordinating budgetary allocations across multiple climate response agencies.

Despite the shortcomings of the existing decentralized response network -- in other words, the network through which federal agencies and non-federal entities engage in climate adaptation planning and resource management -- this structure grants governmental and community-based institutions access to multiple potential funding streams. For example, if one agency has minimal available funds for a project, the municipality has the flexibility to engage with another for the same funding. Furthermore, because local governments, community organizations, and advocacy groups best understand existing and emergent community issues, cross-cutting partnerships -- such as local and federal collaborations and private-public partnerships like those facilitated by the US Army Corps of Engineers Public-Private Partnerships (P3) Pilot program -- are essential to ensure that flood risks are adequately understood and addressed in their own context.²⁷

Figure 1.1^v

Largest 10 Departments/Agencies by Total Appropriations since 2017

These 10 department / agencies represent 93% of the total appropriated funds across all federal departments/agencies



Data as of 1/31/2021

With an extensive history assessing local environmental needs, researching, and delivering technical expertise to local governmental partners, or engaging in collaborative planning processes as established by the Institute of Water Resources, the United States Army Corp of Engineers (USACE, or the Corps) has cultivated the technical expertise, funding pathways, programmatic expertise and established local relationships required to implement large-scale climate resilience projects.

^v Figure 1.1 Represents the appropriations granted to each of the 10 largest departments/agencies in the United States. This figure is screenshot and pulled from the FEMA Spending Explorer, found at <https://recovery.fema.gov/spending-explorer>.

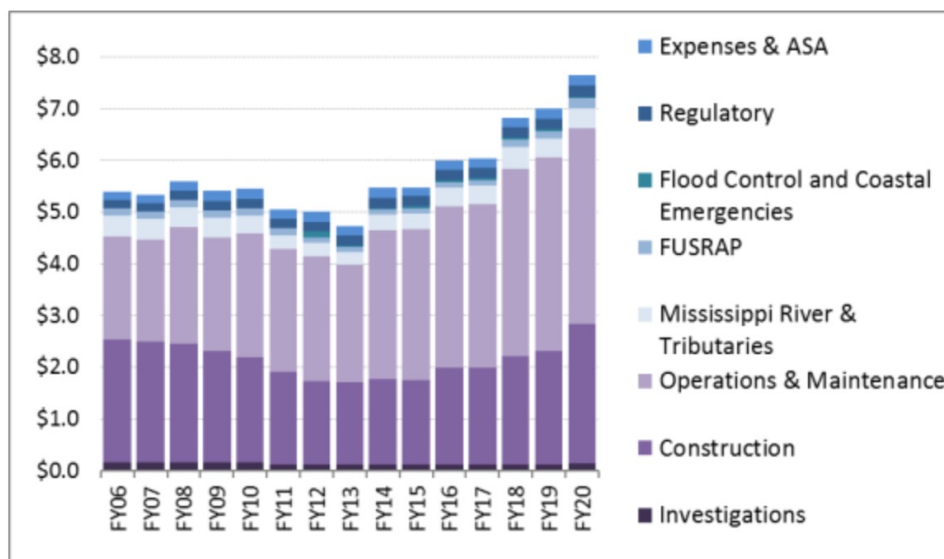
The Role of the Corps

The United States Army Corps of Engineers (USACE) – the *Corps* -- is an engineering unit of the United States Army that oversees military construction and civil works, The Corps' Civil Works mission is to manage domestic infrastructure and environmental systems, most notably U.S. waterways, flood and storm protection, flood-fighting, the repairing^{vi} of levees, water resources and aquatic ecosystem restoration. The Corps' Civil Works mission is to manage domestic infrastructure and environmental systems, most notably U.S. waterways, flood and storm protection, hydroelectric energy systems, water resources and aquatic ecosystem restoration. Annual appropriations to the Corps vary considerably from year to year. From FY2010 to FY2020, Congress allocated amounts ranging from \$4.72 billion to \$7.65 billion.²⁸ Around 30% of USACE's annual appropriations in any given year are directed towards flood risk reduction activities, most of which is directed to combat riverine flood risk.²⁹

Today, USACE operates 25,000 miles of commercial waterways which generate \$18B annually and support twenty percent of US jobs, accounting for almost one-third of the US GDP. Additionally, the Corps has become increasingly responsible for managing numerous domestic environmental and energy programs. For example, the dams under the Corps' oversight provide 25% of US hydropower and three percent of total US electricity.³⁰ Yet, nearly 95% of these dams operated by the Corps are more than 30 years old, and 52% have reached or exceeded the 50-year economic service lives for which they were initially designed.³¹

^{vi} This program is known as the Rehabilitation and Inspection Program (RIP). Historically, this has been funded largely through emergency supplementals following large flood events. For example, Disaster Relief Appropriations Act, 2012 (P.L. 112-77) allocated \$388 million for repairs due to Midwest flooding in 2011 as part of the Disaster Relief Appropriations Act, 2012 (P.L. 112-77) -- the Supplemental Appropriations Act, 2008 (P.L. 110-252) allocated \$740 million for repairs due to flooding, as well. Many repairs across the United States have been halted or delayed due to limitations on the availability of funds through this appropriative process.

Figure 1.2^{vii}



Despite the Corps’ role as the premier federal climate mitigation agency, the reactive culture of federal climate adaptation relegates the Corps to routine O&M of legacy infrastructure, leaving fewer dollars, capacity, and political will for pioneering robust climate adaptation projects. Plus, the increasing costs of maintaining current assets coupled with archaic and intensive bureaucratic processes project delivery time-frames on approved projects, which has resulted in a project backlog of nearly \$96 billion – which seems to only be increasing in size.³² In a recent study, The Institute for Water Resources finds that projects with delays or longer development periods incurred costs that accounted for up to 40% of the project’s final costs. Moreover, USACE asserts that traditional delivery processes could lead to a cost increase of 17.5% above inflation.³³

Given the scale and time-frame at which the US Army Corps of Engineers is required to maintain, update, and deliver climate-ready infrastructure across the United States, it is not surprising that the United States’ infrastructure is no longer equipped to handle increasingly extreme weather events. As

^{vii} Figure 1.2 shows the annual appropriations by *account*. *Account* here simply means the type of expense or authorization to which the appropriation was allocated. It is not to be confused with the system of accounts discussed later in this paper. This image was pulled from the Congressional Research Service, *U.S. Army Corps of Engineers: Annual Appropriations Process and Issues for Congress*, EveryCRSReport.com, Washington, DC, 2020, Digital, <https://www.everycrsreport.com/reports/R46320.html>.

the nation's premier flood mitigation agency, the Corps is faced with two primary challenges: expedite project delivery to meet the increasing demand for civil works projects and the necessity to fundamentally change the way projects are evaluated to include projects in communities that would otherwise be considered infeasible. The Corps must also meet these challenges while facing proportionally lower funding through appropriations.

Within the Corps, regulatory, permitting, and procedural reviews undeniably bog down project delivery - a byproduct of decades of shifting priorities and competing values and interpretations regarding the federal government's role. It similarly struggles to manage growing costs in maintenance and operation for infrastructures that are becoming increasingly obsolete. In 2018 the Corps launched the Revolutionize Civil Works Initiative to better address the growing need for climate adaptive infrastructures across the United States. It has three primary objectives: 1) accelerate project delivery^{viii}; 2) transform project financing and budgeting^{ix}; and 3) improve permitting and regulatory reform on infrastructure projects³⁴. Two of these objectives have shown to be fruitful -- to date, the Corps estimates that it has already saved 16 years of project time, delegated 23 authorities to lower levels, and streamlined cost-sharing agreement processes.

The Corps also launched a Public-Private Partnership (P3) Pilot program intended to expedite the project delivery process and provide increased financial flexibility to non-federal partners in USACE infrastructure projects. However, these programs do not substantially change the process through which civil works projects are evaluated. Instead, they are designed to limit barriers for projects that have already received approvals and funding. In particular, the P3 initiative's innovative approach to

^{viii} They seek to achieve this through 1) innovation – utilization of new materials, designs, and construction practices; 2) streamlining project delivery – expansion of risk-informed decision making to project life cycles, improvement of acquisition processes, delegation of decision making; 3) partnering with non-federal sponsors – providing training and tools to remove administrative barriers that limit partner agency during the development and scoping process.

^{ix} “Infrastructure Initiative.” USACE was tasked with exploring new financing mechanisms through which to reduce costs on the DoD and the Corps itself. Some of these include federal loans through the Corps Water Infrastructure Financing Program, as authorized by the Water Infrastructure and Finance Innovation Act (WIFIA), and Public Private Partnership Strategies, which provide upfront funding that optimize local participation.

project valuations and increased financial flexibility provides a unique framework through which federal agencies, such as the Corps, can not only leverage federal support for climate action, but can also address environmental injustices and inequalities of relief and infrastructure projects in ways that antiquated cost-benefit mechanisms are unable.

This thesis argues that the methodological basis from which federal project assessment are evaluated is based in arbitrary metrics that reflect continuously shifting executive and congressional priorities and preferences. By focusing on the needs of local communities and burdens already facing the nation's most vulnerable communities, the Corps will be able to leverage equity goals without fundamentally altering how those outcomes are measured. It shows that the recently introduced P3 program provides the Corps with the opportunity to prioritize and deliver on the directives and priorities set within the American Jobs Plan.

This thesis seeks to 1) contextualize the role of USACE in the nation's future climate mitigation endeavors given current scientific projections; 2) assess past and current valuations of costs and benefits that USACE uses to justify and recommend public investments; and 3) argue that assessing project feasibility through the monetization of costs and benefits does not reflect allocative efficiency; 4) provide recommendations for alternative approaches and methods to bypass the shortcomings of monetization, while fulfilling the directives of the Revolutionize Civil Works Initiative, P3 Program, and the USACE overall.

I used a historical institutional approach to understand the role of the federal government and the U.S. Army Corps of Engineers in U.S. water resources management and flood risk mitigation. My assessment begins in Chapter 2 wherein I briefly outline the distinct roles of federal and local governments in managing civil works projects and provide a brief overview of the United States Army Corps of Engineers. This chapter introduces the process through which a civil works project is assessed and subsequently selected for federal funding, which are established through the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation*

Studies (P&G). Chapter 2 also outlines the history of the P3 initiative as it pertains to current attempts to solve structural project delivery processes and includes case studies to show its effectiveness.

Chapter 3 gives an overview of the methodologies through which projects are currently evaluated and shows that the monetization of non-market costs and benefits is not rooted in tangible outcomes. Here I evaluate methods employed by other federal agencies as well as academic literature to bridge the gap between theory and practice.

Chapter 4 revisits the impacts of climate change on local economies, the funding and financing mechanisms through which non-Federal entities pay for infrastructure projects and outlines potential pathways through which the Corps could seek to incorporate non-traditional CBA into the way it sets project and spending priorities Chapter 4 also outlines how the P3 initiative can provide new flexibility to incorporate environmental, social, and other non-monetized methods of project evaluation.

II. The Local and Federal Role of the US Army Corps of Engineers (USACE) in Water Resources Management

This chapter discusses the process by which federal agencies and, by extension, USACE evaluate potential projects. It briefly introduces the steps outlined by the *Economic and Environmental Principles and Guidelines for Water and Related Land resources Implementation Studies* (P&G). This chapter then outlines history of the Revolutionize USACE Civil Works and Public-Private Partnerships Pilot Program and its successes thus far.

Shared Impacts and Shared Responsibility

Climate impacts are felt across all geographies, socioeconomic statuses, demographics, and generations, ultimately causing long-term negative effects from which few communities can recover. The effects of climate change pose significant risks to the United States, both physically and economically. According to the climate scenarios known as RCPs (Representative Concentration Pathways), which measure and project the impacts of various concentrations of greenhouse gas emissions on the global climate, by 2090, the impacts of climate change,³⁵ if left unfettered (RCP 8.5) would ultimately cost the U.S. \$224 billion more each year than a more mitigated RCP 4.5 pathway. The same differential would lead to a \$910 million comparative loss of labor hours' worth \$75 billion each year and would also cost the US \$26 billion in coastal property damages, \$12 billion in road damages, and \$5.8 billion in higher electricity demand, among other recreation related losses.³⁶ Furthermore, the impacts of a changing climate extend beyond specific weather events. Furthermore, the impacts of a changing climate compound beyond specific weather events. At a 4.5° C ³⁷ scenario, which has a 92% chance of occurrence by 2100,³⁸ the US economy risks \$520 billion in losses each year, impacting industries ranging from agriculture to tourism.³⁹

Two-fifths of the U.S. population live along coastal areas and account for \$8.3 trillion of goods and services each year.⁴⁰ A study published in the Proceedings of the National Academy of Sciences journal⁴¹ estimates that 36% of the cost of flood damages over 1988-2017 are the result of climate

change induced precipitation changes. Throughout the 21st century, heavy precipitation events in the United States are projected to increase anywhere between 50% to 200% from the historical average, significantly increasing the risk of flood and storm surge in coastal and inland, urban, and rural areas alike.

Despite the Federal government's long history of providing technical and fiscal support for local and regional infrastructure projects, the current processes through which funds are allocated and approved are not meeting current needs of increasing local assistance, dilapidated physical infrastructures, and climate change threats. According to some estimates⁴², existing public infrastructure -- specifically those considered "gray"^x infrastructure -- will require \$4.6 trillion in O&M through 2025. Yet, the federal share of public spending towards infrastructure has been decreasing for decades: in 1980, the federal government's contribution to total infrastructure spending amounted to roughly 37%; in 2017, 22%.⁴³

Federal climate inaction⁴⁴ has left local governments on their own to preempt the worsening impacts of climate change. Cities and states rely increasingly upon their own revenue streams to ensure that they can protect their residents and economies. However, many cities are unable to leverage funding mechanisms that would otherwise allow them to dedicate revenues to specific projects due to strict state requirements or limited authorizing legislation.⁴⁵ In cities and towns that are prone to flooding, state politics and priorities could directly limit a community's ability to prepare for the worsening impacts of climate. Even in the circumstances that cities can fund climate resilience, outcomes are not inherently just for residents. The mechanisms through which cities and states leverage debt⁴⁶ to fund these projects rely upon tax structures⁴⁷ that rely disproportionately⁴⁸ on already-vulnerable communities. As cities continue to fund climate resilience projects, the increased climate protection

^xGray Infrastructures can refer to several characteristics, but for the purpose of this paper, gray infrastructures are man-made water management infrastructures that utilize primarily man-made materials, such as concrete, steel, and iron. Green infrastructures, on the other hand can either be naturally occurring or man-made, but in both instances utilize the natural functions of ecological systems or naturally occurring environmental processes to manage water systems.

and subsequent accrual of economic and social value often leads to the displacement of socially vulnerable residents.⁴⁹

FEMA flood maps aren't designed to account for flooding caused by climate-change induced extreme precipitation events, which presents both local and national problems regarding flood mitigation and disaster prevention.⁵⁰ The First Street Foundation, which uses a model based on federal elevation and rainfall data alongside hurricane flooding estimates, estimates that 14.6 million properties are at risk from 100-year floods, whereas FEMA only estimates 8.7 million properties are at risk.⁵¹ Many of these differences are represented in urban and peri-urban areas, wherein the heightened flood risk is disproportionately present in lower income communities and communities of color. Some communities object to flood-risk designations due to the direct adverse impacts on their insurance premiums. In communities ranging from Buffalo, NY to Fort Lauderdale, FL, communities have convened to fight flood-risk designations to reduce the “unnecessary and unreasonable costs” (i.e. exorbitant flood-insurance premiums) that would ensue. For example, in a community in western Fort Lauderdale that is 80% African-American, First Street estimates that 42% of properties are in the floodplain, whereas FEMA estimates that only 6.5% are at risk.⁵² Moreover, federal relief and aid post-disasters is not allocated in accordance with vulnerability and need, as shown by the outcomes in New Bern, NC and in White's Creek⁵³.

Accordingly, home values are at risk: McKinsey⁵⁴ estimates that by 2030, total home values face a total devaluation of about \$10 to \$30 billion, placing increased financial risk on homeowners. Other estimates⁵⁵ suggest that 300,000 coastal homes, with a present-day market value \$117.5 billion and 14,000 coastal commercial properties valued at \$18.5 billion are at risk of chronic flooding by 2045. By the end of the century, United States homes and commercial property owners risk damages that total more than \$1 trillion^{xi}. In the wake of increasingly extreme climate events and the economic, social, public health, and environmental costs associated with them, direct and sweeping actions to mitigate

^{xi} This value only considers the costs associated with physical damages due to climate and weather events.

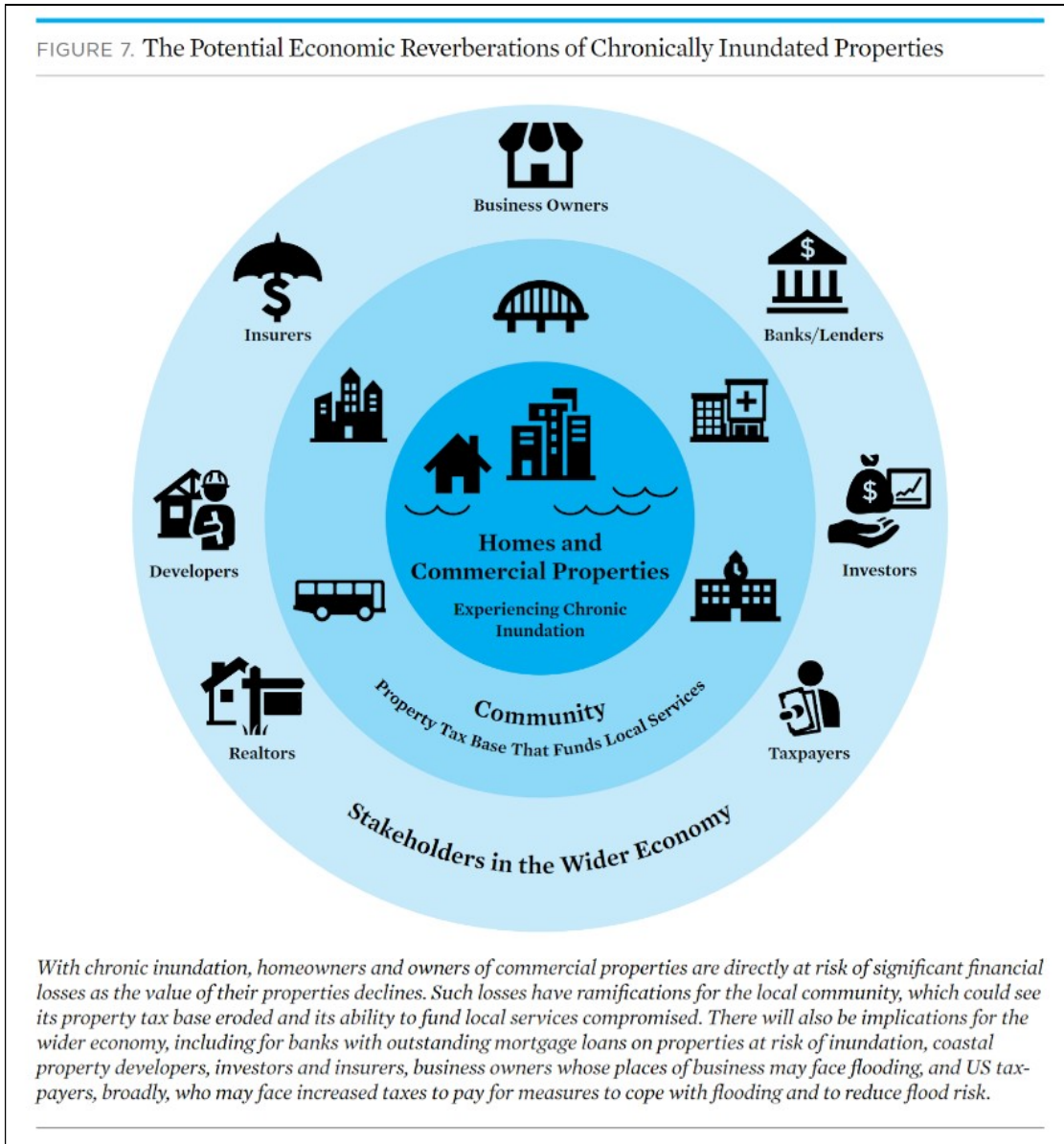
these impacts is vital to ensuring the long-term viability and security of the United States and its localities.

Due to declining property values and rising investment risks in coastal and flood-prone areas, developers, businesses, and municipalities are increasingly likely to divest or opt against investing in certain communities and cities, thereby diminishing a primary revenue source for towns and municipalities. Figure 2.1, created by the Union of Concerned Scientists, outlines a negative feedback loop through which diminishing home values not only affects individual homeowners, but can negatively impact communities at a regional scale. Ultimately, limited efforts to mitigate and adapt to climate change will not only negatively impact homeowners, but will also negatively impact cities, businesses, public revenues, and the communities that rely upon them.

In the wake of the global COVID-19 pandemic that left many US residents without work, shelter, and healthcare resources, the risks of climate disasters are becoming more dire as environmental changes and natural disasters become more frequent, intense, and concurrent. As proven by the ongoing pandemic, the socioeconomic instability induced by disasters and epidemics weakens the ability of towns, cities, states, and even federal agencies to endure significant shocks and rely upon their own resources and infrastructures.⁵⁶

Local governments, states, and federal agencies share responsibility for developing flood control measures such as levees, floodwalls, and coastal dunes. Typically, local governments are responsible for land use and zoning decisions regarding development in floodplains and on coasts, while state and federal entities engage with flood management through programs that influence community and individual decisions regarding managing flood risk.⁵⁷ Local efforts to mitigate floods are essential and necessary to ensure that flood risks are adequately understood and addressed in their own context.⁵⁸ State and local governments are the primary financiers and funders of infrastructure spending – in 2014, state and local governments accounted for nearly seventy-seven percent of total US infrastructure spending,⁵⁹ which amounts to roughly \$348 Billion.⁶⁰

Figure 2.1^{xii}



^{xii} Figure 2.2 represents the multiple impacts and reverberations of climate disasters on larger social systems. This graphic was created by the Union of Concerned Scientists and was pulled from a report called “Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate,” Union of Concerned Scientists (Union of Concerned Scientists, June 18, 2018), <https://www.ucsusa.org/resources/underwater>.

The Federal Role

The federal government engages in partnerships with local project sponsors and provides support for the construction of levees, floodwalls, and coastal dunes. However, local entities bear primary responsibility for the operation and maintenance of the physical assets involved. Numerous agencies, committees, and government entities across all scales of government comprise the United States climate strategy. Each of these agencies and the programs they are responsible for are overseen by different committees in Congress, and thus engage communities in their own unique way. They often overlap in their efforts to provide technical assistance to localities, but do not necessarily use the same methods to assess the need for federal assistance, nor are they necessarily bound by the same performance standards. The Federal Emergency Management Agency (FEMA)^{xiii}, the National Oceanic and Atmospheric Administration (NOAA)^{xiv}, the Environmental Protection Agency (EPA)^{xv}, the United States Fish and Wildlife Service (NRCS)^{xvi}, United States Small Business Administration (SBA)^{xvii}, Department of Housing and Urban Development (HUD)^{xviii}, Bureau of Reclamation^{xix}, the Department of Transportation (DOT)^{xx}, the Farm Service Agency (FSA)^{xxi}, and the US Army Corps of Engineers^{xxii} all play specialized roles in flood-management, funding and financing, emergency planning and disaster relief.

^{xiii} FEMA: National Flood Insurance Program, Community Rating System, FEMA Floodplain Mapping, National Dam Safety Program, Hazard Mitigation Assistance, Public Assistance, Individuals and Households Program

^{xiv} NOAA: Community-Based Restoration Program, Coastal Zone Management Act

^{xv} EPA: National Environmental Policy Act, Clean Water Act, Clean Water State Revolving Fund, National Pollutant Discharge Elimination System

^{xvi} USFWS: Coastal Barriers Resources System, National Coastal Wetlands Conservation Grants, Endangered Species Program, Coastal Program

^{xvii} SBA: Disaster Loan Program

^{xviii} HUD: Community Development Block Grant Program, Sustainable Communities Regional Planning Grants, Home Investment Partnership Program

^{xix} Reclamation: Dam Safety Programs

^{xx} DOT: Dam Safety Programs

^{xxi} FSA: Conservation Reserve Program

^{xxii} USACE: General Investigations, Flood Risk Management Program, Levee Safety Program, Technical Assistance Programs

While federal floodplain management efforts traverse numerous jurisdictions, agency directives, and technical assistance programs, the primary adjudicator of federal infrastructure investment remains the US Army Corps of Engineers. The Corps' authority over U.S. environmental systems dates to the General Survey Act of 1824 and in 1936, was extended to include flood control near waterways through the Flood Control Act, making USACE the nation's premier flood control agency. With an extensive history of researching and assessing local environmental needs, delivering technical expertise to local governmental partners, and engaging in collaborative planning processes as established by the Institute of Water Resources, the United States Army Corp of Engineers (USACE) has cultivated the technical expertise, funding pathways, programmatic expertise, mission-alignment, and established local relationships required to implement large-scale climate resilience projects.

Federal interest in preventing and alleviating flood-related issues began with the Swamp Lands Acts of 1849 and 1850⁶¹. However, it wasn't until the Flood Control Act of 1936 that flood management became a federal responsibility. The federal role in water resources and management was initially limited to mapping navigation pathways and providing advisory services to areas and communities with significant flooding issues. This role changed over the following century and a half; federal involvement in water resources management has been incrementally expanded to include numerous responsibilities, including the development and planning of water resources projects intended for ecological restoration, recreation space expansion, hurricane, and coastal protection, water supply conservation, hydroelectric energy production, and flood management.

The Project Selection Process^{xxiii}

Direct federal and USACE involvement in water resources and flood management projects depends on an in-depth political and bureaucratic process. The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) currently guide the planning process for flood resilience projects within USACE, from which the Corp's decision-making

criteria are derived. Before the Corps can begin a formal study of the feasibility of any given project, it must first receive direction from a Congressional body (typically an authorizing committee or within enabling legislation).

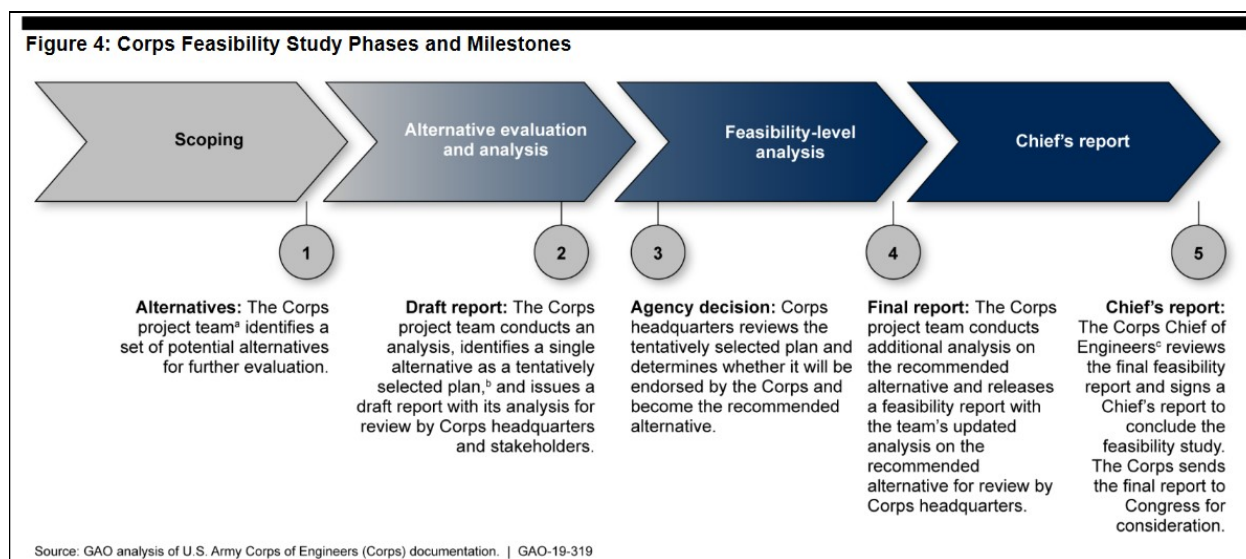
At the onset of a potential water resources project, a scoping process is conducted to determine whether a particular water-related issue is of federal concern. During this phase, the Corps defines the water resource problems and preliminarily determines potential solutions' economic costs and benefits and environmental impacts.^{xxiv} Should the reconnaissance phase indicate that a particular issue area falls within federal priorities, then the Corps and the local partner -- referred to as a Non-Federal Sponsor -- continue to create and sign a Feasibility Study Cost Sharing Agreement. However, before moving forward to the second phase, the Corps must receive both funding and direction from Congress during the appropriations process. The feasibility study evaluates the characteristics of the site, the feasibility of a particular plan or Project, the costs and benefits of the Project and its alternatives, as well as assessing the current and future conditions in the area that are relevant to the water-related issue.

The Corps evaluates projects using a six-step process.⁶² This process defines the Project's objectives, forecasts, and inventories of water resource conditions within a project area. The six major steps are as follows:⁶³ identifying the water and land resource problems and opportunities associated with federal objectives and local concerns; inventorying, forecasting, and analyzing existing water and land resource conditions; formulating plans, projects, and project alternatives; evaluating the effects of all plans/projects and project alternatives; comparing each plan to one another; and finally selecting a plan based on its relative strength compared to all alternatives.⁶⁴

^{xxiii} Using federal documents and GAO studies, this section summarizes the process through which the Corps assesses and compares potential civil works and water resources projects.

^{xxiv} The P&G guidelines outline a *reconnaissance* phase that precedes the *feasibility assessment* phase. However, discussions with the client indicated that recent Congressional direction has led the Corps to combine these phases, simply referring to the initial research and study phases as part of the feasibility assessment process.

Figure 2.2^{xxv}



USACE then creates alternative plans for economic, environmental, and social effects that are finally compared against one another. Costs and benefits are assessed through economic analyses that vary and are project specific⁶⁵. Functionally, these analyses are used to justify any given project based on its net benefit-to-cost ratio^{xxvi}. At the end of the feasibility study phase, the Corps project team sends its analysis to Corps headquarters, where the Chief of Engineers reviews the assessment. Upon review, the Chief of Engineers signs what is referred to as the Chief's report that is then sent to the relevant congressional committees. Upon receipt, Congress decides whether to fund the Project's construction during its annual appropriations process. Final project approval requires the support of Congressional committees, the Assistant Secretary of the Army for Civil Works, State and Local Officials, Project Sponsors, and the Office of Management and Budget (OMB), which enacts enforces the sitting Executive Administration's funding priorities. If approved, non-federal partners must enter into a

^{xxv} Figure 2.2 outlines the general phases through which USACE undertakes a feasibility study. This image is a screenshot pulled from a report prepared by the Government Accountability Office, *Consideration of Project Costs and Benefits in Using Natural Coastal Infrastructure and Associated Challenges*, p. 13. Washington, DC.: GAO, 2019. <https://www.gao.gov/assets/gao-19-319.pdf>.

^{xxvi} Typically, the project alternative with the highest benefit to cost ratio beyond a 1:1 ratio is favored.

Local Cooperation Agreement (LCA) that binds both parties to complete the Project in accordance with Congressional requirements^{xxvii}.

Communities face numerous hurdles when seeking federal aid. However, two of these barriers prove almost insurmountable. Two major barriers addressed in this thesis are: the inability for many communities to garner federal interest in local issues, and the methods through which interest is justified and feasibility is assessed for those same projects. The first barrier that communities face lies in consideration. To be considered for federal support and before the Corps begins its initial assessment of federal interest, the community in question must receive enough political attention and interest to be allocated funding for a study in annual appropriations. The ultimate approval of a project depends on a process that is vulnerable to the whims of political discourse and can take decades to complete. These challenges stem in part from the political process through which agencies advocate for funding as outlined in Chapter 1. However, the process through which the Corps evaluates potential projects presents often insurmountable barriers to localities seeking aid.

Receiving approval for funding or for a study does not guarantee that a study will ever occur, much less that a project will begin development. This was the case with the Fargo-Morehead region, which received approvals for studies on flooding in 1974 that were only completed in 2008. This is further illuminated by the fact that the Corps currently receives only a fraction of funds in appropriations that are required to complete the projects that are currently approved.

Accelerating Project Delivery and Public Private Partnerships

The duration of project delivery process, from the approval for study by the relevant congressional subcommittee to project completion could last over a decade, which diminishes the political willpower necessary to undergo a long-term initiative that is also very costly. To make the project delivery process more efficient, the Corps, in conjunction with the Executive Branch and Congress, has focused on the

^{xxvii} Non-federal sponsors are responsible for a portion of the project's overall costs, depending on the kind of project and the location of the project.

timeline for finishing a project. In recent decades, the efficiency of federal project delivery has been a primary focus of executive actions and budget directives. Federal authorities upon USACE to radically redefine how it delivers projects in water resources, waterways, financial incentives, and permitting processes⁶⁶. Two primary pathways through which authorities have sought to expedite project delivery are through removing bureaucratic barriers as well as providing more funding mechanisms for non-Federal partners to reduce the financial barriers that local governments face in water resources infrastructure development.

Alongside political and public sentiment that infrastructure development in America had failed to keep up with the country's needs, Congress passed the Water Resources Reform and Development Act (WRRDA) of 2014, ratified by President Obama, which re-authorized the Corp's key civil works mission. This allowed the Corps to operate with more autonomy over a longer period of time⁶⁷. Moreover, the bill prioritized expenditures for water infrastructure projects at larger scales. At the same time, it created a pilot program through the Water Infrastructure Finance and Innovation Act to fund water infrastructure projects. The goal was to lower the threshold at which a third-party -- a non-federal public entity, such as a municipality or state -- feasibility study is required before any new project can begin.

The Water Infrastructure Finance and Innovation Act (WIFIA) of 2014, which was signed into law as part of the WRRDA 2014, established a federal credit program administered by USACE and the EPA. It is used as a pathway through which non-federal entities can engage with developing and maintaining federal water infrastructure. Third-party financing and federal government operations are not a new idea—the Congressional Budget Office estimates that from 1998-2005, third parties borrowed roughly \$12 billion to fund federal projects.⁶⁸ However, WIFIA builds on this precedent and provides USACE authorization to pursue alternative financing as a means of advancing its Civil Works mission without requiring Congressional oversight. This authorization led to a series of studies undertaken by various organizations exploring the potential viability of alternative financing methods – particularly the public-private partnership authorization included in Section 5014 of the WRRDA 2014-- as they relate to the Civil Works mission of the Corps.⁶⁹

After the Obama Administration left the White House, the movement to improve Civil Works project delivery continued into the Trump administration. Beginning in January 2017, the new Administration used executive orders to expedite infrastructure project delivery across the United States. Many of these Executive Orders sought to remove regulatory, financial, and permitting reviews that allegedly "routinely and excessively" ⁷⁰ delayed infrastructure projects. In February 2018, the White House released the *Legislative Outline for Infrastructure in America*⁷¹, which proposed a \$200 billion Federal commitment to stimulate \$1.5 trillion in new infrastructure investments through 2028. More specifically, it proposed that this funding be distributed through multiple existing and some new programs: \$100 billion for the Infrastructure Incentives Program to be distributed through the U.S. Department of Transportation (USDOT),⁷² the Environmental Protection Agency (EPA), and USACE; \$50 billion for the Rural Infrastructure Project; \$20 billion for the Transformative Projects Fund that would aid projects that support innovation and require local investment for the various phases of project implementation;⁷³ \$20 billion for Infrastructure Financing Programs, including \$14 billion to existing programs; \$10 billion for the Federal Capital Financing Fund. In addition to outlining legislative pathways, it listed various principles of expedited infrastructure project review to remove regulatory barriers, expedite environmental assessments, and ultimately allow for non-Federal funding sources to be utilized to meet regional and local needs.

The following month, the FY18 Consolidated Appropriations Act was signed into law, guaranteeing a budget increase of \$789 million for the Corps. The relevant Conference Report stated that USACE should expedite its planning, review, approval, and Project delivery process. Later that year, in October 2018, America's Water Infrastructure Act of 2018⁷⁴ (AWIA 2018) was signed into law. It authorized⁷⁵ nearly \$3.8 billion in new USACE Civil Works projects as well as \$7 billion in appropriations⁷⁶ and \$17.4 billion in emergency supplemental funds to support the development of domestic water infrastructure.⁷⁷

Shortly thereafter, The *Revolutionize United States Army Corps of Engineers (USACE) Civil Works* program was begun as a response to these shifting priorities. *Revolutionize Civil Works* has provided a platform through which the Corps has been able to identify and shorten the duration of bureaucratic

processes in project development. USACE established the Public-Private Partnership Pilot Initiative (P3).^{xxviii} The P3 program is designed to expedite locally-led climate resilience projects that will reduce federal costs, maximize federal return on investment, and quickly deliver resilient and reliable water resource infrastructure. An initial memorandum outlined the P3 program and called for the development of evaluation metrics through which 10 potential project partners for the initial pilot program could be assessed. The criteria outlined within this memorandum indicated strong preferences for projects that already had sufficient local political and institutional support as well as local financing and funding sources.^{xxix}

To date, there are several pilot projects that have been selected. Still, only one -- the Fargo-Moorhead Metropolitan Area Flood Risk Management Project (or the F.M. Diversion) -- is currently under construction. The Fargo-Moorhead (F.M.) Metropolitan Area comprises four core cities: Fargo, ND; West Fargo, ND; Moorhead, MN; and Dilworth, MN. extends across two states and numerous county lines. Fargo and Moorhead, the largest of the core cities, lie on the North Dakota-Minnesota border, which follows the Red River. USACE is using the F.M. Diversion Project as a pilot^{xxx} for both the alternative financing methods employed within the P3 initiative as well as a showcase for the expedited delivery process (i.e., as a proof of concept). In this way, the Corps' involvement extends primarily to managing the construction, design, and development of the Southern Embankment, a significant but smaller portion of the overall project that involves the southern leg of the Diversion and spans from Minnesota to North Dakota. Compared with traditional delivery, the P3 approach is projected to save \$277M and be completed ten years sooner; upon completion, USACE projects that the F.M. Diversion will protect roughly 235,000^{xxxi} people and \$19B in property value.⁷⁸ The P3

^{xxviii} Department of the Army (2018). This memorandum defines the P3 to mean a long-term contractual relationship between a public sector contracting authority and a private sector entity for the financing and delivery of public infrastructure or provision of public services, but in the context of a federal entity, it means a contract between the federal government and a non-federal entity (including state and local governments).

^{xxix} These criteria are discussed in depth in the next chapter.

^{xxx} The FM Diversion is credited as a pilot project on its website and discussions with the Client confirmed that the Corps intends to leverage this project's success as a proof of concept.

^{xxxi} Figures 2.5 and 2.6 show the savings and benefits of the Corp's P3 program as it pertains to its successes with the FM Diversion as well as the physical contribution of the Corps as it relates to the FM Area Diversion Project

Program has yet to be tested across different contexts, as the FM Diversion is the only project that has begun the development process. Regardless, the data that is present indicates that it successfully shortens project delivery timelines upon receiving authorization for funding.

More than Bureaucracy

However, while removing bureaucratic barriers plays an important role in the rapid deployment of climate resilience projects, this approach alone is not sufficient. For the communities most at risk, the largest obstacle to project delivery is not bureaucracy. Rather, it is the very assessment process that the Corps undertakes to determine feasibility.

The history^{xxxii} of the F.M. Diversion Project illuminates the complex and slow-moving nature of U.S. climate planning. Flooding in the Fargo-Moorhead Metropolitan area has been the subject of federal study and consideration since 1974. The area has a history of consistent flooding -- the Red River has "exceeded the National Weather Service flood stage of 18 feet in 48 of the past 109 years" as well as every year "from 1993 to 2011." ⁷⁹

The FM Area was one of several regions that were experiencing consistent flooding, and in September of 1974, the Senate Committee on Public Works authorized studies on potential flood mitigation strategies in these areas⁸⁰. It was not until 2008 that the Corps conducted a study that considered potential flood prevention measures. Despite only being a 50-year flood, the 2009 spring flood set a flood record with a stage of 40.8 feet on the Fargo gage. In the 2011 Final Feasibility Report,⁸¹ the Corps notes that there were up to 1000 damage sites in the region and that some residents were unable to access their homes for weeks except by boat.

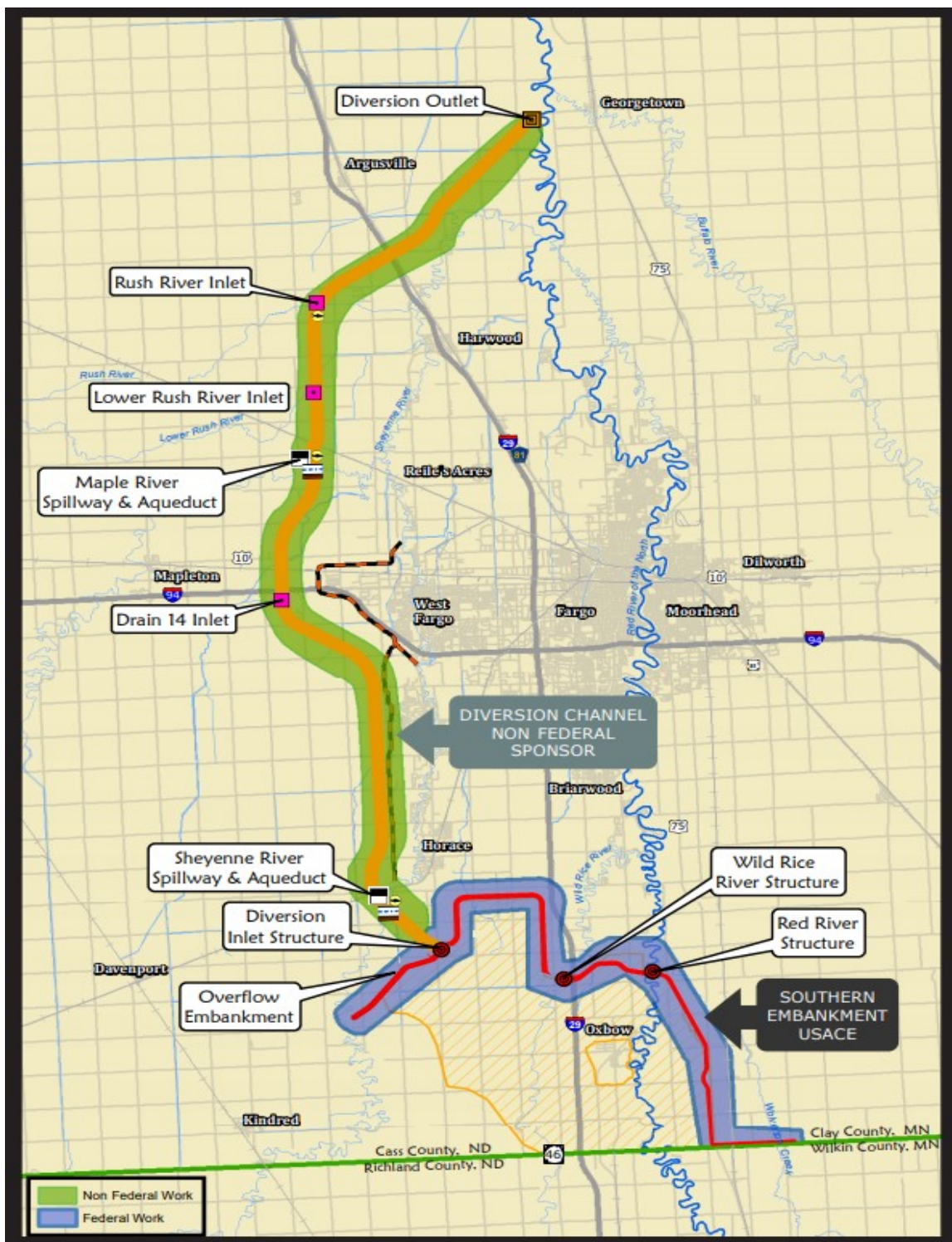
at large. These images were pulled from a factsheet that was compiled to showcase the success of the P3 program. U.S. Army Corps of Engineers. *Screenshot from Fargo-Moorhead Diversion Proof of Concept Fact-Sheet*. 2021, Electronic, USACE Website, <https://usace.contentdm.oclc.org/utis/getfile/collection/p16021coll11/id/5263>.

^{xxxii} The events outlined in the following paragraphs are outlined in depth on the FM Diversion website. The following descriptions originate either from USACE documents or from the website.

Figure 2.5⁸²

| Alternative Financing Outperforms Traditional Project Delivery | | |
|---|---------------------------------------|---------------------------------|
| | Alternative Financing (P3) | Traditional Delivery |
| Authorized | YES | YES |
| Transfers Risk | YES | NO |
| Federal Share | \$750M | \$850M |
| Construction Cost Savings | \$330M | \$0 |
| Time Savings | 10 years | 0 |
| Federal Return on Investment | 410% | 360% |
| MINIMIZES Federal Risk | YES | NO |
| Implementable TODAY | YES | YES |
| Addresses USACE project backlog | YES | NO |
| Addresses COST and TIME growth issues | YES | NO |
| Number of Construction Contracts | 11 | 28 |

Figure 2.6⁸³



In its initial assessment, the Corps estimated that without any Project Condition (or in the No Action alternative), annual flood damages after 2011 would amount to over \$194.8 million. Fargo's levees at the time varied in height, ranging from 30 feet to 42 feet at different points, but were most consistently at 37 feet across the city. Despite only being a 50-year flood, the 2009 spring flood set a flood record with a stage of 40.8 feet on the Fargo gage. In its initial assessment, the Corps estimated that without any Project Condition (or in the No Action alternative), annual flood damages after 2011 would amount to over \$194.8 million, with some estimates reaching \$238 million.⁸⁴ Still, the President's 2012 Budget allocated the Corps only recommended \$5M for this Project. The 2013 and 2014 WRDA's authorized the Corps to begin construction on its portion of the Diversion and authorized a total of \$846M for construction of the Project.⁸⁵

The Corps and the leaders of Fargo, Moorhead and the Flood Diversion Board of Authority signed a project partnership agreement in the Summer of 2016, which indicates the beginning of the Corp's role in the construction process.⁸⁶ However, months later, the Minnesota Department of Natural Resources (DNR) denied the F.M. Area Diversion project a permit to begin construction on the grounds that the project was not consistent with M.N. land use standards and that the Project required more comprehensive adaptation management methods.⁸⁷ In 2017, a U.S. District Court Judge placed a temporary injunction on USACE, effectively ceasing all construction on the Project⁸⁸.

In 2018, Congress signed a new WRDA that again guaranteed to fund for the Project. In 2019, the Corps signed a Public-Partnership Agreement that committed to the federal government to provide \$750M for the completion of the federal portion of the project,⁸⁹ effectively restarting the construction process. Since signing a second PPA in 2019, the Corps has continued to meet delivery deadlines in accordance with the standards set as part of the P3 agreement.

Fargo just provides on example of the ways in which a project could be stalled and ultimately cancelled. The traditional process of delivering projects has led to half a century of wait-and-see politics and ultimately the destruction of property, livelihoods, and loss of life. Despite being an area prone to flooding for decades and receiving approval for a federal study in 1974, the Corps was only

able to complete an environmental assessment on the F.M. Area in 2008. The F.M. Area was only incorporated into the President's Budget after one major flood in 2009 and a second major flood in 2011.⁹⁰ Federal interest and consideration of the Red River Watershed as it pertains to the F.M. Area dates back almost fifty years; it has been 24 years since the disastrous 1997 flood, 12 years after another major flood in 2009, and 10 years since the 2011 flood. In 2021, the Project's construction is still underway.

The Second Barrier: Assessing Project Feasibility

The second barrier lies in how project feasibility is assessed. While some projects receive immediate attention and funding, others receive neither. If the appropriate federal authorities' express interest in a project or location and that project receives both authorization and appropriated funds for a study, then the Corps is permitted to move forward to assess the project's feasibility. For example, the town of Richwood, West Virginia, struggled to receive funding or approval for flood mitigation project⁹¹ funding from multiple federal agencies - namely, the USDA Soil Conservation Service (SCS) and USACE -- even though it was experiencing increasingly severe flooding events. Acknowledging significant flood risk as early as 1967, feasibility assessments conducted from 1987 onward consistently concluded that the potential benefits of significant flood protection in Richwood simply were not justified concerning the costs. In 2008, after numerous floods had impacted the town and region, USACE conducted another feasibility study that assessed ten potential projects:

"A South Fork dam and recreation lake... \$347 million... [a] ringwall along the Cherry River, \$31 million; ringwall downstream of the city, \$28 million; small levee for elementary school, \$105,000; ringwall for the nursing home, \$2 million; hospital veneer wall, \$1.1 million; ringwall for National Guard Armory, \$3.1 million; ringwall for high and middle school and shopping plaza, \$10 million; library veneer wall, \$609,000; municipal building veneer wall, \$742,000." ⁹²

The cheapest Project had a projected cost of only \$105,000, while two other projects cost less than \$750,000. However, none of these made it through the cost-benefit filter. Thus, nothing was built; in

2016. Only eight years later:" Eighty homes were destroyed, 100 were damaged. The high and middle schools were damaged beyond repair. The only grocery store closed and was demolished. Streets became ravines, water, and sewer pipes twisted and erupted. The nursing home has closed, taking away 136 jobs. Damages cost the federal government alone at least \$60 million." ⁹³

One of countless cases, Richwood provides insight to the limited scope inherent within the prevailing cost-benefit framework. In the case of Richwood, federal agencies had undertaken multiple feasibility assessments over fifty years to justify flood mitigation measures, only to eventually spend more money for repairs and relief than mitigation would have cost years prior. The inability for a cost-benefit analysis successfully evaluates a community's need lies in the ways in which costs and benefits themselves are derived.

III. The Federal and USACE Project Feasibility Assessment Process

This chapter discusses the P&G and the guidelines it provides for assessing project feasibility in accordance with National Economic Development Goals. It traces the history of CBA as it is utilized within federal water resources management projects and discusses how different projects are compared to one another to assess potential best outcomes. Finally, it outlines ways in which other federal entities assess non-market costs and benefits.

A Short History of Federal Water Resources Infrastructure Project Feasibility Assessment

The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) guide the planning process for flood resilience projects within USACE and define the kinds of costs and benefits that are employed in federal decision-making as it pertains to civil works projects. The history of the P&G outlines the political nature by which the definition of costs and benefits is derived. When the 1936 Flood Control Act established cost-benefit analysis as the primary method through which to assess public interest, the definition of costs and benefits were not defined, nor were any methodologies or approaches through which these costs and benefits could be measured.⁹⁴ As such, different federal entities approached this assessment in different ways. By the 1950's, the criterion through which Costs and Benefits were assessed had become a political sticking point, with private interests and rival agencies offering competing CBA techniques.⁹⁵

In 1952, the Bureau of the Budget (now the Office of Management and Budget) issued instructions on how to undertake project analyses utilizing economics-centric approaches and other positivist methods.⁹⁶ Over time, the ways in which costs and benefits are calculated within Corps Planning studies have shifted due to political and economic pressures. Some of these directives and changes are outlined through the following documents:⁹⁷

“a 1952 document (Circular A-47) from the Bureau of the Budget; the 1958 report, Proposed Practices for Economic Analysis of River Basin Projects” (known familiarly as “the Green Book”), issued by a subcommittee of the Federal Interagency River Basin Committee; Senate Document 971, approved by President Kennedy in May 1962; and the 1973 Principles and Standards (P&S) and the 1983 Principles and Guidelines (P&G), both issued by the federal Water Resources Council (WRC, 1973; 1983).”

The Water Resources Planning Act (1965) created the Water Resources Council, which oversees the creation of principles and guidelines for water resource project valuation. The WRC created four categories -- referred to as *Accounts* -- by which water resource agencies are to evaluate projects: national economic development, environmental quality, regional economic development, and social well-being.⁹⁸ The *System of Accounts* is a process that is currently employed by the Corps during the feasibility studies phase to better evaluate benefits that are not monetized during the feasibility study. These “Accounts” were developed through the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies by the Water Resources Council in 1983 to consider the various non-monetized benefits of a project. They are assessed during the feasibility assessment process, and can be characterized as follows: the national economic development (NED) account, which displays changes in the economic value of the national output of goods and services; the environmental quality (EQ) account, which displays non-monetary effects on significant natural and cultural resources; the regional economic development (RED) account, which registers changes in the distribution of regional economic activity that result from each alternative plan, and the other social effects (OSE) account, registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.⁹⁹

The Flood Control Act of 1970 determined that these accounts would be weighted equally in project valuation, but by 1973 the *Principles and Standards for Planning Water and Related Land Resources* (P&S) established only environmental quality and national economic development as co-equal objectives with subsequent support from the Carter Administration. In 1983, a year after taking

office, the Reagan Administration rescinded the P&S and established the *Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), which named national economic development as the sole basis for justifying projects. While the Corps still evaluated costs and benefits according to the other accounts, feasibility was decided upon primarily by the way in which they contributed to National Economic Development goals.

A project's contribution to NED goals is defined to be any increase in the net value of goods and service outputs as measured by monetary units, or dollars.¹⁰⁰ Any federal action that causes or induces either a positive or negative outcome, or externalities, must thus be identified and measured. Externalities that cause a positive change in the value of goods and service outputs are *benefits*, and externalities that cause negative change, *costs*. Benefits as they pertain to flood and water resource management projects¹⁰¹ are typically derived from reduction of inundation risk, revenue generated *but for* the project, and benefit associated with activities or economic outputs associated with the project area. Inundation reduction is the primary metric through which benefits are assessed, as they can be quantified as the *avoided* cost in damages, displacement costs due to the project's completion.^{xxxiii} Costs include calculations of direct costs due to a project's development (construction, operation, maintenance) and any potential expenditures induced by the Project's development. Potential benefits are measured in terms of monetary value. They are most often characterized as the avoided costs of damages due to a particular action or Project as a monetized function of avoided damages to homes and commercial buildings.^{xxxiv}

However, many projects do not meet these criteria National Economic Development Goals do not account for issues and costs that occur on the local level that carry over to federal costs. For example, in Richwood, federal costs in aid dwarfed the would-be costs of most of the project alternatives assessed by the Corps prior to these floods. The majority of early-phase feasibility studies -- six out of seven --

^{xxxiii} Avoided damages is calculated by assessing the value of the property and structures in a region and considering the likelihood of damages in accordance with 10,50,100,1000 year flood probability metrics. Through this calculation, costs are annualized across a time period (determined by the project type) and discounted according to a discount rate that is either set by OBM (7%) or determined by the corps.

typically conclude that federal interest does not exist¹⁰² for a given project, as they are ultimately deemed to fall outside of the scope of federal priorities.

The criterion through which feasibility is assessed must be changed to meet the risk facing the nation's most vulnerable populations. For Richwood and countless other communities, the cost-benefit analyses conducted in the area ultimately concluded that the benefits that an intervention would yield in terms of losses avoided did not justify the expenses of building those interventions. The Biden Administration's call to utilize alternative valuation methods to address critical socioeconomic issues and the impact of climate change provides reinforces direction for the Corps to incorporate evaluations of criteria set decades ago. Consideration of changing cost-benefit assessment criterion began most recently with the 2007 Water Resources Development act, wherein the P&G were supposed to have been updated to "address advancements in analytic techniques, public safety, low-income communities, nonstructural solutions; and integrated, adaptive watershed approaches."¹⁰³ Through Section 110 of the Water Resources Act of 2020,^{xxxv} the Corps has been directed to integrate consideration of other criteria into their feasibility assessments, such as non-monetary benefits, environmental benefits, other social benefits, and regional economic benefits, as outlined in the new guidance within the Principles, Requirements and Guidelines (PR&G) -- a GAO study¹⁰⁴ suggest that the degree to which these factors are incorporated into project feasibility assessments is unclear. For example, the Congressional Research Service undertook a study¹⁰⁵ that analyzed the current state of ecosystems services and natural infrastructure valuation processes within the Corps. They used numerous examples, but focused primarily on the following as they pertain to flood mitigation:¹⁰⁶

New York's East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Project. *"The recommended plan includes NNBFs consisting of stones and larger rocks with associated vegetative planting to attenuate wave action and reduce erosion (Figure 2) as part of traditional structural measures. The feasibility report indicates that the NNBF was evaluated based on its cost effectiveness, rather than a benefit-cost analysis. That is, the cost of the NNBF per*

^{xxxiv} The GAO cites Corps' Planning Guidance, which states that "expected annual damages include the value of erosion and storm damage losses over the life-cycle of the project."

^{xxxv} The Corps is supposed to have adopted the PR&G in October of 2020.

*linear foot was compared to the cost per linear foot of a floodwall. The entire recommended plan, which consists of various components in addition to the NNBFs, was subject to a benefit-cost analysis and was found to be economically justified”*¹⁰⁷

and

Virginia’s Norfolk Coastal Storm Risk Management Project. “*The feasibility report recommends NNBFs in combination with traditional structural measures, such as storm surge barriers and pump stations, and nonstructural features, such as elevation, floodproofing, and buyout of structures. The NNBFs include ‘living shorelines to increase resiliency.’ According to the feasibility report, the recommended NNBFs are ‘economically justified by their ability to reduce maintenance costs associated with structural features of the [recommended plan],’ as well as other benefits, such as recreation and education identified.*³⁸ *A benefit-cost analysis was performed on the combined NNBFs and structural features, and the investment was found to be economically justified.*”¹⁰⁸

Similarly, while the Corps has undertaken assessments of multiple plans that incorporate natural and green infrastructure -- for example, in East Rockaway, New York and Norfolk, Virginia -- these plans were ultimately found economically justified due to the hybrid approach that the plans encompassed, utilizing grey infrastructures that could be directly monetized via existing P&G guidelines. A 2015 Corps report, the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk, outlined that the Corps is unsure how to value any ecosystem services or outcomes from a project due to the complexity of ecological systems -- moreover, it stated that the currently understood benefits of green and natural infrastructure systems alone were opaque in that it was difficult to separate the benefits associated with the currently existing hybrid infrastructure systems that dominate the current Corps sample size.^{109 110}

USACE has been unable to integrate full consideration of these benefits due to what it claims are “knowledge gaps” in the ways that these benefits can be measured. The Corps’ struggle to incorporate the monetized costs and benefits of non-market externalities into its benefit-cost analysis approach illuminates a fundamental flaw in the way that federal agencies are required to assess project feasibility.

Cost-Benefit Analysis and Willingness-to-Pay

The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) require that the feasibility of a project is assessed before moving forward in the project delivery process. The feasibility assessment process depends largely upon the results of a cost-benefit analysis of the project and its alternatives.

The Corps relies upon monetized valuations of certain benefits and costs when evaluating a project's feasibility to select a project that demonstrates the greatest net economic benefit.^{xxxvi} The monetization of benefits, costs and other externalities presents methodological problems that also limit the ways in which vulnerable communities can be considered for aid. For externalities that can be associated with a direct market value, monetization is simple. For example, if the Corps built a structure that destroyed ten apple trees at the neighboring farm, the externality would be the destruction of ten apple trees and would be measured by the loss of annual revenues that the farmer would have been otherwise gained from selling those apples. For externalities that do not have a direct market value, ascribing monetary value is difficult. However, measuring them is pivotal to the CBA process.

The 1936 Flood Control Act, which provided authorization for federal action in national flood projects, established cost-benefit analysis as the primary method through which federal cost efficiency is assessed.¹¹¹ CBA¹¹² in the US¹¹³ is rooted¹¹⁴ in welfare economics, and more specifically in a body of literature surrounding¹¹⁵ Pareto's welfare criterion¹¹⁶. Some theorists argue that "allocative efficiency" is the foundational pillar of CBA.¹¹⁷ Allocative efficiency is where financial resources are utilized in accordance with the maximum social benefit that can be attained through using the least number of resources. In other words, Cost-Benefit Analysis is a process through which a federal cost efficiency is assessed, prioritizing projects which are deemed to yield a higher benefit to cost ratio. Similarly, the Flood Control Act implies a focus on social welfare.¹¹⁸

^{xxxvi} Discussions with the client have suggested that *economic benefit* pertains primarily to economic benefit afforded to the nation at-large as opposed to general localized economic benefits.

*“[...] the federal government should improve or participate in the improvement of navigable waters or their tributaries, including watersheds thereof, for flood control purposes if the benefits to whomsoever they accrue are in excess of the estimated costs, and if the **lives and social security of people are notherwise adversely affected.**”¹¹⁹*

CBA relies upon a decision rule called the Kaldor-Hicks Criterion,^{xxxvii} which asserts that a policy, program, or project should be pursued only in circumstances where *net* welfare increases because of an action. Through this lens, any project that could provide benefits with such a surplus that anyone who is made worse-off upon completing the said project could be compensated adequately for their loss would be justified. Kaldor-Hicks criterion suggests that an action that creates a benefit great enough that the benefitting individual(s) could hypothetically pay for other individual losses -- while still maintaining a net benefit -- would be the preferred option. In this way, projects with *net* positive benefits should therefore be adopted,^{xxxviii}

In order to measure the monetary costs of externalities using a Kaldor-Hicks decision approach, federal entities such as USACE use a *Willingness to Pay*^{xxxix} (WTP) foundation when evaluating costs -- if costs are associated with the tangible expenses of a project, and the general public is willing to accept those costs (as agreed upon by their political representatives), then a project's benefits are justified. The Corps uses two primary approaches to quantifying these values: *revealed* and *stated preferences*.¹²⁰

WTP attempts to identify the market valuations of goods and federal entities such as the Corps are tasked with quantifying non-market benefits, such as intrinsic, environmental, recreational, and ecological benefits. WTP begs the question: 1) whose willingness is being considered; 2) make the approaches utilized to identify public preferences discern between *willingness* and *ability* to pay?¹²¹

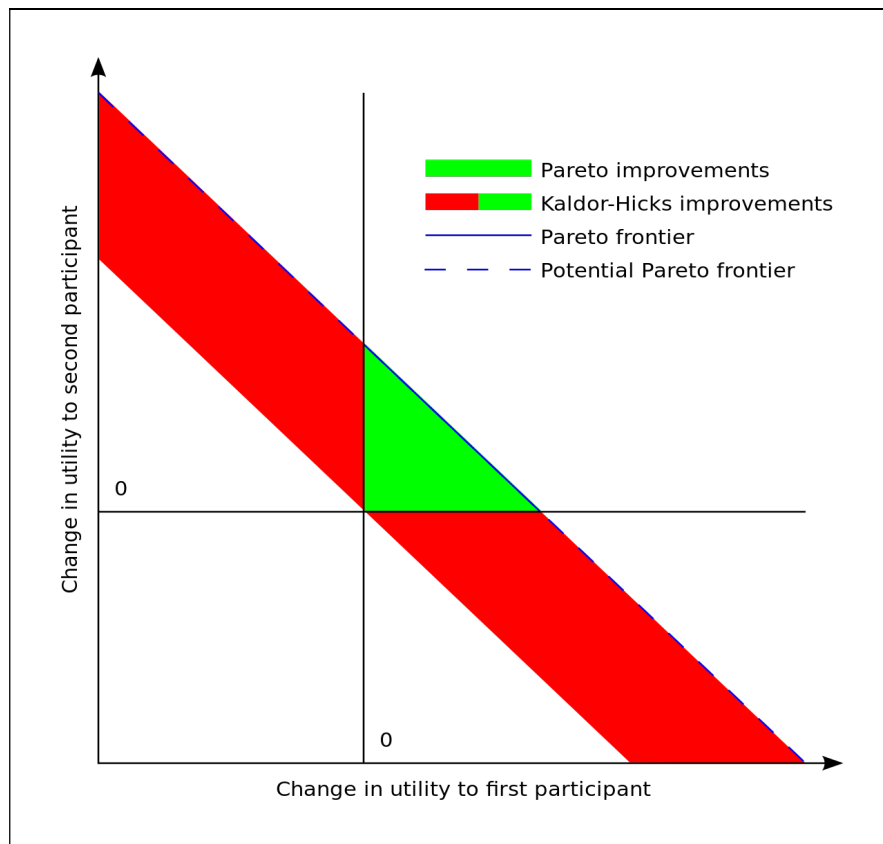
Budget constraints, access to capital, and access to fair representation are but a small number of characteristics that indicate a community's ability to advocate for its true preferences. When presented

^{xxxvii} Melese, Richter and Solomon (2015) point out that a *Pareto optimum* is an unrealistic goal, given that the definition of welfare is elusive and ultimately subjective. More specifically, this optimum requires proving that an action does not adversely affect anyone, necessitating omniscient access to information.

^{xxxix} WTP is a highly biased approach to valuation. For example, it relies upon human values, is limited to goods exchanged in markets, and does not consider values that cannot be monetized.

with two sets of options, one that costs more and one that costs less, individuals with lower access to monetary wealth will usually prefer the budget option. However, this would not necessarily be a true preference. If one asked two individuals, one individual that earned \$10,000 each month and another that earned \$200, if they would be willing to spend \$100 on a meal, first individual is more likely to say yes than the first. WTP presumes freedom of choice and agency when assessing individual willingness to pay and does not account for individuals or communities that do not have this privilege

Figure 2.3^{xl}



^{xl} This chart illuminates the wider range of optimal exchanges of value that can be attributed to the Kaldor-Hicks approach, as opposed to the more limited Pareto Optimum. This image was found online via an open-access internet search and has no confirmed author. Unknown, "Kaldor-Hicks Graph," Wikimedia Commons, August 20, 2006, <https://commons.wikimedia.org/wiki/File:Kaldor-Hicks-en.svg>.

WTP attempts to identify the market valuations of goods and federal entities such as the Corps are tasked with quantifying non-market benefits, such as intrinsic, environmental, recreational, and ecological benefits. WTP begs the question: 1) whose willingness is being considered; 2) make the approaches utilized to identify public preferences discern between *willingness* and *ability* to pay¹²²? Budget constraints, access to capital, and access to fair representation are but a characteristics that indicate a community's ability to advocate for its true preferences. When presented with two sets of options, one that costs more and one that costs less, individuals with lower access to monetary wealth will usually prefer the budget option. However, this would not necessarily be a true preference. If one asked two individuals, one individual that earned \$10,000 each month and another that earned \$200, if they would be willing to spend \$100 on a meal, first individual is more likely to say yes than the first. WTP presumes freedom of choice and agency when assessing individual willingness to pay and does not account for individuals or communities that do not have this privilege.

These approaches assume that the marginal utility of income, finances, or resources is constant across all individuals. For example, a project that leads to direct negative externalities valued at \$10,000 for each household in a community would have drastically different implications for households with a net worth of \$1,000,000 and households with a net worth of \$20,000. Similarly, if the benefits of the project amount to \$100,000 per household -- for a benefit to cost ratio of 10:1 -- one cannot guarantee that those benefits will be evenly distributed across the community. The uneven distribution of the benefits gained by federal action is well documented. Munoz and Tate (2016)¹²³ conducted an assessment of recovery efforts and outcomes across three communities in Iowa after a series of extreme flood events in 2008 and discovered that communities characterized as having high social vulnerability were less likely to receive timely or effective federal aid.

The marginal utility of money as it relates to cost-benefit analysis poses a similar problem of scale. For example, Hammond¹²⁴ (1966) asserts that although a project that costs \$1 and yields a benefit of \$5 has a benefit-cost ratio of 5:1, a comparable project that costs \$1,000 and yields a benefit of \$1,200 is more

ideal despite a 1.2:1 B/C ratio^{xli}. In essence, Hammond argues that the net benefit of \$200 is significantly larger than \$4 and is worth the investment. Moreover, the value of money presents the third issue -- individuals have different perspectives on the value of certain services^{xlii}.

The basis of CBA in welfare economics and the Kaldor-Hicks evaluation approach relies upon the measurement of costs and benefits. In the United States, this measurement is expressed in monetary terms and is evaluated using a *Willingness to Pay (WTP)* model. Not only does WTP not capture the sentiments and preferences of all individuals impacted by federal action, but it relies on unrealistic assumptions, such as a static marginal utility of money within a community or that individuals in a community have the same preferences despite significantly varying socio-economic status.

In other words, to monetize the cost or benefit of any externality, one must assess a community's WTP for that externality. To do this, one must assume that the marginal utility of income is constant across the population and that the value of money itself is equal across the population. For CBA to accurately identify net positive gain because of a project, it fundamentally relies upon unlimited access to information about the externalities caused by a particular project. Moreover, to have an accurate outcome, CBA requires that value of those externalities is accurately measured. However, the monetization of benefits, costs and other externalities presents methodological problems that also limit the ways in which vulnerable communities can be considered for aid.

^{xli} Although Hammond provides commentary and discussion around this concept, this example is derived from a work called *Water Supply: Economics, Technology and Policy*. The three authors in this work discuss methodologies for evaluating water supply economics. J. Hirshleifer, J. C. DeHaven & J. W. Milliman, *Water Supply: Economics, Technology and Policy* (1960).

^{xlii} To continue Hammond's hypothetical, if a community worth \$1,000 receives a net benefit of \$200, they effectively gain a 20% increase in overall value. If a community worth \$10,000 receives a net benefit of \$200, it would be a mere 2% increase in value. In this way, the marginal utility of the benefits more greatly benefits one community than another. This can be extended to even smaller dollar amounts -- a project that costs \$1 that yields a benefit of \$5 -- a net benefit of \$4 -- in a community valued at only \$100 sees an increase in relative value. Yet, both the CBA assessment and net benefits associated with the \$1 project exceed the benefit-to-cost ratio of the project that costs \$1,000 and nets \$200 in benefits in a community valued at \$10,000.

Alternative Approaches to Non-Monetary Assets

In the Corps' attempts to monetize externalities such as the value of ecological restoration on community health outcomes, it has struggled to identify the potential impacts of each variable and linkage within the larger system it impacts without making potentially unsubstantiated assumptions. However, the entire approach through which costs and benefits are monetized rely upon assumptions to fill various knowledge gaps to the degree that their assessed value is meaningless. Other federal agencies have established approaches to evaluating traditionally non-monetized externalities. The DOI, DOT, EPA, HUD, SBA and FEMA all assess costs and benefits for projects and investments while using guidance outside of P&G.¹²⁵

Two primary approaches to adjusting for non-monetized assets are 1) to find ways to monetize every possible externality that can be associated the impacts a civil works project; and 2) adjust the assessment process to weigh non-monetized assets more heavily. The first approach is employed by federal entities such as the Department of Interior, the EPA, and the Department of Transportation.

For example, the Department of Interior incorporates impacts of projects on activities that range from agriculture, commercial and recreation fishing, refuge and reservoir recreation to the impacts a project may have on real estate values.¹²⁶ The EPA uses a BCA that includes impacts on employment, pollution, noise, accidents, and even local and regional taxes and fees.¹²⁷ The Department of Transportation in its implementation of the TIGER grant program includes the value of injuries (reduced or increased), property damages, costs associated with travel time and even emissions reductions.¹²⁸

Figure 2.4^{xliii}

Table 2. Externalities/Benefits Eligible in TIGER Grant Applications.

| Long-Term Outcome | Types of Societal Benefit |
|------------------------------|---|
| Quality of Life | Land Use Changes that Reduce Vehicle Miles Traveled (VMT) |
| | Increase Accessibility |
| | Property Value Increases |
| Economic Competitiveness | Travel Time Savings |
| | Operating Cost Savings |
| Safety | Prevented Accidents (Property Damage), Injuries, and Fatalities |
| State of Good Repair | Deferral of Complete Replacement |
| | Maintenance and Repair Savings (Project reduces maintenance costs or extends life of asset) |
| | Reduced VMT from Not Closing Bridges |
| Environmental Sustainability | Environmental Benefits from Reduced Emissions |

NOAA similarly monetizes costs and benefits that are not otherwise monetized. NOAA estimates that each dollar invested into natural restoration and natural infrastructure yields up to \$7 savings and suggests that natural infrastructure investments generate additional revenue over time.¹²⁹ However, while some of these alternative externalities are inherently monetizable due to the presence of market values, such as increases and/or decreases in local and regional taxes, the other variables rely upon assumptions that are based on probabilities.

The first approach seeks to include as much information as possible when assessing project costs and benefits. As such, it seeks to fill in knowledge-gaps that exist in assessing the true costs and benefits of federal action. However, for non-market benefits and costs, this method relies upon estimating the value of a given externality through assessing willingness-to-pay using criterion that rely on unrealistic assumptions. Moreover, this process is defined by the P&G, which is set by congressional and executive branch leadership, not USACE.

^{xliii} This is a graph pulled from Center for Ports and Waterways. Rep. How Project Selection in the Corps of Engineers Is Affected by Benefit-Cost Ratio (BCR) Analysis. College Station, TX: Texas A&M University, 2018. Prepared for the National Waterways Foundation, <http://www.nationalwaterwaysfoundation.org/TTI%20BCR%20FINAL%20STUDY.pdf>

FEMA employs the second approach. In September 2020¹³⁰, FEMA released a policy update that intends to encourage communities to use green-infrastructure practices more frequently. This policy built upon prior directives¹³¹ that allowed for ecosystem service benefits if the benefit-cost ratio (BCR) of acquisition/open space projects was .75 or greater using traditional reduction benefits. The policy outlines exactly how the agency rates state and local applications for agency funds to pay for flood mitigation projects. Put succinctly, projects that otherwise would have been discounted due to their diminished flood reduction potential would be considered viable due to the environmental benefits that the project would provide to the area. *Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA's Mitigation Programs Policy (FEMA Policy FP-108-024-02)* eliminates the BCR 0.75 requirement, allowing for FEMA consideration of projects regardless of BRC value. The requirements for this process are as follows:¹³²

“Outcome: Ensure HMA applicants and sub applicants and PA Mitigation recipients and subrecipients understand how ecosystem service benefits can be utilized as part of a FEMA BCA.

1. The primary purpose of FEMA's Hazard Mitigation programs is to protect lives and/or reduce or eliminate future property and infrastructure damage. FEMA recognizes the natural environment is an important component of a community's resilience strategy.
2. OMB Circular A-94 states analyses should include comprehensive estimates of the expected benefits and costs to society. The BCA can include ecosystem service benefits for relevant projects regardless of the BCR calculated for the activity using traditional risk reduction benefits.
3. The use of ecosystem service benefits applies to all types of HMA and PA Mitigation projects eligible under FEMA's mitigation programs and resulting in the restoration or enhancement of the natural environment.
4. Pre-calculated benefits cannot be combined with benefits from a traditional BCR calculated using FEMA's BCA Toolkit for purposes of aggregation of benefits. The application of “excess” benefits from the pre-calculated structures cannot be applied to the structure(s) analyzed using a traditional BCA or vice versa. Ecosystem service benefits cannot be combined with pre-calculated benefits.
5. The use of ecosystem service benefits is reserved for satisfying the cost-effectiveness requirement for eligible HMA projects and PA Mitigation

projects; this policy does not affect other programmatic eligibility requirements for projects proposed through either HMA or PA Mitigation.”

By providing consideration for certain projects that otherwise would not be considered under a more traditional CBA assessment, FEMA effectively corrected an imbalanced weight distribution at the onset of the assessment process. FEMA’s approach shows that full consideration of all potential externalities into a CBA is unnecessary, instead weighing characteristics more highly in their assessment process -- such as natural infrastructure elements. In this way, FEMA has incorporated consideration of alternative externalities not into their CBA assessments, but despite them.

Regardless of the approach employed, these methods all recognize and, in some way, add weight to outcomes that directly impact the community that is being considered. By providing weight to outcomes such as increased recreational revenues and property values or by considering nature-based flood resilience projects that otherwise would not pass a cost-benefit analysis, agencies are able to enact policies and undertake projects that align with contemporary priorities. More importantly, however, these approaches allow for greater flexibility in assessing the feasibility of a project in accordance with local needs.

IV. Addressing Local Impacts and the Role of P3 as a Pathway

This chapter outlines how the P3 initiative can provide new flexibility to incorporate environmental, social, and other non-monetized methods of project evaluation. It the impacts of climate change on local economies, the funding and financing mechanisms through which non-Federal entities pay for infrastructure projects and offers three recommendations f the P3 selection process.

As the exponentially worsening impacts of climate change pressures federal agencies to act quickly in deploying climate adaptation solutions to an increasing number of communities that are at risk, ignoring the glaring flaws with the assessment process will likely lead to even more costs and fewer benefits. The Corps and other federal agencies are required to address the impacts of climate change through a process defined by the P&G that overwhelmingly favors inaction. Inaction in the face of climate disaster and relying upon federal disaster relief after the fact benefits primarily those who do not need it. Not only will the lack of federal investment in climate resilience harm entire communities, cities, states, and regions, it already has.

Despite quicker turnarounds on studies, feasibility assessments and even construction timelines, consideration of all projects still requires and begins with Congressional action. Without the support and direction of Congress, the Corps wields insufficient authority to engage in new projects or studies. For many communities, Congressional support is never established, leaving them stranded in the face of impending climate disasters. Similarly, a significant part of the feasibility assessment process relies on the ability to accurately monetize any externalities associated with any USACE intervention. However, access to perfect information is impossible. Moreover, the impacts of climate change are felt on the local level, not a national one – National Economic Development goals alone are not a sufficient basis through which to assess federal interest in any given project.

The P3 program does not fundamentally address delivery issues for communities that are traditionally not truly considered in civil works project assessments. It similarly does not address the issues associated with garnering political interest in a project such that funding for a study and authorization

can be enacted prior to a major disaster. The program^{xliv} assesses projects only after the Congressional interest has been established. In this way, Corps is providing a pathway for cities and regions that have already completed feasibility assessments and have reliable funding sources to expedite the project delivery process and receive USACE funding and support in a shorter time-frame.

As illuminated by Richwood and Fargo-Moorhead, both the process through which federal support is initiated and the ways in which project feasibility are assessed significantly hamper the Corps' ability to quickly respond to the critical needs of vulnerable communities. Once a project is authorized by all relevant authorities in the relevant local and federal jurisdictions, and receives funding, the Corp's updated delivery model can streamline the development and construction process. The P3 program has so far succeeded in delivering projects quickly, as shown by the FM Diversion project. Yet, development of the project began nearly thirty years after an original study was authorized by

To be able to provide crucial support to vulnerable communities, it is necessary that the Corps utilize a more holistic approach in feasibility assessments, as discussed in Chapter 2. However, assessing feasibility necessitates following a process set by the P&G that limits the scope at which the Corps can exercise discretion to allocate aid and support to vulnerable communities. Moreover, the ways in which these costs are weighted significantly favor certain types of benefits over others. In flood and water resource management projects¹³³ benefits are measured by the avoided costs in damages or displacement costs that result from a project's completion. Damages to communities that are assessed at higher values are prioritized when receiving federal support and aid when compared to communities with lower property values.

Although other agencies have attempted to incorporate the monetized values of non-market externalities, ultimately the assessment of costs and benefits of those externalities relies upon assumptions that fundamentally do not consider all outcomes. There are circumstances, however,

^{xliv} Department of the Army (2018). This memorandum defines the P3 to mean a long-term contractual relationship between a public sector contracting authority and a private sector entity for the financing and delivery of public infrastructure or provision of public services, but in the context of a federal entity, it means a contract between the federal government and a non-federal entity (including state and local governments).

wherein the number of assumptions made is minimal and thus a CBA could be more reliable. For example, a sufficient CBA is based upon accurate and available information, such as information that may be present when considering the local impacts of any intervention, localization of benefits and costs allows a federal agency to more accurately determine whether a project or its alternatives are feasible. Chen (2019)¹³⁴ provides a methodological framework through which to apply existing data sources to better understand the fiscal impacts of disasters including but not limited to: declared disaster damage, unemployment, disaster aid, population density, intergovernmental transfers, and poverty rates. Chen's assessment identifies a methodology for assessing the impacts of climate change that extend beyond solely physical impacts.

Although relying upon monetized assets as a baseline to compare potential projects limits the Corp's ability to consider all potential externalities and their effects, incorporating assessment of market-based externalities can lead to equitable outcomes. The Public-Private Partnership program presents a unique opportunity to not only avoid some of the challenges associated with traditional project delivery, but it could also provide a pathway through which the Corps could more seamlessly justify and deliver projects that meet both national and local goals. It utilizes unique criteria designed to assess the local support for a project to guarantee that a project has sufficient support and funding to be completed shortly after USACE involvement. It offers these criteria^{xlv} for project selection:

1) Pre-screening Criteria:

- a. Has a construction cost in excess of \$50 million;
- b. Has non-Federal sponsor support;
- c. Includes design, build, finance, operation, and maintenance or some combination thereof for federally funded projects;
- d. Accelerates project delivery; and
- e. Has the ability to generate revenue or leverage non-federal funding sources;
- f. Existing authorities are sufficient to allow the P3 to be completed;
- g. Proof that a P3 structure would help deliver the project faster;

2) Selection Criteria

^{xlv} As stated in the 2018 memo.

- a. Shows a return on investment;
 - i. P3 project proposals are ranked on the basis of Return on Investment (ROFI);
- b. Project replicability across different scales and contexts;
- c. Reliability of non-federal funding sources;
- d. Project allocates delivery and performance risk to the non-federal entities and not the Corps.

The criteria listed in the 2019 memo make clear the scale and scope of the projects that the Corps hopes to target, as it focuses on projects that have already completed the local scoping, design and approval processes and have largely been approved for construction. The pilot program intends to support projects that have already gathered a significant amount of local support as represented by the presence of non-federal funding sources and are sponsored by a local entity with authority.

Recommendation 1: Maximize ROFI by Prioritizing Local Benefits

The P3 program evaluates projects by their *Return on Federal Investment* (ROFI) was developed as part of the P3 program to assess the potential value that a project may have in a fiscally constrained environment. ROFI is calculated by annualizing the total project benefits and federal costs (as defined by the criteria set by the P&G.

$$\text{ROFI} = (\text{Benefits} - \text{Federal Costs}) / (\text{Federal Costs})$$

ROFI evaluates the cost of a project as if it were an investment, as opposed to a traditional CBA that assesses simple net costs and benefits. In this way, ROFI is a mechanism to justify P3 delivery and funding for projects that have multiple funding and revenue streams. However, benefits in ROFI uniquely include the entirety of the benefits that are afforded to a project upon its completion, not just the portion that the Corps helped to fund and develop. Regardless of the size of the Corps' contribution to the total project, ROFI measures their own costs against the benefits associated with the completion of the entire project.

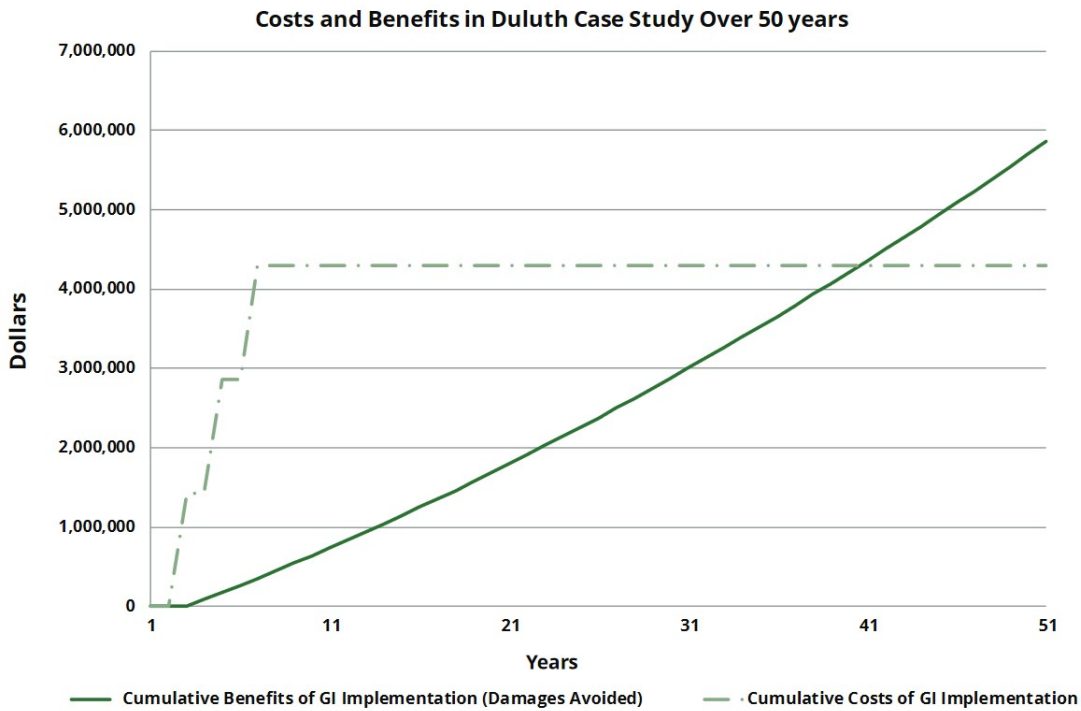
For non-federal partners -- municipalities and states -- this kind of valuation affords a unique opportunity to leverage local funding mechanisms, state grants and value capture techniques alongside Corps technical and financial support to achieve locally desirable goals. The Corps can use ROFI in P3

to prioritize and even incentivize projects that help meet the standards set by Biden Administration and meet federal environmental, social, and economic benefits. Some projects can generate revenue for a locality and thus provide economic resilience, meet environmental standards, or protect existing ecosystem services, or even improve health outcomes. One such instance is Michigan's Muskegon Lake, wherein a shoreline stabilization project and wetland restoration project led to a \$7.9 million increase in property value alongside \$27.9 million in additional recreational value.¹³⁵ Not only did this project meet environmental goals, it also was proven to generate significant revenue for the community.

Another way to assess revenue could be to evaluate local costs savings over time associated with federal intervention in a locality – much in the way that benefits are currently valued as costs avoided, the municipal costs avoided because of a project could be included as a return on federal investment in the form of either a benefit or a revenue generating outcome. There are numerous examples of localities that have used green-infrastructure solutions that resulted in significant cost-savings: for example, Philadelphia estimates that its Green City, Clean Waters program will save the city \$8 billion more than the gray infrastructure alternative.¹³⁶

By following the precedents set by FEMA and the EPA that weigh certain priorities higher than others to balance a project feasibility assessment, the Corps can leverage the P3 pilot program to test projects that reduce the cost-burden on localities long-term. For example, there are significant evidence that natural and green infrastructure solutions provide more benefits and lower costs in the long term. Duluth, MN assessed the benefits and costs of a green infrastructure project over fifty years and found that the cumulative benefits of green infrastructure began to increasingly outweigh the costs after 40 years.

xlvi Figure 3.1¹³⁷



^{xlvi} Figure 3.1 shows the discrepancy between costs and benefits in green infrastructure assessments. At a 11-, 21-, 31 and up to 41 year planning horizon, the costs of the project technically exceed the benefits. However, the costs of the project remained static within the first decade due to a diminished O&M cost, and the benefits of the infrastructure continued to increase. If this project were evaluated at a 50 year planning horizon, it would have a favorable cost benefit ratio, whereas, at a 20 year horizon, it would not. Moreover, there are fundamental problems with comparing two projects across horizons, particularly those with vastly different lifecycles and purposes or utility. Screenshot from *A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction* (Washington DC, 2015), prepared by Eastern Research Group, Inc. on behalf of the National Oceanic and Atmospheric Administration. Digital. <https://coast.noaa.gov/data/digitalcoast/pdf/gi-cost-benefit.pdf>

Recommendation 2: Prioritize Non-Federal Partners that Utilize Progressive Financing Mechanisms

Another pathway is to prioritize projects that utilize local funding mechanisms based on progressive funding structures. As a program designed to pilot innovative project financing and delivery approaches, P3 is ideally placed to incorporate equity considerations into their financing criteria.

Infrastructure projects at the local level are funded through some mixture of loan financing, state and federal funding through grant programs, existing cash-flows associated with current revenue sources, and the leveraging of debt through both revenue and general obligation bonds.¹³⁸ Each of these sources relies upon the cash-flows associated with revenue sources on both a state and local level.

These revenue sources disproportionately burden a locality's most vulnerable residents. Property taxes account for 30% of local revenue, but not all properties are assessed fairly -- some estimates indicate that in 90% of cities, lower value homes are assessed at higher values than they are worth, while more expensive homes are assessed at lower values¹³⁹. Sales taxes, which account for 7.3% of local revenues, effectively tax lower income people at twice the rate of upper income families¹⁴⁰. Similarly, flat charges and service fees, which account for 23% of local revenues, have a proportionately higher cost for families with fewer assets.

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The reliance on property values as a revenue scheme places the fiscal priorities of municipalities at odds with their social responsibilities. In Miami, real-estate speculation and the influx of high-net worth residents on coastal beachfront properties has increased municipal coffers¹⁴³. Similarly, in places like

Boston and Philadelphia, cities are incentivized to protect their high-value revenue sources as well as to invest in climate infrastructure that ultimately helps the city continue to grow their revenue bases¹⁴⁴

Requiring progressive financing structures, such as through land-value capture techniques or revenue bonds funded through alternative sources of revenue such as corporate taxes, or income taxes, can help alleviate the burden placed on lower-income communities for climate infrastructure development. Land-value capture techniques are one form of progressive financing structure that have been employed in cities to much success. San Francisco has used impact fees to fund public infrastructure for decades – in 2016 revenues from impact fees were nearly \$237million.¹⁴⁵ Other land-value capture techniques include betterment contributions, special assessment districts, and linkage fees.

Recommendation 3. Prioritize projects that are proven to directly benefit vulnerable and lower-income communities.

Finally, the Corps can use P3 to prioritize and even incentivize projects that show that they significantly or proportionally inhibit the negative externalities that climate change has on vulnerable communities. The Biden Justice40 initiative provides directives to all federal agencies to assess the pathways through which their own programs can contribute to directing climate adaptation funding to better serve what it deems *disadvantaged* communities.¹⁴⁶ By incorporating preferential treatment of cities, states and other communities that propose projects that better help alleviate the burdens of climate change on already vulnerable communities, USACE can not only contribute to this initiative but also help substantiate the positive outcomes of intentional federal action in local contexts.

This can be done through weighing projects which prove that the benefits of the proposed project will directly benefit those communities, either by providing direct flood mitigation benefits to these communities or leveraging any value generated by the project to provide financial relief for climate induced stressors, protected rents, and frozen property tax rates. Similarly, a project that reduces energy costs and heat island effect in a neighborhood that is currently underserved in those areas could be weighed more heavily.

V. Conclusion

The Biden Administration's Justice40 Initiative alongside priorities outlined within the American Family Plan provide federal guidance to not only address the racial and economic disparities caused by status-quo federal programs, but also reassess how the federal agencies evaluate their effectiveness in addressing the environmental, social, racial, and economic outcomes of their actions. Through weighting local needs, costs and benefits, agencies can address these outcomes more directly.

The pressures of climate change place localities and their communities at increasing risk, and yet federal aid has not adjusted to meet the demand for climate ready infrastructures. Not only does climate change pose severe economic risks for individuals, families, cities, regions, and the United States as a whole, it also poses a significant threat to the very lives of the people who are most vulnerable to its impacts. Addressing the needs of vulnerable communities on a local level is a federal responsibility because federal policy is responsible for the creation of a significant number of these vulnerable communities. The Federal Housing Authority for decades refused to back loans to Black families and families who lived near communities that were predominantly Black. Because the FHA and the Supreme Court¹⁴⁷ also allowed individuals and private companies to also discriminate based on race, federal policy directly created communities that were ineligible for investment.¹⁴⁸

The communities impacted by these policies are the same communities that are disproportionately at risk today. Because they were denied investment and loan backing by both public and private sources, housing developments for these communities occurred on the cheapest available land, often low-lying land, and floodplains.¹⁴⁹ Due to this disinvestment, these homes and communities have an overall lower monetary value. Current federal policy, such as policy requiring the assessment of costs and benefits using monetized metrics derived from the costs avoided to homes and other private property, not only exacerbates this segregation and disproportionate impact but it perpetuates it. Communities such as Richwood with lower property values cannot be considered for federal aid because they are ultimately deemed too socially vulnerable.

Although there are numerous federal programs designed to provide disaster mitigation and emergency services, not all communities receive just or equal access to such resources and support. For example, policies that were developed in the 19th century to protect rural communities are now primarily applied to urban regions, and as demonstrated by the above U.S. case studies, there are significant inequities in the distribution of disaster relief not only between, but within cities. Specifically, federal evaluation techniques and financial mechanisms developed over the 20th century have cemented and promulgated the economic and environmental marginalization and disinvestment of communities of color,¹⁵⁰ lower and middle-income communities,¹⁵¹ and Indigenous communities¹⁵² by denying them¹⁵³ designations and access to federal disaster aid.

But the floods and extreme weather events that caused so much damage in Bordeaux-Whites Creek, Richwood, and Sunnyside did not occur on Capitol Hill -- the representatives and bodies who are responsible for setting budgets, appropriations and legislative priorities are inherently disconnected - by multiple layers -- from the communities that are the most impacted. The impacts of climate change are being felt on a local level -- by municipalities, regions and the people that live therein. -- not a national one. While federal agencies serve as intermediaries between local entities and Congressional agenda-setters, ultimately the security and livelihood of our communities rely on the ability for a federal body to not only communicate the needs of a community in distress, but also the empathy and adjudication of civic duty on behalf of legislators to act on those needs in an increasingly gridlocked legislative environment.^{xlvii}

As the United States' premier flood management agency since the mid-19th century, the relationships it has developed within local, state, and regional contexts ensures that the US Army Corps of Engineers (USACE) is uniquely equipped to provide technical and financial support to these communities. Although the Corps is responsible for managing the riverine, coastal, and storm surge

^{xlvii} The communication of local needs and subsequent galvanization for aid can also be heavily influenced by popular or national media exposure. As a result, any reporting bias in media exposure that may overrepresent the needs of some communities over others inadvertently affects the willpower and leverage for which legislators seek to provide solutions to those problems.

hazards associated with climate change, years of diminished funding for new construction has led to a large backlog of projects that the Corps has yet to complete. Expediting this delivery process and removing obstacles to quick and equity-minded projects is essential and has been the focus of recent efforts to more proactively delivery climate infrastructure. Because of federal requirements and the need to allocate funds in accordance with Congressional and national interest, all USACE water resources projects undergo an assessment process that allows Congressional committees and representatives to compare projects and subsequently outline federal priorities.

Public-Private Partnership initiative within the Corps could present a unique opportunity to not only avoid some of the challenges associated with traditional project delivery, but it could also provide a pathway through which the Corps could more seamlessly justify and deliver projects that meet both national and local goals. Although the P3 program does bypass the initial feasibility assessment process, it provides a pathway for cities and regions that have already completed feasibility assessments and have reliable funding sources to expedite the project delivery process and receive USACE funding and support in a shorter time-frame. This thesis recommends that the Corps use the P3 Pilot program to test project delivery strategies that meet the goals set by Biden Administration, abide by the recently updated P&G, and ultimately incentivize localities to begin projects that directly benefit lower-income communities and communities of color. We recommend that USACE use P3:

- 1) to reduce future cost-burdens on local taxpayers by prioritizing the deployment of infrastructure solutions that provide more benefits than costs in the long term, such as green and natural infrastructures.
- 2) To prioritize projects in which the non-federal partner has leveraged progressive financing resources that do not disproportionately burden lower-income communities.
- 3) To prioritize projects that are proven to directly benefit vulnerable and lower-income communities.

The P3 program is designed to expedite locally-led climate resilience projects that will reduce federal cost, maximize federal return on investment, and quickly deliver resilient and reliable water resource

infrastructure. P3 seeks to accelerate delivery of long-lasting, resilient water infrastructure while simultaneously increasing the return on federal financial investments.

Although P&G and CBA are ultimately dictated by congress and the executive branch, the P3 program offers the Corps flexibility to address systemic issues that plague the nation's most vulnerable communities. Because the P3 selection process occurs after Congressional support has been established, the Corps can leverage its own authority in prioritizing and selecting projects for the P3 program that not only meet the goals set through the Biden Justice40 and American Jobs Plan, but also reduce local cost-burdens by prioritizing projects that promote community resilience.

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⁸⁷ “MNDNR EIS Does Not Identify Any Additional Reasonable Alternatives to Diversion Project,” Metro Flood Diversion Authority, January 23, 2019, <https://fmdiversion.gov/mndnr-eis-does-not-identify-any-additional-reasonable-alternatives-to-diversion-project/>.

⁸⁸ “District Judge Delays Construction; Local Leaders Hope Order Brings Minnesota Department of Natural Resources Back to the Table,” Metro Flood Diversion Authority, August 15, 2019, <https://fmdiversion.gov/district-judge-delays-construction-local-leaders-hope-order-brings-minnesota-department-of-natural-resources-back-to-the-table/>.

⁸⁹ “Hoeven: Signing of PPA at \$750 MILLION, New p3 Account in Budget Advance Red River Flood Protection, Implementation of Plan B.” Metro Flood Diversion Authority, December 12, 2019. <https://fmdiversion.gov/hoeven-signing-of-ppa-at-750-million/>.

⁹⁰ FM Area Diversion, “About the Project,” Metro Flood Diversion Authority, May 14, 2021, <http://fmdiversion.gov/about-the-project/#timeline>. The President’s budget referenced here is cited in this timeline on February 12, 2012.

⁹¹ Loeb.

⁹² Ibid.

⁹³ Ibid.

⁹⁴ The Chicago Chapter of the American Statistical Association. “History of Cost Benefit Analysis.” Conference Presentation, May 5, 2006. Accessed: August 16, 2021.

<https://community.amstat.org/zthechicagochapterold/calendar/pastevents/20052006/may52006conference/downloadpresentationshistoryofcostbenefitanalysis>

⁹⁵ Ibid.

⁹⁶ National Research Council, 3.

⁹⁷ Ibid.

⁹⁸ National Research Council, 2.

⁹⁹ These descriptions are pulled directly from section 3.8.2 in the Final Fargo-Moorhead Metro Feasibility Report.

¹⁰⁰ Center for Ports and Waterways. Rep. How Project Selection in the Corps of Engineers Is Affected by Benefit-Cost Ratio (BCR) Analysis. College Station, TX: Texas A&M University, 2018. Prepared for the National Waterways Foundation

¹⁰¹ Ibid.

¹⁰² National Research Council. "3. Assessing Benefits and Costs of Corps Projects" in *Analytical Methods and Approaches for Water Resources Project Planning*. The National Academies Press, April 14, 2004.

<https://doi.org/10.17226/10973>.

¹⁰³ Loeb.

¹⁰⁴ U.S. Library of Congress, Congressional Research Service, *Flood Risk Reduction from Natural and Nature-Based Features: Army Corps of Engineers Authorities*, by Nicole T. Carter and Eva Uplec. R46328 (2020), 5.

¹⁰⁵ U.S. Government Accountability Office, *Army Corps of Engineers: Consideration of Project Costs and Benefits in Using Natural Coastal Infrastructure and Associated Challenges*, GAO-19-319 (Washington, DC, 2019), accessed August 17, 2021. <https://www.gao.gov/assets/gao-19-319.pdf>;

¹⁰⁶ Ibid.

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

¹⁰⁹ Ibid.

¹¹⁰ U.S. Department of Defense, U.S. Army Corps of Engineers, Environmental Laboratory, *North Atlantic Coast Resilience Comprehensive Study* (DC, 2015),

https://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf

¹¹¹ The Chicago Chapter of the American Statistical Association. "History of Cost Benefit Analysis."

Conference Presentation, May 5, 2006. Accessed: August 16, 2021.

<https://community.amstat.org/zthechicagochapterold/calendar/pastevents/20052006/may52006conference/downloadpresentationshistoryofcostbenefitanalysis>

¹¹² Richard Hammond, "Convention and Limitation in Benefit-Cost Analysis," *Natural Resources Journal* 6, no. 2 (1966): pp. 195-222, <https://digitalrepository.unm.edu/cgi/viewcontent.cgi?article=3716&context=nrl>. CBA was first utilized by USACE to simplify decision-making processes as they relate to project development¹¹² and, ultimately, avoid economically infeasible projects. The Flood Control Act of 1936 is rooted¹¹² in the New Deal principle that the federal government should be responsible for managing natural disasters and floods, and the Corps has become increasingly responsible for managing numerous domestic environmental, energy and infrastructure for the public good.

¹¹³ Francois Melese, Anke Richter, and Binyam Solomon, "Chapter 1. Introduction," in *Military Cost-Benefit Analysis: Theory and Practice* (Abingdon: Routledge, 2018), pp. 1-20,

https://nps.edu/documents/103424423/107207147/Melese_Richter_Military_Cost-Benefit_chapter_2015.pdf/049d9071-7a52-4322-92af-d4696d425374?t=1463083887000.

The Corps' relationship with CBA began as early as 1902, as legislated through the U.S. River and Harbor Act wherein the Corps was required¹¹³ to report on a potential project's "desirability", including assessments of project costs and "commerce benefited." To this end, the Corps required that project proposals were able to substantiate beneficial outcomes that outweigh the costs incurred during its lifecycle. The 1936 Flood Control Act subsequently mandated and legitimized cost-benefit analysis, which was to this point only a *de facto* process within the Corps, concretizing an economically based approach to assessing benefits and costs as they relate to flood control and water management projects.

¹¹⁴ Joseph Arnold, "The Evolution of the 1936 Flood Control Act," Office of History, United States Army Corps of Engineers, 1988,

<https://web.archive.org/web/20110529061103/http://140.194.76.129/publications/eng-pamphlets/ep870-1-29/entire.pdf>. In the author's note, Arnold discusses the confusing nature of this document, not only for academics such as William Leuchtenburg and Arthur Maas (two prominent historians on this era and piece of legislation), but also for the constituents who supported it and Pres. Roosevelt. Arnold contends that because of the juxtaposition between the stated goals of the legislation and the "hastily drawn series of implementation features" that were the result of compromises between disagreeing parties, the legislation eventually became subject to a myriad of interpretations over time.

¹¹⁵ Melese et al.

¹¹⁶ Vilfredo Pareto, COURS D'ECONOMIE POLITIQUE, vol. II (1896) via

<https://community.amstat.org/zthechicagochapterold/calendar/pastevents/20052006/may52006conference/downloadpresentationshistoryofcostbenefitanalysis>

¹¹⁷ Ibid.

¹¹⁸ Joseph L. Arnold, *The Evolution of the 1936 Flood Control Act* (Fort Belvoir, VA: Office of History, U.S. Army Corps of Engineers, 1988).

¹¹⁹ Ibid.

¹²⁰ National Research Council. "3. Assessing Benefits and Costs of Corps Projects" in *Analytical Methods and Approaches for Water Resources Project Planning*. The National Academies Press, April 14, 2004. <https://doi.org/10.17226/10973>.

¹²¹ Matthew Kotchen, "Yale School of the Environment," Yale School of the Environment, 2010, <https://environment.yale.edu/kotchen/pubs/CBAchap.pdf>.

¹²² Matthew Kotchen, "Yale School of the Environment," Yale School of the Environment, 2010, <https://environment.yale.edu/kotchen/pubs/CBAchap.pdf>.

¹²³ Cristina E. Muñoz and Eric Tate, "Unequal Recovery? Federal Resource Distribution after a Midwest Flood Disaster," MDPI (Multidisciplinary Digital Publishing Institute, May 17, 2016), <https://www.mdpi.com/1660-4601/13/5/507>.

¹²⁴ Hammond.

¹²⁵ Center for Ports and Waterways. Rep. How Project Selection in the Corps of Engineers Is Affected by Benefit-Cost Ratio (BCR) Analysis. College Station, TX: Texas A&M University, 2018. Prepared for the National Waterways Foundation, <http://www.nationalwaterwaysfoundation.org/TTI%20BCR%20FINAL%20STUDY.pdf>

¹²⁶ Ibid

¹²⁷ Ibid.

¹²⁸ Ibid.

¹²⁹ Ibid.

¹³⁰ Thomas Frank, “Rising Costs of U.S. Flood Damage Linked to Climate Change,” E & E news (Scientific American, January 13, 2021), <https://www.eenews.net/stories/1063716253>.

¹³¹ U.S. Department of Homeland Security. Federal Emergency Management Agency. *Considerations of Environmental Benefits in the Evaluation of Acquisition Projects under the Hazard Mitigation Assistance Programs* (DC, 2021), https://www.fema.gov/sites/default/files/documents/fema_hma-ecosystem-service-benefits_fact-sheet_january-2021.pdf

¹³² United States Department of Homeland Security, Federal Emergency Management Agency, *Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA’s Mitigation Programs Policy*, (Washington, DC, 2020), https://www.fema.gov/sites/default/files/2020-09/fema_ecosystem-service-benefits_policy_september-2020.pdf

¹³³ Ibid.

¹³⁴ Gang Chen, “Assessing the Financial Impact of Natural Disasters on Local Governments,” *Public Budgeting & Finance* 40, no. 1 (November 2019): pp. 22-44, <https://doi.org/10.1111/pbaf.12245>.

¹³⁵ Ibid.

¹³⁶ Melissa Kramer, “Enhancing Sustainable Communities with Green Infrastructure: A Guide to Help Communities Better Manage Stormwater While Achieving Other Environmental, Public Health, Social and Economic Benefits,” U.S. Environmental Protection Agency (U.S. Environmental Protection Agency’s Office of Sustainable Communities, October 2014), <https://www.epa.gov/sites/default/files/2014-10/documents/green-infrastructure.pdf>.

¹³⁷ National Oceanic and Atmospheric Administration

¹³⁸ “Funding,” The Legislative Analyst’s Office (The California Legislature’s Nonpartisan Fiscal and Policy Advisor), accessed August 17, 2021, <https://lao.ca.gov/Infrastructure/Funding>.

¹³⁹ Jason Grotto, “How Unfair Property Taxes Keep Black Families from Gaining Wealth,” Bloomberg.com (Bloomberg, March 9, 2021), <https://www.bloomberg.com/news/features/2021-03-09/racial-inequality-broken-property-tax-system-blocks-black-wealth-building>.

¹⁴⁰ Misra.

¹⁴¹ Jason Grotto, “How Unfair Property Taxes Keep Black Families from Gaining Wealth,” Bloomberg.com (Bloomberg, March 9, 2021), <https://www.bloomberg.com/news/features/2021-03-09/racial-inequality-broken-property-tax-system-blocks-black-wealth-building>.

¹⁴² Misra.

¹⁴³ Angely Mercado, “The Wealthy Are Hoarding Livable Homes as Climate Change Makes Land Uninhabitable,” Massive Science, June 23, 2021, <https://massivesci.com/articles/climate-change-gentrification-miami-norfolk-flagstaff/>.

¹⁴⁴ Isabelle Anguelovski et al., “Opinion: Why Green ‘Climate Gentrification’ Threatens Poor and Vulnerable Populations,” PNAS (National Academy of Sciences, December 26, 2019), <https://www.pnas.org/content/116/52/26139#fn-7>.

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¹⁴⁶ “The Path to Achieving Justice40,” The White House (The United States Government, July 20, 2021), <https://www.whitehouse.gov/omb/briefing-room/2021/07/20/the-path-to-achieving-justice40/>.

¹⁴⁷ John Kimble, “Insuring Inequality: The Role of the Federal Housing Administration in the Urban Ghettoization of African Americans,” *Law & Social Inquiry* 32, no. 2 (2008): pp. 399-434, <https://doi.org/10.1111/j.1747-4465.2007.00064.x>.

¹⁴⁸ Alexis C. Madrigal, “The Racist Housing Policy That Made Your Neighborhood,” *The Atlantic* (Atlantic Media Company, July 27, 2021), <https://www.theatlantic.com/business/archive/2014/05/the-racist-housing-policy-that-made-your-neighborhood/371439/>.

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¹⁵⁰ Christopher Flavelle, “Why Does Disaster Aid Often Favor White People?” *The New York Times* (The New York Times, June 7, 2021), <https://www.nytimes.com/2021/06/07/climate/FEMA-race-climate.html>.

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¹⁵³ *Ibid.*

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