S. HRG. 116–217

IMPROVING AMERICAN ECONOMIC COMPETITIVENESS THROUGH WATER RESOURCES INFRASTRUCTURE

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

SEPTEMBER 18, 2019

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ONE HUNDRED SIXTEENTH CONGRESS
FIRST SESSION

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IMPROVING AMERICAN ECONOMIC COMPETITIVENESS THROUGH WATER RESOURCES INFRASTRUCTURE

WEDNESDAY, SEPTEMBER 18, 2019

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee met, pursuant to notice, at 10:08 a.m. in room 406, Dirksen Senate Office Building, Hon. John Barrasso (chairman of the committee) presiding.

Present: Senators Barrasso, Carper, Capito, Braun, Boozman, Ernst, Cardin, Whitehouse, Gillibrand, Van Hollen.

OPENING STATEMENT OF HON. JOHN BARRASSO, U.S. SENATOR FROM THE STATE OF WYOMING

Senator BARRASSO. Good morning. I call this hearing to order.

Today we will be holding a hearing on improving American economic competitiveness through water resources infrastructure. Today's hearing is the start of the important process to pass bipartisan water infrastructure legislation during this 116th Congress. We begin that process taking testimony from the stakeholders who are most impacted.

The Senate Environment and Public Works Committee has established a tradition of working in a bipartisan fashion when it comes to passing much-needed infrastructure legislation. Just before the August recess, this committee unanimously passed the most substantive highway legislation in American history. America's Transportation Infrastructure Act of 2019 is a significant step in improving our Nation's roads and our bridges. It will grow the economy, improve road safety, expedite important projects, and enhance the quality of life for all Americans.

Roads and bridges are critical to our economy and our way of life. Water infrastructure is also critical. That is why we are here today. America's water infrastructure helps move goods across the Country, and prevent catastrophic floods and disasters. It provides clean and abundant water to millions of American communities, farms, ranches, and small businesses. This is why we must continue the tradition of passing water resources legislation every 2 years.

In 2018, this committee passed America's Water Infrastructure Act. This bipartisan legislation passed the Senate by a vote of 99 to 1—almost unheard of today—and it was signed into law by President Trump. The Water Infrastructure Act, when fully implemented by the Army Corps and the EPA, will create new jobs, grow

the economy, provide more water storage, protect lives and property, and cut red tape. The bill is also the most significant drinking water legislation that we have had in decades.

However, work still needs to be done. This spring, extreme rainfall and rapid snowmelt contributed to widespread flooding along the Missouri, the Mississippi, and the Arkansas Rivers. Pictures of flooded farm fields and destroyed Midwestern communities filled the news. American farmers suffered billions of dollars in damages. According to the U.S. Department of Agriculture's Farm Service Agency, agricultural producers reported over 19.4 million acres of crops were not able to be planted in 2019, the highest level since the agency began releasing reports in 2007.

In addition, arid Western States still grappled with water supply issues. For example, on July 17th of this year, an irrigation tunnel collapsed near Fort Laramie, Wyoming, affecting over 100,000 acres of farmland between Wyoming and Nebraska. This tunnel collapse blocked a vital artery that provides water for numerous farming and ranching communities in Wyoming and in Nebraska.

In some cases, these irrigation systems are over 100 years old. More needs to be done to assess the health of these irrigation systems, so we can avoid such collapses and widespread crop failures in the future. While the Army Corps does not own these systems, I believe the Army Corps can play a vital role in assessing the State of this aging infrastructure.

In addition, water storage remains a serious concern for Western States, whose ranchers rely on water to grow alfalfa and to raise cattle. Congress no longer authorizes the construction of giant water storage reservoirs, due in large part to their high cost and the lengthy permitting process.

However, working with the States, I believe we can help build smaller scale storage reservoirs, which can give relief to our ranching and our farming communities. We must ensure our ranchers, farmers and communities get the water that they need.

I look forward to working with the members of this committee on a bipartisan basis to enact new water infrastructure legislation in 2020. The process toward passing that bill begins today.

I have gotten a call from Senator Carper. He is unavoidably detained for a short period of time. But he will be here to help with the committee momentarily.

So we are going to turn to the witnesses, but before we hear from our witnesses, I want to just take a moment to introduce a very special friend and a long-time friend, Pat O'Toole. I have had the pleasure of knowing Pat for many years now. He and his family are sheep and cattle ranchers in southern Wyoming, along the Little Snake River.

Pat has served as the president of the Family Farm Alliance, an organization dedicated to advocating for farmers, ranchers, and irrigation districts in western States since 2005. He has been a board member since the 1990's.

Pat is also a fellow former member of the Wyoming State legislature, having sat in the Wyoming House of Representatives from 1986 to 1992, after which he served as a member of the Clinton administration's Western Water Policy Review Advisory Committee.

Now, I know Pat to be a tireless advocate for the agriculture community in Wyoming, and a leader when it comes to western water storage policy. He knows just how important water supply and storage is to our State's communities. It is the cornerstone of our economy and everything we do in Wyoming.

So, Pat, it is a privilege to welcome you as a witness again today before the Environment and Public Works Committee, and I want to thank you for traveling all the way from Wyoming to be with us today in Washington. Thank you.

Senator Cardin, Senator Carper has been delayed for a few moments, and he asked that we proceed. I don't know if you would like to make any comments before I turn to the witness.

OPENING STATEMENT OF HON. BENJAMIN CARDIN, U.S. SENATOR FROM THE STATE OF MARYLAND

Senator CARDIN. Mr. Chairman, let me first thank you for holding this hearing. Clearly, the Water Resources Development Act is critical legislation. This committee has a proud tradition of Democrats and Republicans working together. I have a great deal of confidence in Chairman Barrasso and Ranking Member Carper, and Chairman Capito and myself as chair and ranking on the overall committee and the Infrastructure Committee, that we will act, again, in the best interest of our Country and pass a bipartisan bill.

The only point I want to make is that WRDA is important for our environment. I could tell you a long story about the Chesapeake Bay and how important that is, but the committee has already heard this two dozen times.

Senator BARRASSO. No, no, go ahead.

[Laughter.]

Senator CARDIN. The WRDA bill has helped us deal with the water quality of the Bay, which is critically important to the iconic way of life, and to the economy of Maryland. One trillion dollars of the economy our of region is based upon the Chesapeake Bay.

So I could talk about the economic issues, the Port of Baltimore. The Port of Baltimore ranks ninth as far as foreign value of imports, No. 1 role for auto and trucks in the Country.

So when you look at WRDA, we have come up with innovative ways, including the environmental restoration of Poplar Island, mid-Bay, which is not only the site where we can put dredge material, which is always challenging, in order to keep our harbors at the depth they need to be, but is also an environmental restoration, so it is a win-win situation.

It is that type of innovation that is coming out of this committee, almost always by unanimous votes, that help our environment and help our economy.

So I just really wanted the committee and the witnesses to know, we have a proud tradition, we want to continue that tradition. We have a great deal of confidence in our leadership of this committee.

And I see that I have talked long enough so that Senator Carper could get here.

[Laughter.]

Senator BARRASSO. Senator Carper.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. I thank my colleagues for saving my seat, and to both of you for the good work, the Chairman of the full committee and the chairman of the relevant subcommittee, we are delighted to work with you and the members of your staff.

Welcome to our guests today. We look forward to hearing from each of you. I want to thank our Chairman for holding an important oversight hearing to kick off our discussions on the next Water Resources Development Act.

I am proud of the bipartisan work that Senator Cardin referred to that we are able to use and employ in accomplishing last Congress on water infrastructure, including significant reforms through the Army Corps of Engineers and the first reauthorization of the Drinking Water Safe Revolving Loan Fund in 22 years. I hope that this hearing will provide us with some important insights as we work to develop the bill in this Congress, and I look forward to hearing testimony from all of our stakeholders here today and others that are not here today.

In the drafting process, the last Water Resources Development Act, also known as AWIA, along with our staffs, Chairman Barrasso and I heard repeatedly that the Office of Management and Budget micromanages the Corps of Engineers, and that there had been a troubling lack of transparency with respect to OMB's Corps budgeting and project selection process. OMB relies upon a method for prioritizing projects that fails to capture all of a project's benefits. This method, called the benefit-to-cost ratio, considers only a project's national economic benefits. When a Corps project provides important regional and local economic benefits, like flood reduction or ecosystem restoration, these benefits are often not considered by OMB when it determines which projects should receive funding. This means the budget and work plans regularly fail to include the construction of projects that would address critical needs in small, rural, and tribal communities.

OMB is also a little bit of a black box, and the agency rarely, if ever, discloses how projects are evaluated, raising serious questions about which projects will make it into the final Army Corps work plan each year. This is also the case for projects that receive supplemental appropriations for damages sustained during a flood or storm event.

Last Congress, we made strides in improving transparency with the Corps budgeting process. It is my hope that we can continue to build on that important progress.

Millions of Americans across our Country really do rely on Army Corps projects, in my State, and I think in the States of everybody who is a member of this committee. These projects help us safely navigate our waters, stay safe from flooding and storm damage, and lead to benefits of healthy aquatic ecosystems and marsh land. We need more investments in Corps projects, not less.

In the mid–1980's, though, Federal funding for new project construction and major rehabilitation began to steadily decline and it has never recovered. As a result, we now face a backlog of projects and maintenance needs, and most of the Corps' infrastructure has now exceeded its useful life span.

The most recent American Society of Civil Engineering Infrastructure report card tells an unsettling story. Our Country's dams, our levees, our inland waterways, receives a grade of D, as in dismal, representing a cumulative construction and deferred maintenance backlog of more than $100 billion.

Clearly, our committee has important work to do in this regard, and frankly, so does this Congress, and so does the Administration. I think we are up to it though, and I look forward to working with all of our colleagues and the members of their staffs, to deploy the green as well as the gray infrastructure projects that our economy needs.

Thank you, Mr. Chairman, and thank you for holding this important hearing. Again, welcome to our witnesses. Thank you.

Senator BARRASSO. Thank you very much, Senator Carper.

We have three witnesses today: Pat O'Toole, the president of the Family Farm Alliance; we have Mr. Jamey Sanders, who is vice president of the Choctaw Transportation Company; and we have Mr. Derek Brockbank, who is the executive director of the American Shore and Beach Preservation Association.

So I want to welcome all of you and remind all of you that your full written testimony will be included as part of our hearing record. So I ask that you please try to keep your statements to 5 minutes, so that will give us some time for questions. We are going to have votes starting at 11, and we hope to be able to work through all the questions before we have to leave for the vote.

With that, I look forward to hearing each of your testimonies, beginning with Mr. O'Toole. Please proceed.

STATEMENT OF PATRICK O'TOOLE, PRESIDENT, FAMILY FARM ALLIANCE

Mr. O'Toole. Thank you very much, Senator Barrasso, Senator Carper, members of the committee. I can't tell you how honored I am to be here. I have spent my life trying to figure out how these systems work, particularly in water. I have written testimony that is quite extensive, but I would like to just tell you some personal stories.

Our family started ranching in 1881, when my wife's great-grandfather trailed horses from the Mexican border to the Colorado-Wyoming border. Our ranch is in a valley that the State line crosses 31 times, which makes us a Colorado-Wyoming valley, so we have learned water policy issues in both States, which sometimes they are the same and sometimes they are very different.

But we have a lot of experience in that, and luckily for us, we have leadership at our conservation district level that is world-class visionary, about how we get that resilience that is going to take us to get to the future. Today on our ranch, there is a project that will be the final piece of a trout passage for the entire watershed, we will be trout-passage friendly. We work with Trout Unlimited on it. It starts in the Forest Service and ends up on private land. We have done that for 20 years. This is the last project to do that.

What it did was what I call integrated our irrigation and fishery, so not only are we having a great success story for the fish part, but it has made the irrigation systems throughout the valley much

more efficient and much more critically helpful for us as ranchers and farmers.

A year ago, we were finishing the driest year in the history of the Yampa River. The Yampa River is the headwaters of the Colorado River. And it was brutal. We got no second cutting of alfalfa in our family. It was followed by the second worst winter I have ever experienced. So the $61 hay that I would have put up if I would have had the water was $270 to feed my livestock because of the brutal winter, followed by one of the top five wettest years that we have ever had in the springtime.

All of those things have an economic reality to them. Our community built storage years ago that I was involved in with the Wyoming legislature. Those people at the lower end of the valley with storage got that second cutting. Their fisheries survived; their process was still intact.

We are working now on another project in the State of Wyoming, the upper part of the valley, in coordination with the State of Colorado. We have unanimous support from their upper district. And it is about working together.

I think one of the things that is so important, this committee is called the Environment and Public Works Committee. This is the appropriate committee to deal with what I consider to be the crisis of the future. I have this saying that I believe: Mother Nature always gets the last at bat. We saw that in the last 12 months of the incredible volatility. When you talk to farmers and ranchers, it is volatility that is the issue that they talk about.

I visited with a lot of people about this testimony, because I think this issue is so important. A friend of mine, Jim Faulstich, from South Dakota, said that his Governor said the 1st of September was the biggest disaster in the State of South Dakota. They then had a 12-inch rain after that. And I said, what are you going to do, Jim? He said, probably going to have to sell our cows. I saw a picture last night of relatives in Nebraska who went through flooding all last year, and the picture was them putting up what hay they were able to put up. The bales were half sunk in another flood yesterday.

Understanding this volatility issue is critical. Next week, I will be on a horse taking cattle off the national forest. The national forest is not functioning correctly. There is a study that is mentioned in my testimony of 160,000-acre feet of water isn't going into the Platte River system because the forest isn't functioning. It is so critical that we address these issues on scale.

In my world, I talk about, you can't solve a million-acre problem with a hundred-acre solution. We have to start thinking at a scale, and whether it be on the Missouri River system or the Platte River system, the Colorado River system, we have run out of easy answers. The event that Senator Barrasso talked about in Wyoming was on the Platte River system that was built during the Roosevelt Administration, not Franklin. We are talking about century-old infrastructure that has serviced us well. The 104,000 acres that weren't able to be produced in Wyoming is an incredible, devastating event. And yet its infrastructure was over 100 years old.

So I think our challenge us rejuvenating through this committee, the appropriate committee, the ability to use our infrastructure cor-

rectly. A thing that jumped out at me really quickly was the fact that half of our fruit now comes from overseas. We have lost a million acres of production in the last 5 years in California, another million expected in the next 5 years. We have to realize how important our infrastructure is, so that America produces for itself, and so that ranchers and farmers and rural America have a future that they can look forward to.

My grandkids are the sixth generation on our ranch. They all ride and rope and do all those things. If we don't understand how critical it is that our water infrastructure be taken care of, they are not going to have the opportunity that I hope that they have.

Thank you very much for this opportunity.

[The prepared statement of Mr. O'Toole follows:]

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Testimony for the Hearing Record of Patrick O'Toole
On behalf of
Family Farm Alliance

Submitted to the United States Senate
Committee on Environment and Public Works

Legislative Hearing on "Water Resources Development Act of 2020"
September 18, 2019

Good morning, Chairman Barrasso, Ranking Member Carper and Members of the Committee:

On behalf of the Family Farm Alliance (Alliance), thank you for the opportunity to present this testimony on the 2020 Water Resources Development Act (WRDA). My name is Pat O'Toole, and I have served as President of Board of Directors of the Alliance for over 14 years. As you know, WRDA is a biennial piece of legislation that is the main vehicle for authorizing water projects to be studied, planned and developed by the U.S. Army Corps of Engineers (Corps). It is also the legislative vehicle for implementing policy changes with respect to the Corps' water resource projects and programs. As such, this legislation is very important to the rural communities of the Western United States.

About the Family Farm Alliance

The Alliance is a grassroots organization of family farmers, ranchers, irrigation districts, and allied industries in 16 Western states. The Alliance is focused on one mission: To ensure the availability of reliable, affordable irrigation water supplies to Western farmers and ranchers. We are also committed to the fundamental proposition that Western irrigated agriculture must be preserved and protected for a host of economic, sociological, environmental, and national security reasons – many of which are often overlooked in the context of other national policy decisions.

Personal Background and Experience with Water Development

I have served on the Family Farm Alliance's Board of Directors since 1998 and was named as the organization's President in 2005. I am also a former member of Wyoming's House of Representatives. I presently serve on the Advisory Committee for AGree, a national agricultural

policy group, and work closely with both the Intermountain Waterfowl Joint Venture and Partners for Conservation.

My family has a strong background in irrigated agriculture and our 125-year old ranch (Ladder Ranch) located near Savery, Wyoming produces cattle, sheep and hay. My family and Ladder Ranch were the recipients of the distinguished 2014 Wyoming Leopold Environmental Stewardship Award. Our ranch straddles the Wyoming-Colorado border and has long afforded me the opportunity to view some unique water issues first-hand. I have testified before Congressional committees several times, where, among other things, I have highlighted the permitting challenges I have encountered in building the Little Snake Supplemental Irrigation Supply Project (High Savery Project) in Wyoming. That project was built in less than two years, but it took more than 14 years to permit. That reservoir is now delivering water that benefits multiple uses on the Little Snake River.

Overview

Water challenges in the West are significant and daunting. These challenges are not unique to any one state; rather they impact every state west of the 100th Meridian. Despite wet conditions this winter, the Colorado River Basin has experienced the longest dry spell in recorded history and one of the driest in the past 1,200 years.[1] According to research evaluating tree rings, hydrological conditions in California in the mid-2010s were the worst to hit the region since the 13th century.[2] Drought conditions in the Pacific Northwest over the last half-decade have been severe. Just this year, heavy rains and snowmelt overwhelmed parts of the Platte-Missouri River system. When we do have good water years, there is insufficient storage available to take advantage of mother nature's generosity in the dry years that inevitably follow.

All of these examples underscore the critical importance of having sufficient infrastructure in place to optimize water supplies. The need is obvious, and this belief is shared by many in the West. Earlier this year, the Family Farm Alliance – working with the California Farm Bureau Federation and Western Growers Association – transmitted letters signed by over 100 national and Western agriculture and water organizations, calling upon Members of Congress to develop an infrastructure package that addresses water infrastructure needs for storage and conveyance.

Water is the lifeblood of our nation. Without reliable and affordable water supplies, every sector of our economy would suffer – from agriculture, to manufacturing and high-tech, to local community needs. Food cannot be grown, businesses cannot operate, and homes and schools cannot be built or operate without water. Critical water infrastructure must be maintained and modernized to ensure the delivery of water today and for future generations. As Congress considers

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[1] "Lingering Colorado River Drought Could Lead to Water Shortages," John Fialka, E&E News, 6 Sept 2018. Available: https://www.scientificamerican.com/article/lingering-colorado-river-drought-could-lead-to-water-shortages/

[2] Evidence Suggests California's Drought is the Worst in 1,200 Year, Woods Hole Oceanographic Institution, News Release, Dec. 14, 2014 found at http://www.whoi.edu/news-release/California-drought.

an infrastructure package, it is of paramount importance that maintenance, rehabilitation and development of water infrastructure is a high priority.

Many communities in the semi-arid and arid West – as well as the farms and ranches they are intertwined with – owe their existence, in large part, to the certainty provided by water stored and delivered by the U.S. Bureau of Reclamation (Reclamation) and other state and local water storage projects. The Corps also has a presence in the West, although more irrigated acreage is supplied by projects constructed by Reclamation. The Corps provides outdoor recreation opportunities to the public, and provides 24% of U.S. hydropower capacity. Their most visible missions include planning, designing, building, and operating navigation locks and dams; other civil engineering projects include flood control, beach nourishment, and dredging for waterway navigation; design and construction of flood protection systems through various federal mandates; and environmental regulation and ecosystem restoration. Clearly, the federal government plays an enduring role in Western water supply, flood control and waterway navigation infrastructure maintenance, rehabilitation and development. They do so consistent with state water laws, including working with local water interests in support of their efforts to manage water resources.

It is critical that water infrastructure for agricultural water providers is recognized as nationally important and qualified as such in potential infrastructure legislation. Qualifying projects should include water conveyance, surface water storage, aquifer recharge, and other water supply enhancement opportunities. Infrastructure legislation should address aging water infrastructure as well as the development of new infrastructure.

Western water managers face significant regulatory and policy-related challenges. Water infrastructure that was built early in the last century is aging. Meanwhile, less progress has been made at the federal level towards developing new and improved water infrastructure to keep up with the growing water demands of agriculture, expanding cities, energy production, and other needs.

While water conservation, water efficiency, and water transfers can be important tools for addressing certain water supply challenges, these tools are limited and do not yield the quantities of water that storage facilities do. Adequate water supplies for the future require supply enhancement measures – new and expanded water storage projects - that provide long-term solutions across the West.

For farmers to survive and for food to continue to be produced in America, a stable water supply must be available. In many areas of the West, water resources are available, and projects are waiting to be developed. However, the policies of the federal government make development of that water nearly impossible. Water wars are being fought throughout the West simply because we have not had the vision to develop new, dependable sources of water for our collective future.

Given the magnitude of the food security issue to the nation's economic and social wellbeing, policy makers must prioritize protection, enhancement and further development of our water supplies. This economically critical infrastructure is aging and needs improvement.

Such aging infrastructure presents a further challenge because it requires ever increasing maintenance and replacement investments. For example, as of 2013, the replacement value of the U.S. Bureau of Reclamation's infrastructure assets was $94.5 billion. Investing in this infrastructure on the front end will save taxpayers' money in the long run and allow us to preserve it, and the many benefits it provides, for future generations.

We appreciate this opportunity to discuss conceptual ideas for the 2020 WRDA. The following "wish list" assumes that the Senate WRDA under consideration will not necessarily be a Corps-centric bill, but could provide a vehicle to address other national and Western water resources challenges, as well. This has happened past Congresses, with the passage of the Water Infrastructure Improvements for our Nation (or WIIN) Act of 2016 and America's Water Infrastructure Act (AWIA) of 2018. We believe a Western water title of the bill could provide a vehicle for several other water bills currently being considered in Congress. There are other ideas and legislative proposals that could also be included in such a title, as described further below.

Considerations for 2020 Water Resources Development Act: Related Western Water Legislation

As you know, several water bills have been introduced in this Congress that would be appropriate to include in a Western water title of WRDA 2020. These bills are summarized below.

S. 2044 – The Water Supply Infrastructure Rehabilitation and Utilization Act

S. 2044, sponsored by Senator McSally (R-ARIZONA) includes provisions to deal with extraordinary maintenance challenges and is designed to amend the aging infrastructure section of a 2009 law (P.L. 111-11) that was created, in part, to help prevent future disasters of the type that occurred in 2008, when the Truckee Canal failed near Fernley, Nevada. S. 2044 – introduced just before the July Fourth recess - is another bill that gives local operators of federally owned facilities the tools they need to maintain and improve aging water infrastructure in a timely manner. Alliance Advisory Committee Member Wade Noble (ARIZONA) testified on behalf of the Alliance in July before the Senate Energy and Natural Resources Committee in support of this bill. This bill contains two important provisions.

The first provision deals with extraordinary maintenance challenges and is designed to amend the aging infrastructure section of P.L. 111-11, which contains provisions that many Western water interests pushed for following the Truckee Canal failure in 2008. P.L. 111-11 authorizes Reclamation to finance extraordinary maintenance on reserved and transferred works up to 50-years with Treasury rate interest rates – but appropriated funding is needed up front for these

provisions to work. Unfortunately, Reclamation rarely budgets for these non-federal obligations. This bill requires Reclamation to take requests from water users who require federal funding and long-term financing terms to make these improvements possible and to report those requests to Congress for their consideration in the appropriations process.

S. 2044 also includes provisions that create a pilot project for entities who operate Reclamation facilities to request a re-evaluation of their Corps water control manuals. Water managers are faced with greater stresses on available supplies and continue to seek to balance reservoir benefits for water supply, fisheries, and flood protection. The Corps has traditionally operated dams and reservoirs for flood control purposes. In some cases, operation might be constrained by limited on-the-ground water information or existing flood guide rule curves that were developed decades ago, before the advent of modern precipitation forecasting technology. There are opportunities to work with the Corps to demonstrate the feasibility of new technology like Forecast Informed Reservoir Operations (FIRO). Applying FIRO with deviations from past rules could allow for more proactive, rather than reactive, reservoir operations.

S. 1932 – The Drought Resiliency and Water Supply Infrastructure Act

The Alliance in June supported a bipartisan Western drought and water supply bill introduced in the Senate by Senators Dianne Feinstein (D-CALIFORNIA), Cory Gardner (R-COLORADO), Martha McSally and Kyrsten Sinema (D-ARIZONA). The *Drought Resiliency and Water Supply Infrastructure Act* (S. 1932) builds on Senator Feinstein's 2016 California drought legislation that was included in the WIIN Act. S. 1932 extends funding under the WIIN Act for an additional five years, including $670 million for surface and groundwater storage projects, and supporting conveyance; $100 million for water recycling projects; and $60 million for desalination projects. It creates a new loan program for water agencies at 30-year Treasury rates (currently about 2.6 percent) to spur investment in new water supply projects. Repayment can be deferred until five years after completion of the project. This bill also authorizes $140 million for habitat restoration and environmental compliance projects, including forest, meadow and watershed restoration and projects that benefit threatened and endangered species.

H.R. 2473 - Securing Access for the Central Valley and Enhancing Water Resources Act

This bill, sponsored by Rep. Harder (D-CALIFORNIA) provides a broad approach to addressing water issues facing California's Central Valley, home to many Family Farm Alliance members. It does this by increasing storage opportunities, spurring innovation, and making investments in our aging infrastructure. The bill also leverages federal resources to identify prime locations for groundwater storage and recharge in California and across the Western United States. This bill requires Reclamation to expedite feasibility studies for four specific storage projects in the Central Valley, including: Sites Reservoir, Del Puerto Canyon Reservoir, Los Vaqueros and San Luis Reservoirs and provides $100 million in storage funding. The bill also invests in water reuse and recycling by increasing funding for WaterSMART programs from $50 million to $500 million and extending the program's authorization. It establishes a water infrastructure and drought resolutions

fund to provide $300 million for water surface and groundwater storage, reclamation and reuse, and WaterSMART program projects. The bill would also create an innovating financing program which would provide low-interest federal loans to fund local water infrastructure projects, and would reauthorize the Rural Water Supply Act.

S. 1570 – The Aquifer Recharge Flexibility Act

The legislation – introduced by Senator Risch - aims to improve aquifer levels in Idaho and across western states by expanding the ability for aquifer recharge through federal lands and facilities. It would apply to all Western states except for California (because of existing Central Valley Project Improvement Act recharge authority) and would allow Reclamation-owned facilities to be used to recharge aquifers in the West. Currently, such recharge projects need to go through an approval process that requires easements and congressional authorization. Some restrictions would still apply in the bill, such as that water or power service contracts for Reclamation projects and existing obligations to fish, wildlife or water quality protection aren't affected. S. 1570 has a House companion bill sponsored by Rep. Fulcher (R-IDAHO).

H.R. 1621 Water Supply Permitting Coordination Act

This bill – introduced again by Rep. McClintock (CALIFORNIA) would authorize the Secretary of the Interior to coordinate Federal and State permitting processes related to the construction of new surface water storage projects on lands under the jurisdiction of the Secretary of the Interior and the Secretary of Agriculture and to designate the Bureau of Reclamation as the lead agency for permit processing, and for other purposes. This bill would establish a framework in which federal agencies with permitting responsibilities for the construction of new surface water storage projects must work together, coordinate their schedules, share data and technical materials, and make their findings publicly available.

All of these bills are supported by the Family Farm Alliance, and would appropriate to include in a Western water title of the 2020 WRDA. We urge that you coordinate with your colleagues on the Senate Energy and Natural Resources (ENR) Committee to investigate opportunities to use WRDA 2020 as a vehicle to advance these provisions in a Western U.S. and/or Reclamation title.

Considerations for 2020 Water Resources Development Act: Other Concepts

The following recommendations primarily consist of issues we have advanced in recent WRDA and Western drought legislative initiatives. Also, the recent flooding in the Midwest could provide a catalyst to address some of the concerns your committee heard at the field hearing in Iowa a few months back. Here are some recommendations, in no order of priority:

WIIN Act Extension

We support efforts to extend the Water Infrastructure Improvements for our Nation (or WIIN) Act, which is set to expire in 2021. As you know, the WIIN Act provides a much-needed streamlined process for the review, approval and funding of water infrastructure projects – both federal and non-federal. Our members in several Western states have benefited from this program, and more are sure to see value from this in the future. The aforementioned S. 1932 would update and/or replace some of the water supply development provisions in the WIIN Act.

Pilot Project to Adjust Flood Control Curves

The 2018 AWIA authorized the Corps to receive and expend funds from an owner of a non-Federal reservoir to formulate, review, or revise operational documents for any non-Federal reservoir to prescribe regulations for the use of storage allocated for flood control or navigation. Some of our members report that reviewing and adjusting Corps flood control curves can be a steep challenge. Water users who have been working with the Corps in some cases have found it a difficult process, with the Corps very cautious about making such changes. It may be helpful to provide some guidance to the Corps to return to Congress with a report identifying recent projects where storage capacity in a reservoir(s) has been reallocated or the Flood Control Manual has been altered to periodically allow for additional storage.

Water Supply Permitting Coordination

We will continue to advocate for advancing Chairman Barrasso's initiative to streamline the current multi-agency permitting processes that can delay the construction of new or expanded surface water storage projects by creating a "one-stop permitting shop" process through Reclamation. Past legislation driven by the Chairman (similar to that introduced by Rep. McClintock - H.R. 1621, above) set a schedule and timelines for agencies to consult and cooperate to complete environmental compliance analyses on these projects. This would also allow third parties to pay the costs of such permit processing to speed things up. Congress provided similar authorities to the Corps in the 2014 Water Resources Reform and Development Act (WRRDA 2014), P.L. 113-121, a law that was passed in both the House and Senate on a bipartisan basis and was signed into law by President Obama.

These provisions would direct the Secretary of the Interior (through Reclamation) to serve as a central hub for all federal permits, approvals, and decisions required related to new water storage projects. This includes permits for Clean Water Act (CWA), National Environmental Policy Act (NEPA), and Endangered Species Act (ESA) compliance, among the others. In carrying out this task, Reclamation would be directed to identify all federal agencies with permitting responsibilities or authority, notify them of pending applications, and set a schedule by which all cooperating agencies must complete and submit their reviews and permits. Cooperating agencies would be required to adhere to the coordinated schedule and use one unifying document for all environmental reviews. These provisions would be intended to significantly reduce the time, cost,

and inefficiencies associated with the existing multi-track, multi-agency NEPA analyses. Currently, each reviewing agency compiles its own data and reviews it separately in a vacuum.

These provisions should also allow willing states to participate as cooperating agencies. By allowing states to be involved at their discretion, the review process could include state developed science, data, and technical materials. This section should also require that, consistent with existing law, all relevant project data be made publicly available online. Finally, in order to help make multi-purpose surface storage projects more viable in an era of tightened federal budgets, this section of the bill should include a mechanism in which non-federal public entities are allowed to contribute financially to help defray the costs of the "one-stop shop" permitting review process.

An "opt-out" provision should be provided that would allow local project sponsors to proceed on a different project implementation path that has historically provided successful outcomes with another federal agency in the lead role. Meeting the challenge of expanding and modernizing the West's aging water infrastructure will require highly qualified professionals serving in both the public and private sectors. Very rarely are there “one size fits all" templates that apply to management of Western water resources challenges.

In many cases, local water agencies have long-time relationships with local and regional Reclamation engineers and managers that have led to successfully completed projects, such as the ongoing collaborative work in the Yakima Basin in Washington State, where successful water and environmental projects are being completed with Reclamation functioning as the lead federal agency. In other cases, local entities have developed close working relationships with other federal water agencies such as the Corps. In these cases, local entities should be able to continue to work with the federal agency they successfully worked with in the past for projects of this nature. To cover this range of possibilities, the "opt-out" section should provide flexibility for local project sponsors to either l) engage with Reclamation in the facilitated permitting process articulated in this bill; or 2) opt-out, and proceed on a project implementation path that has historically provided successful outcomes with another federal agency such as the Army Corps in the lead role.

We believe provisions should be included that require the Secretary of the Interior to submit to the non-federal entity an estimate of the total cost of the federal administrative permitting process for the proposed projects and to provide a scheduled update on the actual administrative costs with an appropriate explanation of any major cost differences.

This section should also include language with a specific reference to non-federal state and local water supply projects that could be integrated with the operation of federally owned facilities. We want to ensure Reclamation is the lead agency in the case of permitting a non-federally built storage project that has a direct federal nexus with a Reclamation project – i.e. Sites Reservoir (California)– where it will be integrated into the operation of the Central Valley Project (as proposed by the local Joint Power Authority) but remain a non-federally developed and owned

facility. We would be happy to work with Committee staff to prepare specific language that would address this concern.

Water Rights Protection

The Alliance has long advocated that solutions to conflicts over the allocation and use of Western water resources must begin with recognition of the traditional deference to state water allocation systems and laws. We have previously testified in support of the Water Rights Protection Act (WRPA), introduced in past Congresses, and in this Congress, it was introduced by Rep. Tipton (COLORADO) as H.R. 579. WRPA-like provisions would protect communities, businesses, recreational opportunities, farmers and ranchers as well as other individuals that rely on privately held state-based water rights for their livelihood from federal takings. Specific language should prohibit the Department of the Interior (Interior) and U.S. Department of Agriculture (USDA) from conditioning any permit, lease, or other use agreement on the transfer of a non-federally held water right to the U.S. and directs federal policy to be consistent with state water law for surface water and groundwater resources.

Our farmers and ranchers rely on their vested water rights to secure operating loans in order to irrigate and produce crops and water livestock. Federal agencies should not be able to leverage those private water rights against farming and ranching families who have long depended upon federal permits and leases to support actions like grazing.

Permits for Water Transfers

The Supreme Court a few years back declined to review a George W. Bush-era rule exempting water transfers from Clean Water Act permits, leaving in place a lower-court decision that reinstated the policy. The U.S Environmental Protection Agency (EPA) issued the Water Transfers Rule in 2008 that excludes inter-basin water transfers from permitting requirements. Such systems are common in drinking water, irrigation, flood control and power generation infrastructure throughout the country. The rule formalized EPA's longstanding position that water transferred from one body of water to another via a pipe, tunnel or pumping station doesn't require a CWA National Pollutant Discharge Elimination System (NPDES) permit as long as there wasn't an industrial, municipal or commercial use along the way.

We support including provisions in 2020 WRDA that codify the existing CWA NPDES exclusion for the conveyance of waters of the U.S. when the transferred water is not subject to intervening industrial, municipal or commercial use. This would effectively limit any potential new level of regulation, permitting and certain litigation that could be put into place by another future Administration that could effectively hamstring the economies of states like Arizona, California, Colorado, Wyoming and other Western states, where millions of acre-feet of water are delivered through inter-basin transfers every year.

Missouri River Flooding

Farmers in the lower Missouri River have voiced serious concerns system about 1) impact of ecosystem priorities on traditional flood control responsibilities of the Corps; and 2) the need for more storage in the lower part of the system, below the big dams on the Missouri River system in the Dakotas and Montana. With the attention on the recent flooding in the Midwest, WRDA could provide a forum to tackle some of the problems that have surfaced, there, which your Committee has been tracking in recent hearings.

Reclamation Fund

Aging Reclamation infrastructure is a critical concern, as evidenced in Chairman Barrasso's own state of Wyoming. In the early morning hours of July 17, an underground tunnel collapse on the Fort Laramie Canal caused water to back up and the canal bank to breach, leaving 104,000 acres dry as repairs are planned and completed. The Fort Laramie Canal provides irrigation water to 104,000 acres in Wyoming and Nebraska served by the Goshen and Gering-Fort Laramie Irrigation Districts and two ditch companies. More than 400 farms in Wyoming alone rely on it.

In California's Central Valley, subsidence is threatening the integrity of hundreds of miles of canals – such as the Friant-Kern Canal - and other irrigation conveyance and storage structures. More disasters of this type loom on the horizon, and we need to apply the highest levels of creativity to find funding and financing resources to tackle aging water infrastructure challenges now.

The House Natural Resources Oversight and Investigations Subcommittee held a hearing in July 2019 to review the Bureau of Reclamation's infrastructure funding, including review of current balances in the Reclamation Fund at Treasury. The Reclamation Fund was established to help pay for construction and maintenance of those water projects in the West, but receipts to the fund have exceeded its annual appropriations, leading to a surplus balance of almost $17 billion.

Earlier this year, the Alliance supported legislation that would extend the Reclamation Water Settlement Fund, which allows for direct access to the Reclamation Fund. The Alliance supported this legislation, since tribal water rights settlements will continue to move forward, with or without the Fund. Future settlements that are authorized by Congress will hit Reclamation's budget even harder. However, that support was conditioned with a request that Congress apply a similar approach in addressing and modernizing aging water structures utilizing existing balances in the Reclamation Fund. We were pleased to see the House subcommittee seriously address this concern with a hearing.

Green Project Reserve for the Clean Water State Revolving Fund

The Green Project Reserve (GPR) is a fund that is currently included in annual appropriations, where not less than 10 percent of the funds made available to each state for Clean Water State Revolving Fund (CWSRF) capitalization grants are set aside to address green infrastructure, water or energy improvements, or other environmentally innovative activities (those that demonstrate new and/or innovative approaches to delivering services or managing water resources in a more sustainable way). These four categories of projects are the components of the GRP.

Congress' intent in enacting the GPR was to direct state investment practices in the water sector to guide funding toward projects that utilize green or "soft-path" practices to help utilities enhance water and energy conservation, among other objectives. The EPA WaterSense program defines water efficiency as the use of improved technologies and practices to deliver equal or better services with less water.

Water efficiency encompasses conservation and reuse efforts, as well as water loss reduction and prevention, to protect water resources for the future. This includes retrofitting or replacement of existing agricultural irrigation systems to more efficient agricultural irrigation systems.

Energy efficiency is the use of improved technologies and practices to reduce the energy consumption of water quality projects, use energy in a more efficient way, and/or produce/utilize renewable energy. This would include renewable energy projects such as wind, solar, geothermal, micro-hydroelectric, and biogas combined heat and power systems (CHP) that provide power to a Publicly Owned Treatment Works. It also includes micro-hydroelectric projects involve capturing the energy from pipe flow.

Over time, GPR projects could enable utilities to take savings derived from reducing water losses and energy consumption, and use them for public health and environmental enhancement projects. EPA expects that green projects will help the water sector improve the quality of water services without putting additional strain on the energy grid, and by reducing the volume of water lost every year.

The GPR sets a new precedent for the CWSRFs by targeting funding towards projects that States may not have funded in prior years. We would like your Committee to include provisions in 2020 WRDA to make the GRP "permanent".

Principles to Consider

The Congress and the federal government certainly cannot change the hydrology of the West, but there is a role it can play to support family farmers and ranchers. As the Committee continues its efforts to develop policies to improve water management in the long-term, we ask that you consider the following observations and principles:

- One size does not fit all. The best solutions come from the local level, and program funding and implementation criteria should be flexible to best apply to and fall within the context of what local watershed interests are doing.
- State water laws, compacts and decrees must be the foundation for dealing with shortages.
- Water use and related beneficial use data must be accurately measured and portrayed.
- Benefits of water use must reflect all economic / societal / environmental impacts.
- Water conservation can help stretch water supplies, but has its limits in certain situations.
- Public sentiment supports water remaining with irrigated agriculture, and developing strategic water storage as insurance against shortages.
- Technologies for water reuse and recycling are proven effective in stretching existing supplies for urban, environmental and other uses.
- Planning for water shortage in the West must look to the long-term in meeting the goals of agriculture, energy, cities, and the environment.
- A successful water shortage strategy must include a "portfolio" of water supply enhancements and improvements, such as water reuse, recycling, conservation, water-sensitive land use planning, and water system improvements. New infrastructure and technologies can help stretch water for all uses.
- Unintended consequences associated with reducing productive agricultural land/groundwater recharge/riparian habitat benefits should be avoided and, if unavoidable, minimized and fully mitigated.

It is critically important for policy makers to understand the dynamics of how streams work, and how important the role of upstream water storage is to provide balanced irrigation components downstream. Our members have a demonstrated track record of implementing projects to improve water use efficiency. However, there are other areas of the West where well-managed flood irrigation operations provide multiple critical benefits: food production, groundwater recharge, and wetlands habitat hundreds of species of wildlife. Snowpack-driven systems feed wetlands in Western intermountain areas. While 70 percent of the land in the West is owned by the federal government, 70 percent of the wetlands occur on the 30 percent of the land in private ownership. Wetland resiliency comes from senior water agricultural water rights remaining functional and lucrative. Irrigated working lands provide multiple environmental and societal benefits.

Conclusion

Extreme hydrologic events – marked by drought on one end, and floods on the other – will requir everyone in the West to adopt a new paradigm, one that truly promotes wise management of thi limited and valuable resource. This new paradigm will also mean additional investment i technology, conservation and new water storage and management infrastructure in order to dea with the uncertainties that lay before us. We are confident that your Committee will once agai show a strong commitment to existing and future water infrastructure, recognize the uniqu challenges faced by rural communities, and take strong strides to address those challenges.

The public infrastructure challenges our Nation is currently facing are daunting, and they will require innovative solutions. The infrastructure investments made by prior generations have benefited this country for over a hundred of years. Now it is this generation's responsibility to invest in our water infrastructure for future generations.

Thank you again for the opportunity to testify on this important legislation. The Family Farm Alliance and our members stand ready to assist you in your efforts to begin assembling the 2020 WRDA. I will answer any questions you may have.

Senator BARRASSO. Thank you for your testimony, Pat.
Mr. SANDERS.

STATEMENT OF JAMEY SANDERS, BOARD MEMBER, ASSOCIATED GENERAL CONTRACTORS OF AMERICA AND VICE PRESIDENT, CHOCTAW TRANSPORTATION COMPANY

Mr. SANDERS. Chairman Barrasso, Ranking Member Carper and Senators of the Environment and Public Works Committee, thank you for inviting me to testify on this vitally important topic.

My name is Jamey Sanders. I am Vice President of Choctaw Transportation Company, located in Dyersburg, Tennessee. We are a fourth-generation construction company, specializing in heavy marine construction and port operations. I have spent all my life in this industry, and I care deeply about the vitality of our water resources infrastructure, and understand the challenges ahead.

I currently serve as Chair of the Federal and Heavy Construction Division for AGC of America. AGC appreciates and thanks the committee for its continued efforts to help develop and improve our Nation's water resources infrastructure.

As many are aware, there is a backlog of more than a thousand authorized water resources construction projects that will cost more than $98 billion to complete. I am here to tell you that contractors are able and willing to tackle this backlog, but we need Congress' help in untying the regulatory and layered bureaucratic knots from the contractors' hands.

As the Assistant Secretary of the Army for Civil Works, R.D. James, often says, his focus is to "move dirt." AGC could not agree more, and we urge that this motto be at the forefront as Congress drafts WRDA 2020.

The benefits of our Nation's waterway systems are the envy of the world, and well-known to all who sit on this committee. Harbors maintained by the Corps handle 95 percent of America's import and export trade, while the inland waterways system moves freight at half the cost of rail and one-tenth of the cost of trucks. Spending just $5 billion a year on this program generates an estimated net benefit of $87.1 billion in economic development, a 16 to 1 return.

To that point, revenues in the Inland Waterways trust Fund and the Harbor Maintenance Trust Fund should be used for their intended purposes. They should be categorized as mandatory spending and taken off the discretionary budget.

The delays in commencing and completing critical water infrastructure projects have broad and far-ranging ripple effects. For example, just last week at Victoria Bend, mile 595 on the Mississippi River, shoaling caused by the historic 2019 flooding in the Midwest caused major delays in towboats transporting hundreds of barges, loaded with all types of vital commodities that help drive our Nation's economy. As many as 85 towboats were sitting still for days waiting for emergency dredging operations by the Corps to reopen the river to traffic, costing many companies and consumers untold dollars which we will never get back.

Many times, budgetary and environmental bureaucratic processes can stand in the way. While we must be good stewards of the

taxpayer dollars and protect our environment, we must find ways to move dirt more quickly to deliver the benefits to communities that depend on these projects.

As you draft the 2020 WRDA bill, AGC recommends that you consider including the following recommendations, among others listed in my written testimony. Congress should require Federal agencies to follow a One Federal Decision process for all environmental reviews and authorizations for major infrastructure projects. This will allow for a single NEPA review for a project that ends with a single record of decision issued by the lead agency.

Reform the benefit-cost analyses. The Chief Reports submitted to Congress show that the project benefits are at least as great as the cost. However, OMB subjects these projects to a second, more rigorous benefit-cost ration. OMB often requires benefits at two and a half times greater than cost.

Congress should establish formalizing partnering on civil works projects to help create an environment that is more conducive to solving project level problems and making timely decisions. Congress should enact specific deadlines for completing the permitting and review processes.

Encouragingly, this committee has recently passed similar reforms in the Highway Reauthorization Bill. This bill details provisions to streamline the environmental approval processes, reduce duplication, and increase accountability and transparency, all of which would be great benefit if included in the WRDA 2020.

Thank you again for inviting AGC to testify before the committee today. I look forward to answering your questions. Thank you.

[The prepared statement of Mr. Sanders follows:]

Statement of

Jamey K. Sanders
Vice President
Choctaw Transportation Company, Inc.

on behalf of

The Associated General Contractors of America

to the

U.S. Senate

Committee on Environment and Public Works

For a hearing on

"Improving American Economic Competitiveness through Water Resources Infrastructure"

September 18, 2019

The Associated General Contractors of America (AGC) is the leading association in the construction industry representing more than 27,000 firms, including America's leading general contractors and specialty-contracting firms. Many of the nation's service providers and suppliers are associated with AGC through a nationwide network of chapters. AGC contractors are engaged in the construction of the nation's commercial buildings, shopping centers, factories, warehouses, highways, bridges, tunnels, airports, waterworks facilities, waste treatment facilities, levees, locks, dams, water conservation projects, defense facilities, multi-family housing projects, and more.

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Statement of Jamey K. Sanders
Choctaw Transportation Company, Inc., Dyersburg, Tennessee
Committee on Environment and Public Works
United States Senate
September 18, 2019

Chairman Barrasso, Ranking Member Carper and Senators of the Environment and Public Works committee thank you for inviting me to testify on this vitally important topic.

My name is Jamey Sanders. I am Vice President of Choctaw Transportation Company located in Dyersburg, Tennessee. We are a fourth-generation construction company specializing in heavy marine construction and port operations. I have spent all of my life in this industry and care deeply about the vitality of our water resources infrastructure and understand the challenges ahead. I currently serve as the chair of the Federal and Heavy Construction Division for the Associated General Contractors of America ("AGC") and have been involved with AGC for most of my life.

For years, AGC has worked with this Committee to ensure the safe and efficient delivery of high-quality facilities and infrastructure for our nation. AGC appreciates and thanks the Committee for its continued efforts to help develop and improve our nation's water resources infrastructure and improve water infrastructure. By taking steps to enact a bill authorizing a water resource development act (WRDA) in the 116th Congress and keeping this critical legislation on a two-year reauthorization schedule, this Committee is demonstrating its commitment to fostering economic growth.[1] AGC also commends the Committee for the major legislative reforms it enacted in 2014, 2016, and 2018 to streamline how the federal government approves and completes water resources infrastructure projects. I hope that my testimony today will help the Committee build on that progress in the next WRDA bill.

As my statement will discuss, the scope and breadth of the various study and approval requirements that apply to WRDA projects often represent a significant factor in the lengthy time it takes to complete many water infrastructure projects. As many are aware, there is a backlog of more than 1,000 authorized water resources construction projects that will cost more than $98 billion[2] to complete. In order to build 21st century infrastructure, we need to be able to build it sometime this century. I am here today to tell you that contractors are able and willing to tackle this backlog, but we need Congress' help in untying the regulatory and layered bureaucratic knots from contractors' hands.

As the Assistant Secretary of the Army for Civil Works, R.D. James, often says his focus is to "move dirt." AGC could not agree more, and we urge that this motto to be at the forefront as Congress drafts WRDA 2020.

In my testimony today, I will discuss:

I. The need for and value of WRDA 2020;
II. Why dedicated, predictable and sufficient funding is necessary to meet system needs and realize its full high value / high return benefits;
III. Which bureaucratic processes remain ripe for improvement; and
IV. AGC's recommendations to help Congress to ensure the safe and efficient delivery of critical water resources infrastructure projects.

[1] "Overall, Corps projects help to generate $109.83 billion in net annual economic benefits and generate $34.16 billion in revenue to the U.S. Treasury." S. Rept. 114-283 - WRDA 2016.
[2] Written Testimony by Lieutenant General Todd T. Semonite at U.S. Congress, House Committee on Appropriations, Subcommittee on Energy and Water Development, and Related Agencies, House Appropriations Subcommittee on Energy and Water Development Holds Hearing on Army Corps of Engineers and Bureau of Reclamation Fiscal 2020 Budget Request, 116th Cong., 1st sess., March 27, 2019.

I. THE NEED FOR AND VALUE OF WRDA 2020

The benefits of our nation's waterways system are the envy of the world and are well known to all who sit on this Committee. WRDA 2020 is needed and would authorize funding for critically needed U.S. Army Corps of Engineers (Corps) Civil Works projects, including navigation (*e.g.*, dredging and locks), flood control (*e.g.*, levees), hydropower (*e.g.*, dams), recreation (*e.g.*, parks) and water supply.

Water resource infrastructure is critical to the economy and yields high returns on investment. Harbors maintained by the Corps handle 95 percent of America's import and export trade, while the inland waterways system moves freight at half the cost of rail and one-tenth the cost of truck transportation. Spending just above $5 billion a year on this program generates an estimated net benefit of $87.1 billion in economic development, a 16-to-1 return, and $27.3 billion in revenue to the U.S. Treasury, a 5-to-1 return.[3] Critically, these projects prevent an estimated $48.5 billion in economic loss annually from damaging storms and severe weather. Recent events, such as the many devastating natural disasters and increased global competitiveness, further highlight the importance of investing in our nation's water infrastructure.

II. DEDICATED, PREDICATBLE & SUFFICENT FUNDING IS NECESSARY TO MEET SYSTEM NEEDS AND REALIZE ITS FULL POTENTIAL BENEFITS

Dedicated, predicable and sufficient funding is critical for any federal project. While WRDA 2020 has jurisdiction over authorizing projects, our nation's long-term water infrastructure needs warrant the protection of water resources trust funds.

To that point, revenues in the Inland Waterway Trust Fund (IWTF) and the Harbor Maintenance Trust Fund (HMTF) should be used for their intended purposes. AGC appreciates the recent FY 2020 Energy & Water Development appropriations bill, S. 2470, advanced out of the Senate Appropriations Committee, which—for the sixth consecutive year—makes full use of the estimated annual revenues from IWTF and meets the spending targets in WRDA 2014 for the HMTF. Congress should protect these critical trust funds and require the full annual use of the revenues towards authorized and intended purposes.

But dedicated and predictable funding will only get us so far if it is not enough to undertake the projects authorized. To this point, a 2018 article[4] asserted that the federal government has appropriated only a small percentage of the authorized projects from WRDA 2014 and 2016. According to the article, of the 64 projects worth $25.3 billion that Congress authorized in those laws, 49 of them had not received any federal money. It went on to note that the federal government spent only $689.1 million on the projects, 2.7 percent of the authorization. Clearly, this funding issue is one that must be addressed if the projects this Committee plans to authorize in WRDA 2020 are intended to be realized in a timely fashion.

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[3] Stockton, Steven l. The Military Engineer. *The Nation's Water Infrastructure*. Retrieved from: http://themilitaryengineer.com/index.php/tme-articles/tme-magazine-online/item/455-the-nation%E2%80%99s-water-infrastructure

[4] Fischleer, Jacob (2018, July) *Authorized Flood Projects Left High and Dry on Funding*. Retrieved from: https://www.rollcall.com/news/policy/flood-project-funding-high-dry?utm_source=rollcallheadlines&utm_medium=email&utm_campaign=newsletters&utm_source=rollcallheadlines&utm_medium=email&utm_campaign=newsletters

III. BUREAUCRATIC PROCESSES REMAIN RIPE FOR IMPROVEMENT

a. Preconstruction Phase Issues

Even fully-funding a water resources infrastructure project does not mean that it can commence in a timely fashion.[5] Budgetary and environmental bureaucratic processes can stand in the way.

Currently, our nation's water resources projects are subject to two budgetary vetting procedures. The Chief Reports submitted to Congress show that the project benefits are at least as great as the cost. However, the Office of Management and Budget (OMB) subjects these projects to a second, more rigorous benefit-cost ratio (BCR). OMB often requires the benefits be 2.5 greater than the cost.[6] OMB's separate BCR often requires additional reviews and adjustments resulting in delays and additional scope adjustments.

On the environmental side, construction companies cannot legally break ground on the project until all the necessary environmental approvals are granted, which sometimes can take up to a decade or more. While we must be good stewards of the taxpayer dollars and protect our environment, we must find ways to move dirt more quickly to deliver the benefits to communities that depend on quality water resources infrastructure.

Both of these preconstruction process issues may be to blame for slow to commence disaster recovery projects. For instance, in February 2018 Congress appropriated $17.4 billion[7] to the Corps for disaster recovery projects. It took almost six months for the Corps to release its work plan and contractors are still waiting on many of these projects to be put out to bid.

The delays in commencing and completing critical water resources infrastructure projects have broad and far ranging ripple effects that extend beyond just a particular water resources infrastructure project. For example just in the last week at Victoria Bend located at Mile 895 on the Mississippi River, shoaling caused by the historic 2019 flooding in the Midwest caused major delays in towboats transporting hundreds of barges loaded with all types of vital commodities that help drive our nation's economy. As many as 85 towboats were sitting still for several days waiting for emergency dredging operations by the Corps to reopen the river to traffic costing many companies and consumers untold dollars which we will never get back.

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[5] Projects funded by the American Recovery and Reinvestment Act (stimulus package) were effectively exempt from NEPA (via "categorical exclusions") to speed up project investment *and still* there were no "shovel ready" projects. In addition to the NEPA review process, there are dozens of separate environmental statutes that may apply to any one construction project – spanning many federal government agencies that each required their own permits, permissions, licenses and approvals.

[6] U.S. Congressional Research Service. Army Corps of Engineers: Water Resource Authorization and Project Delivery Processes R45185; April 19, 2019), by Nicole T. Carter and Anna E. Normand.

"Congress established federal policy for evaluating Corps projects in the Flood Control Act of 1936 (49 Stat. 1570) by stating that a project should be undertaken 'if the benefits to whomsoever they may accrue are in excess of the estimated costs' and if a project is needed to improve the lives and security of the people. For flood risk reduction projects and navigation projects, the Corps performs a benefit-cost analysis (BCA) to compare the economic benefits of project alternatives to the investment costs of those alternatives. For ecosystem restoration projects, the Corps performs a cost-effectiveness analysis to evaluate for each project alternative its associated costs and its anticipated environmental benefits. Disagreement persists about various aspects of these analyses, including the use of BCAs in decision-making, how (and which) benefits and costs are captured and monetized, and how to value future benefits and costs (which relates to the use of a discount rate to evaluate how future costs and benefits are valued in the present). The quality and reliability of BCAs shape federal decision-making and the efficacy of federal and nonfederal spending on federal water resource projects. Executive branch budget-development guidance for the Corps over the last decade has used a benefit-cost ratio (BCR) threshold as one of the primary performance metrics for selecting which construction projects to propose for funding. Recent requests have included ongoing projects that have benefits that are at least 2.5 times the project costs (i.e., BCR>2.5) or address a significant risk to human safety. In contrast, the threshold for an Administration recommendation for construction authorization is typically that the benefits exceed the costs (i.e., BCR>1). An issue for Congress and nonfederal project sponsors is the uncertain prospects for construction for the suite of congressionally authorized projects that do not meet the budget-development BCR threshold."

[7] Public Law No: 115-123.

b. Construction Phase Issues

The construction business is a people business. The people on the jobsite, both contractor and owner, will ultimately determine project success. In the private sector, owners have various incentives to complete a project on time and on budget, or even ahead of schedule or under budget. These private owners have finite resources. Their employees can be hired, fired, rewarded or held accountable with relative ease based on performance. There are clear incentives for getting the job done as efficiently as possible.

In federal construction, there are not always similar economic or ideological incentives to efficiently or quickly complete the job. Federal employees may be entrenched and protected—in many ways—from being held accountable. Federal employees may not have the resources necessary to quickly manage administrative tasks. Jobsites can be in remote locations where field staff can be left to their own devices. The agencies are not paid based on how quickly or efficiently they complete work. Rather, they are paid based on the amount of project funding Congress appropriates.

To our knowledge, there are no clear incentives for agencies or their employees to deliver a project on time or on budget, let alone ahead of schedule or under budget. One of the greatest challenges federal contractors face on their construction projects jobsite is obtaining decisions, especially timely ones, from federal agency employees. As with any construction project, unforeseen issues may emerge. The problem comes with getting the federal agency to decide to act—or not. Decisions may have to move up the chain of command. If the right person or persons are not available, the decision sits on their desks.

What I have said above, however, is not applicable to every agency or agency employee. Just as there are good contractors and subpar ones, there are good federal construction employees and not so good ones. Just as the federal government tries to avoid the poor performing contractors, we try to avoid poor performing federal construction employees or, at least, bid accordingly. And, after major disasters like Hurricane Katrina, no agency—state or federal—was more motivated and able to rise to the occasion to rebuild the greater New Orleans area better than the Corps. It is those times when there are not major disasters, or the eyes of the country are not on us that we must find ways to ensure federal agencies and employees are properly motivated—economic or otherwise—to perform in an effective and efficient manner. Congress must find ways to better incentivize federal agencies—including the Corps—to deliver construction projects more quickly, more efficiently to help improve our Nation's resulting benefits.

IV. AGC RECOMMENDATIONS FOR WRDA 2020

AGC puts forth the following list of recommendations for the Committee's consideration as a WRDA 2020 bill is drafted. These recommendations will minimize delays during project planning and permitting to ensure faster delivery of critical water infrastructure projects.

1. PUT TRUST IN THE TRUST FUNDS: **Congress should ensure that revenues from the Inland Waterways Trust Fund (IWTF) and Harbor Maintenance Trust Fund (HMTF) are fully appropriated on a multi-year basis and used for their intended purpose.** The IWTF and the HMTF should not be subject to the annual, discretionary appropriations process. Instead, they should be categorized as mandatory spending and taken off the discretionary budget. Just as our nation's roads, bridges and transit systems—improvements to which are funded through the Highway Trust Fund—have access to multi-year funding through contract authority, so too should our waterway highways have access to truly dedicated, multi-year funding.

2. REFORM BENEFIT-COST ANALYSES: **Congress should reform the benefit-cost analyses (BCAs) and eliminate duplicative and confusing accounting process.** Currently, our nation's water resources projects are subject to two vetting procedures. The Chief Reports submitted to Congress show that the benefits are at least as great as the cost. However, OMB subjects these projects to a second, more rigorous,

benefit-cost ratio. OMB often requires the benefits be 2.5 greater than the cost. OMB's separate BCA often requires additional reviews and adjustments resulting in delays and additional scope adjustments.

3. ONE FEDERAL DECISION: Over the last 50 years, Congress enacted a host of laws that seek to ensure a balance among environmental, economic and health concerns. To implement those laws, Congress provided a range of federal agency review and permitting processes. **Congress should require federal agencies to follow a "One Federal Decision" process for all environmental reviews and authorizations for major infrastructure projects.** This will allow for a single National Environmental Policy Act (NEPA) review for a project that ends with a single Record of Decision (ROD) issued by the lead agency.[8] Indeed, recognize that separate NEPA reviews for a given project[9] consume significantly more agency resources than a joint NEPA document because of repeated interagency consults (endangered species, historic properties, coastal zone impacts, state water quality standard certification), repeated public comment/hearing responsibilities and increased opportunity for conflict, for example. Agencies need to stop redoing NEPA at various steps of the project development and permitting process. A clear focus on delivering and outcomes versus process.

4. INCENTIVIZE CONSTRUCTION PHASE EFFICENCIES: **Congress should commission a Government Accountability Office report to review how Corps Civil Works Program projects are funded, how or if those projects pay for Corps' employee salaries, if there are any financial incentives that the Corps uses to reward its employees for on time and on budget projects, and if other federal construction agencies have such incentives.** The incentives to deliver a project on time and on budget should come from both parties on a construction contract: contractor and owner. Congress should investigate ways to incentivize—via carrot and not stick—project-level Corps employees to deliver projects on time and on budget.

5. IMPROVE WATER RESOURCES CONSTRUCTION PROJECT-LEVEL PARTNERING: AGC members and local non-federal sponsors have observed a severe reduction in water resources project-level partnering on Corps' projects. Many see partnering as becoming the exception rather than the rule. For partnering to be effective, representatives with authority on Corps and contractor staffs must be involved. The greatest problem in this area is the lack of Corps District or Division participation on a periodic basis. As a result, there can be a lack of oversight on the project that can lead to problems. Without involvement of personnel with authority on the project or engagement in a proactive manner, problems that could have been addressed often fester until a District or Division office can no longer ignore it. By requiring that Corps engage in proactive, periodic meetings at the District/Division levels, problems can be identified either before they happen or before they become worse. For partnering to be successful, all parties must be involved early and often. **Congress should establish formalized partnering on Civil Works projects to help create an environment that is more conducive to solving project-level problems and making timely decisions.**

6. ESTABLISH FIRM DEADLINES AND PENALITIES: **Congress should enact specific deadlines for completing the permitting and review process.** Executive Order 13807[10] aims to reduce environmental review and permitting time, to the extent permitted by law, to "not more than an average of approximately 2 years" following the publication of the notice of intent to prepare an environmental impact

[8] President Trump's Executive Order (EO) 13807: "Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects" (Aug. 15, 2017) calls for "One Federal Decision," unless separate NEPA documents are requested by the project sponsor or a single environmental review is not the best method for the project. The President has tasked the Council for Environmental Quality (CEQ) and the Office of Management and Budget with implementing the "One Federal Decision," the regulatory process will take years and is subject to litigation. Congress should codify this "One Federal Decision" requirement.

[9] For example, undergoing a comprehensive NEPA review at the project outset, followed by, perhaps, subsequent NEPA reviews during the project's Section 408 review (requests to alter USACE civil works) and again during the Section 404 review (requests to discharge dredged or fill material into U.S. waters); both reviews are considered a "federal action" that is currently subject to NEPA.

[10] *See* footnote 8.

statement (EIS) and all federal authorizations are complete within 90 days after the ROD. Similarly, FERC has set expeditious schedules for all federal agencies, and state agencies acting under federal delegated authority, to reach a final decision on requests for federal authorizations necessary for natural gas infrastructure projects (a 90-day deadline for other federal decisions upon the issuance of FERC's final EIS, unless a specific schedule is otherwise formally noticed by FERC).[11] To ensure that deadlines are met, **Congress should require the Corps to implement the financial penalty provisions enacted in WRDA 2014** that created a unique system of reprogramming a federal agency's funding if that agency missed its deadline for rendering a decision on a permit, license, or other approval.

7. LIMIT THE SCOPE OF RE-EVALUATIONS: **Congress should direct federal agencies to develop clear standards for determining what project changes warrant a re-evaluation of previously approved environmental documentation** (i.e., what constitutes a material change?). Currently, projects are being delayed because minor changes or adjustments to the project design or location – or even just changes to construction means and methods (e.g., change in how diverting water flow) – will trigger another round of lengthy coordination at the federal and state level, possibly a supplemental EIS, and several more public review periods that restart the statute of limitations and give opponents more time to sue (sometimes just to stop or to delay the project). Projects also are held up when environmental field surveys (wildlife, wetlands) become "stale" and agencies require new, updated information. Additionally, there could be a limit on the text or page length of environmental analyses for activities that are repeated in the same fashion in like environments.

8. REDUCE DUPLICATION: **Congress must take steps to reduce duplication in the permitting process. To reduce duplication, the monitoring, mitigation and other environmental planning work performed during the NEPA[12]review must satisfy federal environmental permitting requirements, unless there is a material change in the scope of the project.** Many Clean Water Act (CWA) Section 404 (individual) permit delays stem from delays in other federal environmental permissions, authorizations, certifications, etc., required before a District Engineer will sign off on the permit application.[13] Key examples include delays and repetition with assessments/analyses under the Endangered Species Act (ESA) Section 7 consults, the National Historic Preservation Act (NHPA) authorizations Section 106 authorizations,[14] and

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[11] 18 C.F.R. § 157.22. FERC issued a Final Rule (Order 687) and regulations establishing the process by which it would exercise its responsibilities under Section 313 of EPAct -https://www.ferc.gov/whats-new/comm-meet/101906/C-2.pdf

[12] U.S. Congressional Research Service. Army Corps of Engineers: Water Resource Authorization and Project Delivery Processes R45185, April 19, 2019), by Nicole T. Carter and Anna E. Normand.
"The National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. §4321) requires federal agencies to fully consider a federal action's significant impacts on the quality of the human environment, and to inform the public of those impacts, before making a fina decision. The U.S. Army Corps of Engineers (Corps) integrates its NEPA compliance process with the development of a feasibility study. That is, during the study process, Corps identifies impacts of potential project alternatives and any environmental requirements that may apply as a result of those impacts, and it takes action necessary to demonstrate compliance with those requirements. In Section 1005 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014; P.L. 113-121), titled Project Acceleration, Congress directed Corps to expedite NEPA environmental documentation compliance for Corps studies. In March 2018, Corps issued implementation guidance for this provision. Corps published implementation guidance for the categorical exclusion portion of Section 1005 in August 2016; the provision called for the agency to survey its use of categorical exclusions and tc identify and publish new categorical exclusion categories that merit establishment. Corps has not established new categorical exclusior categories pursuant to Section 1005 of WRRDA 2014."

[13] While the Corps makes the Section 404 permit decision, other federal and state agencies have substantial roles in the permit application process. The result is a process that requires extensive interagency coordination. The Corps must comply with environmental review requirements under various federal laws before issuing a CWA Section 404 permits. These laws include NEPA, ESA at 16 U.S.C. §§ 1531, *et seq.*, NHPA at 16 U.S.C. §§ 470, *et seq.*, CZMA at 16 U.S.C. §§ 1451, *et seq.*, and many others. Each law has different requirements, and the Corps must ensure that all applicable requirements are satisfied before a permit is issued. The Corps' regulations include procedures for NEPA compliance (*see supra*) and for Section 106 compliance (33 C.F.R. § 325 App. C). As reflected in those regulations, the Corps has an independent obligation to comply with those laws.

[14] Another suite of laws relates to historic and cultural protection and preservation. These laws have often elevated tribal nations' concerns. More generally, attention to how the project affects an area's cultural heritage (local communities) must be considered. These factors should be part of the EIS analysis (e.g., to identify sites of historic significance, the presence of Native American graves).

the Coastal Zone Management Act (CZMA) consistence determinations, for example, which are a part of the NEPA process. For water infrastructure projects, Congress should require the Corps to always be a cooperating agency in the NEPA process (when it is not serving as the lead agency) and, in that regard, assume the responsibility for ensuring that the above-referenced consultation requirements are completed during the NEPA review and such consults are sufficient for the 404 federal permit authorizations.

9. INCORPORATE REFORMS FROM S. 2302: Encouragingly, this Committee has recently incorporated many of the above environmental review and permit streamlining recommendations in another infrastructure bill. In August, the EPW Committee unanimously passed its highway and bridge reauthorization bill (S. 2302, America's Transportation Infrastructure Act of 2019). S. 2302 details provisions to streamline the environmental approval processes, reduce duplication and increase accountability and transparency. **AGC recommends that the Committee consider adopting similar streamlining and transparency provisions listed below in drafting the next WRDA bill.** Sec. 1301 of the bill includes the following provisions, specific to Department of Transportation (DOT), relating to environmental reviews for "major projects" that require an EIS:

- Establishes a two-year goal for completion of environmental reviews under NEPA, and a 90-day timeline *thereafter* for related project authorizations (permits license, approval)
- Calls for a single environmental review (NEPA) document and record of decision per project to be signed by all participating agencies
- "The final environmental impact statement for a major project shall include an adequate level of detail to inform decisions necessary for the role of the participating agencies in the environmental review process."
- Requires the establishment of a performance accountability system for tracking major projects, which would include at a minimum the environmental reviews process schedule, whether the established schedule is being met, and time taken to complete the environmental review process
- If a cooperating agency fails to meet a deadline, the DOT Secretary shall submit a report to Congress (Senate EPW Committee and the House Transportation and Infrastructure Committee) and make it publicly available on the Intranet)
- Requires the DOT Secretary to provide a report on environmental review best practices, programmatic agreements and potential changes to internal departmental procedures to speed up environmental reviews

CONCLUSION

AGC appreciates and thanks the Committee for its continued efforts to help improve our nation's water resources infrastructure. Thank you again for inviting AGC to testify before the Committee today. I look forward to answering any questions you may have.

Senator BARRASSO. Thank you very much for your testimony, Mr. Sanders. It is really very helpful. Thank you.

Mr. BROCKBANK.

STATEMENT OF DEREK BROCKBANK, EXECUTIVE DIRECTOR, AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION

Mr. BROCKBANK. Thank you.

American shoreline is infrastructure that upholds the U.S. economy. Forty percent of the U.S. population lives in a coastal shoreline county, with a combined GDP of $7.9 trillion dollars. If counties, not States, just counties, along the coast were considered as an individual country, they would rank No. 3 in global GDP, behind only the U.S. and China.

So if we want to improve American economic competitiveness, we had better make sure that the coastal infrastructure that is protecting America's most populous and prosperous regions from rising seas and increasingly powerful storms are ready for the challenges ahead.

If Hurricane Dorian had stalled over the Atlantic coast of Florida rather than the Bahamas, the tenor of this hearing would be vastly different.

American Shore and Beach Preservation is an organization of beach and coastal practitioners, the communities, industry and local elected officials and academics who build, maintain, manage and research our Nation's beaches and shorelines. We have been advocating for healthy coastlines since 1926. Thank you for including us here today.

When we talk about coastal infrastructure, we are talking about natural infrastructure, beaches, dunes and wetlands, and occasionally hard infrastructure, seawalls and riprap that project homes, communities and other coastal infrastructure along a coast. We have seen time and again communities with wide beaches and high, healthy dunes come away from coastal storms with far less damage than communities who haven't maintained their "first line of defense."

Nearly every beach on the east and Gulf Coast and many on the Pacific and Great Lakes coasts, from Rehoboth to Gulf Shores, has been restored, renourished and re-engineered to mimic natural systems. Most estuarine coastlines are also engineered, either armored or restored as wetlands and living shorelines.

What connects all these shorelines is the need for sand and sediment. Sand and sediment are the building materials of a healthy coastline. Beaches and wetlands are dynamic systems that should naturally be eroding and rebuilding, but too often they cannot rebuild because we have prevented sediment from ever reaching the coast. Levees prevent flooding, and sediment deposition, hardened cliffs, riverbanks and dams keep sediment out of waterways. Jetties and dredging send sediment far offshore.

In short, we are facing a coastal sediment crisis, in addition to the challenges of rising seas and localized subsidence. As the Environment and Public Works Committee develops water resources legislation and provides the Administration oversight, we encourage you to do three things. One, direct the Army Corps of Engineers to better manage sediment; two, change the Army Corps de-

cision-making frameworks, so that multi-benefit projects that can use the natural infrastructure can out-compete single benefit projects; and finally, encourage the Office of Management and Budget to better fund and support coastal flood risk management.

We believe the most influential thing and fundamental thing the Army Corps can do to better manage coastlines is operate under principles of regional sediment management, RSM. This is the concept that sediment is a resource, not a waste product, and managing sediment within a watershed or littoral system, not a project-by-project basis, is more ecologically sound and saves money. In short, we need to move sediment within the system, not remove it.

RSM goes well beyond just re-using dredged material, but an important part of RSM is beneficial use. The Corps dredges about 214 million cubic yards of sediment per year from navigation channels. Of that, 38 percent is beneficially used. That is not good enough. The Corps should beneficially use 100 percent of uncontaminated dredged material.

One way to help do this is change the understanding of the Federal standard. As part of the Army Corps' determination of the least cost alternative for disposal of dredged material, the Corps should include the economic valuation of sediment, including potential ecosystem restoration benefits, flood risk reduction benefits, and other economic values and long-term costs.

The next fundamental way to improve coastal project development and prioritization is modifying the benefit-cost ratio, the BCR, as we have heard before, to better support multi-benefit projects. In designing a project authorized as flood risk reduction or coastal storm risk reduction, the Corps calculates the benefits derived from reducing flood risk without fully considering other benefits. So projects are not designed to maximize habitat creation or economic development.

In the case of beaches, the economic value can be remarkably high. Economist Dr. James Houston has calculated that beach travel and tourism generates $285 billion to the national economy, and generates $23 billion in Federal tax revenue annually. These types of economic figures ought to be considered when deciding which flood risk management projects to prioritize.

The result of advancing RSM and beneficial use and reform of the Corps BCR will be improved decision-making frameworks that appropriately value natural infrastructure, the beaches, dunes and wetlands, that provide flood risk management but so much more. Army Corps mandates are too broad and the challenges of the coast too great for the Corps to continue to focus on projects that only solve one problem at a time.

Finally, the EPW Committee should look at the role OMB has in underfunding and delaying coastal projects. The Administration's annual budget drastically underfunds coastal flood risk management ,and even when Congress funds coastal projects via appropriation adds and shore protection or via supplemental appropriations, OMB can withhold funding with very little transparency.

ASBPA looks forward to working with the EPW Committee to address these challenges in WRDA and in future infrastructure legislation. Thank you.

[The prepared statement of Mr. Brockbank follows:]

asbpa
American Shore & Beach Preservation Association
Advocating for healthy coastlines

Environment & Public Works Committee Hearing Testimony

September 18, 2019

American Shore and Beach Preservation Association, Derek Brockbank, Executive Director

America's Engineered Shoreline

America has an engineered shoreline. The most iconic beaches in the country have all been restored, renourished, and re-engineered to mimic natural systems. The beaches of the Jersey Shore, Delaware, Ocean City, the Hamptons, Gulf Shores, Galveston, Malibu, Santa Monica, and Waikiki are part of our national coastal infrastructure that has been engineered with nature as a guide. Coney Island was the first significantly engineered beach, renourished back in 1923. Today, nearly every beach on the East and Gulf Coast, and many on the West and Great Lakes coasts, have been engineered. Increasingly, even our estuarine and back-bay shorelines are engineered, either by "armoring" with bulkheads and riprap, or with more natural solutions such as restoration and living shorelines.

The U.S. Army Corps of Engineers (USACE), authorized by and acting under policy established in Water Resource Development Acts (WRDAs), has been building natural infrastructure and engineering with nature for a long time. And the American Shore and Beach Preservation Association (ASBPA) has been working with USACE for nearly a hundred years.

ASBPA is an organization of beach and coastal practitioners. We are the communities, industries, and academics who build, maintain, manage and research our nation's beaches and shorelines. We are geologists, engineers, town managers, elected officials, professors, students and coastal advocates. Our mission is to merge science and policy to protect, restore and enhance the U.S. coastline; we were founded in 1926 and have been advocating for a healthy coastline ever since.

ASBPA believes a healthy coastline, whether restored or natural, provides **four interconnected values** to coastal communities specifically and to the nation more broadly:

a) **Protection** from coastal storms, hazards and sea level rise, and as buffer to sensitive estuarine ecosystems[1][2];

[1] USACE has documented that coastal storm damage risk reduction projects reduced damages from Hurricane Sandy by $1.9 billion, however this comprehensive regional analysis has not been publicly produced for subsequent hurricanes.
USACE – NAD, "MEMORANDUM FOR RECORD - SUBJECT: Damages Prevented by Corps Projects, Hurricane Sandy", Nov. 19, 2012.
https://www.nad.usace.army.mil/Portals/40/docs/ComprehensiveStudy/Estimate%20of%20Sandy%20damages%20avoided.pdf *[Submitted for the record.]*

[2] Narayan, S. "The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA", *Scientific Reports,* Vol. 7, Article number: 9463 (2017). https://www.nature.com/articles/s41598-017-09269-z

b) **Ecologically valuable habitat** for birds, turtles, fish and other coastal plants and wildlife;
c) **Economic vitality** though tourism, shipping, fishing and other industries;
d) **Recreation** for tens (if not hundreds) of millions of Americans who visit the beach in greater numbers than all our national parks combined.

ASBPA would like to see these values maximized in USACE's management of our nation's shoreline. Doing so will take USACE using the full authorities provided to them, Congress authorizing and encouraging USACE to use a multi-benefit approach to coastal management and project development, and the Office of Management and Budget (OMB) budgeting for, and allowing the timely use of congressionally appropriated funds, for critical coastal projects.

WRDA

In the last two WRDAs, Congress has included a number of provisions that allows or directs USACE to manage the US coastline to achieve these multiple benefits. The three areas discussed here are:

1) **Regional Sediment Management** (RSM) and the **Beneficial Use of Dredged Material** (BUDM)
2) Modification of the **Benefit-Cost-Ratio** (BCR)
3) **Natural Infrastructure**.

Regional Sediment Management and the Beneficial Use of Dredged Material

Regional Sediment Management (RSM) is a comprehensive approach to planning and integrating riverine and coastal projects with the core principle that sediment is a finite resource not to be wasted. RSM seeks to *move* sediment from where it is not wanted to where it is wanted, rather than simply *removing* sediment from the littoral system. RSM can reduce overall costs through cross-business line planning and budgeting. Beneficial Use of Dredged Material (BUDM) is one aspect of RSM, in which sediment dredged for navigation purposes is used to benefit a restoration and/or flood risk reduction project. Ultimately, ASBPA believes that USACE needs to evolve its budgeting and planning operations to reflect RSM principles so that **100% of uncontaminated dredged sediment is used beneficially**.

On average, USACE dredges about 214 million cubic yards of sediment per year from navigation channels nationwide. Of that, 82 million cubic yards (or 38%) is used beneficially on beaches, in wetlands, and in nearshore water each year.[3] This is a good first step, but in an era of sediment shortage – less sediment is reaching the coast than ever before due to dams, hardened riverbanks and cliff faces, and straightened channels – and rising seas, anything less than 100% beneficial usage is not enough. One good example of RSM in practice is at the mouth of Columbia River in Oregon, where the USACE Portland District is working with partners to develop a network of nearshore placement sites for dredged sediment. The goal is to keep material in the littoral zone so that it feeds the beaches of Oregon

[3] Federal coastal navigation projects were inventoried to examine the extent to which RSM goals have been implemented across USACE at the project level. This study examined USACE navigation projects that beneficially reuse sediments dredged from Operations & Maintenance (O&M) projects nationwide. These data were derived from a comprehensive analysis of nearly 20 years of USACE dredging data at both the national and district level. The data have been quality checked, updated, and revised over the last five years through extensive interviews of USACE staff at the District, Division and HQ levels. *USACE RSM, 2019. USACE Navigation Sediment Placement: An RSM Program Database (1998-present), U.S. Army Corps of Engineers Regional Sediment Management Program, https://gim2.aptim.com/rsm, accessed July 2, 2019.*

and Washington through natural coastal processes. Placing 500,000 cubic yards of sediment in a nearshore site, with no more than five centimeters of accumulation on the seabed per disposal, has yielded $200,000 in cost savings to date, helped naturally maintain an eroding coastline, and yielded no crab mortalities (the primary environmental concern with nearshore placement in this region).

In another example of RSM, near St. Augustine, FL, the Jacksonville District has combined multiple federal projects so that timing of dredging and placement is aligned. They have also instituted inlet bypassing, so less sand accumulates in the St. Augustine Inlet and instead is distributed to a down drift shoaling area that distributes sand to eroding beaches. This resulted in a $2 million cost savings from reduced dredging and associated environmental mitigation efforts and by combining permits.

WRDA 2016 authorized a pilot program for BUDM (Sec. 1122), that was expanded in WRDA 2018 (Sec. 1216). Sec. 1122 was slow to get going: implementation guidance took a year to finalize, and after 90+ projects were submitted for the initial ten pilot projects, project selection took nearly another year. But the projects are now underway. One project, Deer Island Lagoon in MS, has been completed, and USACE has estimated the remaining nine will be in construction by FY2022, assuming current dredge timelines hold and construction funding is available.[4][5]

Local communities have widely supported the 1122 program. Washington State Department of Ecology (WADEC), the local sponsor for the "Grays Harbor South Jetty Placement" project, used this process to convene key stakeholders to plan for the beneficial use of dredge sediment to help protect shipping channel jetties, coastal beaches and nearshore habitats from erosion while avoiding and minimizing adverse impacts to environmental resources, and navigation safety. Through the development of the Grays Harbor project, WADEC identified additional opportunities for beneficial use in other parts of Washington, and developed a strategy to achieve economies of scale through coordination with local partners across the state – reducing the cost sharing challenges that many communities face. Although the Grays Harbor project is not impacting the Town of Ocean Shores, WA, Mayor Crystal Dingler has credited the 1122 process with helping her community by providing "*invaluable information concerning our ongoing erosion problems. This continued engagement in our community process to address emergencies and support long-term strategies are critical to helping our community make resilient investments for our future. Without such data and assistance, we are operating blind*."[6]

USACE has not publicly determined when or how the additional ten projects authorized in WRDA 2018 Sec. 1216 will be selected, but USACE and congressional appropriations committees have each indicated they would like to see the successful completion of the first ten pilot projects before constructing the next ten.

What else is needed:

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[4] FY19 appropriations included an $8.5 million increase to CAP204 (BUDM) to $10 million with report language, "the Corps is directed to fund these pilots, if otherwise competitive, under the CAP Section 204 line item and the applicable additional funding line items in this account." FY20 Energy & Water appropriations passed by the House includes $7.5 million for "BUDM Pilot Program" as well as $20 million for CAP204 (BUDM).

[5] See also: "Increasing Beneficial Use of Dredged Material" ASBPA Factsheet *[Submitted for the record.]*

[6] Interview with Bobbak Talebi, Senior Coastal Planner, Shorelands & Environmental Assistance Program, Washington State Department of Ecology, July 2, 2019.

The BUDM pilot project is an important step in directing USACE districts to think more broadly about how they can use dredged sediment and how they can work with local project sponsors. But this sort of approach must be systemic across USACE projects, not limited to a handful of pilot projects, or within districts that seek innovative approaches. ASBPA recommends the following 2 policies:

1. **Requiring the U.S. Army Corp of Engineers (USACE) to include the economic valuation of sediment, including potential ecosystem restoration benefits, storm damage reduction benefits, and other economic values and long-term costs when determining the "least cost alternative" for the disposal of dredged materials.**

   Conceptually, the Federal Standard is an important policy to ensure USACE is efficiently spending taxpayer money: the cost of a navigation project should only include the least expensive placement of the dredged material. However, current implementation of the Federal Standard is based on the understanding of dredged material as a "spoil" that needs to be disposed of, rather than a resource that should be used. As seas rise and offshore sediment sources become scare, we now understand that sand is the second most used natural resource in the world behind water.[7] Geologists and geomorphologists are considering whether imported sand from as far away as Greenland could be economically feasible in the future.[8] The Federal Standard must be based not on the cheapest way to *get rid* of dredged sand, but the most efficient way to *use* dredged sediment (including beach-quality sand and fine-grains that restore ecosystems) beneficially.

   The simplest way to do this is to account for dredged sediment's value to projects – both federal and non-federal – that could use that material currently and in the future to benefit the public. The value of future uses would presumably come with a discount rate, but if a community wanted to use material dredged from a channel to restore a beach in, say, ten years, but it would cost them more to go off-shore than it would to access the material if it were still in the channel, than that cost must be borne by the navigation project. In short, dredged material needs to be treated as any other natural resource would. If a navigation project disturbed a wetland, there would need to be recompense to restore the ecological value of a wetland; similarly if dredge material is removed, a project should account for the *public use value* of the sediment.

2. **Require each USACE district to produce an annual five-year sediment management report that forecasts expected sediment removal (i.e., dredging) and placement needs, sets goals for sediment reuse, and identifies local and state partners that may want access to federally dredged sediment and will be consulted on timing of projects.**

   While many USACE districts are already employing regional sediment management (RSM) concepts and planning, RSM is not consistently practiced throughout all USACE districts and not all districts provide public plans for how they manage sediment. Requiring a five-year sediment management plan from each district will help a) ensure districts are all operating using the budgetary cost-saving principles of RSM; b) ensure transparency in project planning and budget

[7] https://www.imf.org/external/pubs/ft/fandd/2015/12/edwards.htm
[8] https://www.nytimes.com/interactive/2019/07/01/climate/greenland-glacier-melting-sand.html

development, thereby allowing local communities to have a better understanding of when they will need to provide their local cost share; and c) ensure states and all sediment-user stakeholders are at the table as USACE districts plan where and how to remove and use sediment within their watersheds and littoral systems.

Five year sediment management plans can likely build upon existing plans, but should include:

- A five year sediment budget for each watershed and/or littoral system within the district, including:
  - Expected sediment removal projects with estimates of amount and type of sediment to be removed;
  - Expected and potential sediment placement projects with estimates of amount and type of sediment needed;
  - Coordination with neighboring districts for watersheds and/or littoral systems that cross district boundaries;
- Goals for maximizing beneficial re-use of sediment and cost-savings from aligning projects that cross budget-lines;
- A list of state agencies, local communities and NGO partners who will be consulted and/or informed in the planning of any sediment project.

Benefit-Cost-Ratio

Benefit-cost-ratios (BCRs) for water resource infrastructure projects ensure the federal taxpayer is only paying for projects that provide positive economic benefits – when benefits outweigh costs. However, as currently implemented, USACE BCRs have two fundamental flaws:

a) BCRs are calculated using the economically verifiable benefits of a project's primary purpose, while under-calculating other benefits; and
b) Projects in wealthier communities inevitably get prioritized over projects in poorer communities, since the economic benefit of risk reduction is greater for valuable property than inexpensive property.

Using the economically verifiable benefits of a project's primary purpose sounds sensible, but it means projects are designed to maximize just a single benefit, rather than balancing multiple benefits. A project that is intended to reduce flood risk, such as a beach and dune system, might also have tremendous value as habitat and in supporting a tourism-based economy. But in designing a project authorized as a "flood risk reduction" or "coastal storm risk reduction," **USACE will calculate the benefits derived from reducing flood risk, but not the full recreation benefits, nor any of the ecological or social benefits, so the project will not be designed to support the economy or habitat**. Furthermore, a project that does have multiple benefits must compete for federal dollars with no advantage against projects that have a single benefit.

In the case of beaches, the economic value and even the direct return on investment via tax revenue can be remarkably high. Economist Dr. James Houston has calculated that beach travel and tourism generates $285 billion to the national economy and $23 billion in federal tax revenue annually.[9]

[9] Houston, J.R. 2018. "The economic value of America's beaches — a 2018 update." *Shore & Beach*, 86 (2), 3-13. *[Submitted for the record.]*

Additionally, beach tourism support 2.5 million jobs directly and 4.4 million jobs including direct, indirect, and induced impacts.[10] While USACE is not an economic development agency, and not in business to generate revenue for the U.S. Treasury, these economic figures ought to be considered when deciding which flood risk management projects to prioritize.

Second, prioritizing flood risk management projects based on calculation of avoided economic damage means projects in areas of a high concentration of wealth and property value have a higher BCR than less wealthy or less densely populated areas. This may be a sensible market-based decision-making tool, but it exacerbates the problem of lower income communities living in flood-vulnerable areas without federal support in reducing risk. It also perpetuates a cycle of development in flood-vulnerable areas to increase the economic benefits derived from risk reduction measures. A **more sensible BCR or decision-making tool would account for the societal value created by reducing risk to low-income communities as well as valuing open space or other flood mitigation measures that are currently dis-incentivized by the BCR**.

WRDA 2018 authorized two studies to look at USACE budgeting practices, a National Academy of Science (NAS) study on USACE budgeting (Sec. 1103) and a General Accountability Office (GAO) study on Benefit-Cost Analysis Reforms (Sec. 1204). To ASBPA's knowledge Sec. 1103 has not been funded nor begun, while Sec. 1204 is currently underway. Both of these studies will help reform USACE's BCR process and should be completed as soon as possible.

What else is needed:
While studies are helpful in clarifying specific challenges to current policy or operating procedure, as well as recommending potential solutions or steps for improvement, they don't actually change anything. **USACE's BCR for flood risk management projects is an archaic tool that needs to be modernized.** ASBPA recommends the following policy:

3. **For water infrastructure projects, including flood risk reduction projects, proposed for authorization, require USACE to determine and publish the full range of benefits – including, but not limited to, economic value derived from tourism and recreation; ecological improvements and social cohesion – as part of the (BCR).**

   While this will support better projects whose primary purpose is flood risk management, it may also support better navigation projects that have multiple benefits (such as important BUDM placement sites, or ecological value in clearing channels).

Natural Infrastructure

Wide beaches, high dunes, and verdant wetlands, reefs, mangroves and seagrass beds are essential to the 40% of American who live along the coast. Properly maintained, this natural infrastructure can improve communities' resilience and is itself resilient. Dunes and marshes can adapt to rising seas, and reefs and coastal forests regenerate after storm damage. The same can't be said for "grey" (concrete and steel based) infrastructure. USACE has been building beaches and dunes for flood risk reduction for nearly a century and restoring aquatic ecosystems for more than half a century. It should be looking at

[10] Ibid.

how to fully integrate these missions in combination with its mandate to maintain coastal navigation. By doing so, USACE can more effectively restore and rebuild our nation's natural infrastructure, in collaboration with other federal, state and tribal agencies.

USACE has many authorizations to use natural infrastructure solutions and to consider natural and nature based features in place of more traditional grey infrastructure. Recent WRDAs have clarified and built upon previous authorizations:

- WRDA 2016, Sec. 1154 authorized collaborative regional assessments on coastal resilience that prioritized natural infrastructure;
- WRDA 2016, Sec. 1184 required "natural features" to be considered in feasibility studies;
- WRDA 2018, Sec. 1149 specifically allowed "natural and nature based features" to be included in aquatic ecosystem and flood risk management projects;
- WRDA 2016 & 2018 authorized regional coastal resilience studies in the South Atlantic, Great Lakes, and coastal Texas that included natural infrastructure solutions.

None of these were wholly new authorities requiring action from USACE, so implementation has been mixed. Districts that use "natural" solutions have more leeway to do so, but ASBPA hasn't seen a notable increase in use of natural infrastructure since 2016. ASBPA considers comprehensive coastal resilience studies to be invaluable and is pleased that the South Atlantic Coastal Study has been funded and is underway, and disappointed that the Great Lakes Coastal Resilience study has not received approval to begin as a new start and is still on hold.

What else is needed:

Rather than simply encouraging USACE to use or consider natural infrastructure in place of hard, grey infrastructure, **Congress should advance the recommended policies above, which will result in natural infrastructure being the preferred alternative due to its multi-benefit approach**. Additionally USACE's regulatory requirements should ensure natural solutions are as easy to permit as hard infrastructure. For example, USACE took a good step in creating a nationwide permit for living shorelines, but USACE could look at regulatory hurdles to natural infrastructure and ensure permitting is not easier for a comparable gray infrastructure project.

The USACE's efforts to "Revolutionize"

Many of the challenges the USACE has in modernizing to meet the needs of the 21st century – the ability to adaptively manage projects in the face of climate impacts, expediting project delivery, being reactive to the high and lows as well as delays in funding by the Administration and Congress – is not something Congress can directly fix. These challenges are procedural and cultural that will take years, if not decades, to fully address. ASBPA has been pleased with General Todd Semonite's call to "Revolutionize" USACE, as well as Director of Civil Works James Dalton's efforts at implementing procedures to allow USACE to operate as a risk-informed, not risk-averse institution.

But after Gen. Semonite and Mr. Dalton leave, these efforts will need to continue. It is incumbent on Congress, and the Environment & Public Works (EPW) Committee specifically, to **provide oversight to ensure these procedural and cultural changes continue**. USACE is an essential agency as our nation faces the biggest coastal threats in history, and it needs to be operating efficiently and effectively.

Office of Management and Budget (OMB)

Finally, it is imperative to note that efforts to reduce flood risk to coastal communities proposed by USACE, then approved and funded by Congress, have far too often been stymied by OMB.

Since Congress no longer provides project specific funding ("earmarks"), OMB both sets the USACE budget for the administration *and* has final approval on project funding. This means that projects that do not meet OMB's specifications, simply do not get funded. Or a project may be delayed and made more expensive in efforts to comply with OMB specifications. Even more troublesome is that OMB's specifications for what they will fund are opaque and inconsistent.

OMB's review of coastal flood risk projects does not appear to be evenly balanced with inland flood risk management projects. Over the past decade, USACE's annual budget has been between 19 (FY2011) and 120 (FY2017) times greater for inland versus coastal funding.[11] The administration's proposed FY2020 budget included just $18 million on coastal flood risk investigation and construction, compared with $193 million for inland flood risk investigation and construction. H.R. 5895, the FY19 mini-omnibus Appropriations bill that included Energy & Water, called for a report from USACE to help identify the shortfall on coastal funding, stating "the report shall include [for each of the last ten fiscal years] the total amount of funding allocated to coastal projects… name each project and include an analysis comparing level of funding in proportion to the amount of work needed in coastal areas."[12] But to our knowledge this report has never been produced.

Perhaps more frustrating than OMB's proposed funding levels, which Congress can choose to accept or change (i.e., provide additional funding), is OMB's ability to withhold or delay funding to coastal projects when Congress has provided additional funds for coastal projects ("shore protection") and USACE has developed a workplan for which projects should be funded. OMB should have a role in fiscal oversight to prevent misuse of funds, but too often their oversight has crossed the line to standing in the way of Congress's and USACE's intent.

Conclusion

As the EPW Committee reviews the success of recent WRDAs and develops policies for a 2020 WRDA, ASBPA encourages the committee to consider how USACE is able to advance coastal projects that have multiple benefits. USACE has been building beaches for 100 years and wetlands for 50 years, so the concept of restoring natural infrastructure with flood risk reduction, ecological, economic and recreation benefits is not new. But the next step is for USACE to maximize each of these values for individual projects and within coastal systems. This will take systemic changes to increase the beneficial use of dredged material, budgeting changes to ensure the full value of sediment is calculated and all benefits are included in a BCR, and on-going oversight to ensure procedural and cultural changes at USACE proceed, as well as oversight into OMB under-funding and delaying coastal projects.

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[11] Whitehouse, S. "Letter to A.S.A. RD James", Feb. 12, 2019.
https://www.whitehouse.senate.gov/news/release/whitehouse-calls-out-major-gap-between-inland-and-coastal-states-on-key-water-resource-funding

[12] H. Rept. 115-929 – "Energy and Water Development and Related Agencies for the Fiscal Year Ending September 30, 2019, and for Other Purposes," 115th Congress (2017-2018)
https://www.congress.gov/115/crpt/hrpt929/CRPT-115hrpt929.pdf

Finally, the needs of our nation's coastline are too enormous to be solved with policy changes and authorized projects in WRDA alone. **Our country must make a major investment in infrastructure that includes dedicated support for coastal resilience and for waterways**. From sediment management to preparing for storms and rising seas, the challenges of our coastlines and our waterways are linked and must be solved together. The policy solutions described here -- including RSM, BCR reform and natural infrastructure -- all address these challenges. But to be successful these need significant federal funding and need to be part of a national infrastructure investment program. ASBPA looks forward to working with the EPW Committee to address these challenges in WRDA and in infrastructure legislation.

Thank you for considering our testimony, and we are happy to answer any questions.

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Senator BARRASSO. Thank you all for your testimony. We will start with 5-minute rounds of questions, and I will start.

Mr. O'Toole, would having the Federal Government partner with the States to build additional water storage in the west, would that have a significant impact economically for rural communities in States like Wyoming?

Mr. O'Toole. Thank you for the question, Senator. As you know, I served on the Select Water Committee in Wyoming. There was a genius in Wyoming of putting aside dollars for infrastructure, long-term renewables, non-renewables and renewables were of the philosophy of where we came from.

But I will tell you that because of budgetary things in Wyoming alone, I know a lot about Colorado also, the ability to assist with funding is critical.

I sit on the Yampa Roundtable, which is all the rivers in northwest Colorado and southwest Wyoming. Every single watershed realizes because of the early runoffs, we have to have storage. That is every single watershed, sub-watershed, including mine, in that part of the Country.

And that is true everywhere. I have seen the map of California that the 50-year plan, 50 years old, none of it was done except for the incredible expansion of population. I think the infrastructure part, storage particularly, because of the early runoffs, is critical. So it would be very important.

Senator BARRASSO. Could I also ask you about the idea of invasive species and the amount of water that invasive species take up? We hear that certainly in Wyoming quite a bit. What can you tell the committee about the impact of invasive species on the water supplies, upon which your organization's members depend? What actions do you believe that the Federal Government could take that would be most effective in fighting these invasive species, which drain so much of the water?

Mr. O'Toole. In my written testimony, I talked about the 160,000-acre feet of water that the Forest Service themselves has said is not going into the Platte River system. That is every one of the systems, because the forest, because of the invasive species, the pine beetle. In my world, I used to ride horses through the trees. You don't do that anymore. It is now pickup sticks. So gathering livestock, hunting, all the activities that we have spent our whole lives doing in the national forest are not doable. We are seeing a lack of thinning, a lack of controlled burns, a lack of aspen regeneration, all things that I think are doable in the context of the dollars that you have in the bills, Senator.

It was interesting, I had a call with the Imperial Valley Irrigation District, which is the southernmost part of California. When they understood that number, the 160,000-acre feet, if that were replicable on the Colorado River, they said, boy, we would be willing to invest in that, thousands of miles away. Because it is so important to understand when a forest is functioning, and the invasives haven't taken over, you have a whole different watershed reality of water in the system. As we go into the systems now that are more challenged, nothing could be more important.

Senator BARRASSO. Mr. Sanders, stakeholders are concerned with the Corps' long history of projects being over budget and taking too

long to build. Congress authorized the Olmsted Locking Dam project in 1988, $775 million. After 30 years of delays, $3 billion, the Corps of Engineers finally opened the project last year. You are smiling, you are familiar with it.

Any thoughts on how to improve the process so that water projects actually can be developed and put online more efficiently?

Mr. SANDERS. I attended the ribbon cutting last year for Olmsted. Nobody could have been happier to see it open than us. The people that have been sitting with barges behind Lock 52 and 53 for the last 30 years experiencing extreme delays in that.

Olmsted is a great example. I think it is awful easy to point fingers at the Corps of Engineers, looking at the execution of Olmsted. I think if you really dig down into it, we can all point fingers at all of us that were involved in that project over that time, and not working to get it done. And look what happened.

So the previous Administration, they finally got upset and decided to move dirt. Got it fully funded and the industry answered. They got it built ahead of time, ahead of schedule, open to the public, all the delays, just untold millions of dollars in delays that we have been experiencing at Lock 52 and 53 disappeared. They are now demolishing those, now that we have Olmsted open.

So fully funding a project is something that, it is wonderful. We need WRDA 2020, it is our mechanism for getting these projects on the street. But the Administration and the Congress has to look at fully funding these projects, and industry can deliver.

Senator BARRASSO. Let me ask a final question, Mr. O'Toole. The Forecast Informed Reservoir Operations, FIRO, is the idea that modern weather and water forecasting technology can be used to better inform decisions on when to retain and release water from reservoirs and to maximize available water storage. A pilot to test this information is currently ongoing at Lake Mendocino in California. I think there are some positive initial results.

Section 1211 of America's Water Infrastructure Act requires the Corps to submit a report to Congress identifying other candidates for use of this technique. Could maximizing the use of existing water storage, this information, forecasting information, would that benefit farmers and ranchers in Wyoming and other rural States?

Mr. O'Toole. Yes, Senator, it is really interesting, because living on a two-State river, watching the way that information comes to farmers and ranchers, is depending, really, on the system that you are watching. But I think that what we see is being able to plan ahead for letting water out, so that more water in these storms, because of the intensity that I talked about earlier, I just can't overstate the intensity piece of this, how important it is that we have both the ability to plan ahead.

I think the second part is storage, and in California, they have several projects, storage projects, online that would be designed to take that high water that comes from intense storms and save it, rather than have it go out to the ocean. So that planning capability I think is critically important.

Senator BARRASSO. Senator Carper. Thank you.

Senator CARPER. Again, thank you all for wonderful testimony. We are delighted that you are here.

Mr. O'Toole, sometimes you have said, and I will paraphrase you, you said something about understanding the volatility issue is critical, understanding the intensity issue is critical. There is an old song by Stephen Stills, Buffalo Springfield, it says, something's happening here, just what it is isn't exactly clear. What do you think is happening here?

Mr. O'Toole. Let me say first that the Family Farm Alliance wrote a paper on climate in 2007. It is the same philosophy that we have today. We realize, whether it be intensity and volatility, or whether it be growth, or whether any of the aspects that are challenging our water supply, what I think is happening here is we have run out of the easy answers. Without a new initiative and philosophy on storage, on recharge of aquifers, on understanding how the systems work, we are just not prepared either on the food side or on the population side for what is inevitably happening.

Senator CARPER. Same question for Mr. Brockbank.

Mr. BROCKBANK. We are a science-based organization, and all the science points to climate change as being the driving force in most sea level rise, increasing storm intensity. So our coasts, it is absolutely critical to do adaptation to prepare for these storms. But there is no adaptation that can be done that will withstand unabated sea level rise from climate change.

Senator CARPER. All right, thank you. Another question, if I could, for you, Mr. Brockbank. It relates to one we just had. Extreme weather events, precipitated by climate change, continue to drive up costs of emergency response in this Country. I assume the ASBPA hears about this issue regularly from coastal communities, especially those that are impacted by storms and long term by sea level rise as a result of climate change.

You touched on this, but I am going to ask you to dig down a little bit more. How can coastal communities and beach communities in particular adapt to rising seas?

Mr. BROCKBANK. Thank you. I would say two points to this. One is to make sure they are maintaining and building out their coastal defenses. When I talk about coastal defenses, you have to look at those natural systems that are intended to withstand and protect the community. So you build out a wide beach berm that reduces the wave intensity. You buildup a high dune system. That dune system can actually prevent storm surge from building in. Your back line, your communities, once they are in sort of the estuarine system, wetlands can absorb storm surge like a sponge and reduce that.

So you need to be able to maintain those beaches, the dunes, and the wetlands. The advantage to each of those, particularly a dune system and wetlands, is they are able to actually accrete, they are able to grow with sea level rise. Vegetative dunes can elevate and grow, wetlands can, if maintained, can actually grow with sea level rise.

The second point is, and this speaks to some of the work of the committee, is after a storm, it is important that these systems are not simply restored to the way they were before, but they need to be allowed to be built even better, built stronger, built to the challenges that we are facing in the coming years, not the challenges we were facing in the past years. This committee has taken some

steps to make changes to P.L. 84–99 that reflect this. But continuing to push the Corps to make modifications to projects post-storm that will allow for greater protection in the future is absolutely essential.

Senator CARPER. All right, thank you.

A different question, if I could, for Mr. O'Toole, and if we have time, for Mr. Brockbank as well. Stakeholders and sponsor collaboration within the Army Corps of Engineers is essential to solving today's water resources challenges. This helps to limit the costs of missed opportunities, promotes better planning, provides transparency and results in more fiscally and environmentally sound projects.

How can the Corps work better with stakeholders in planning and managing its projects?

Mr. O'Toole. If I might respond with a personal story——

Senator CARPER. You are like me; I love to respond in telling stories.

Mr. O'Toole. There you go. So, we met with the head of the Corps of Engineers, his name was Rock Salt. Sat with Secretary Salazar and a person working on low-head hydro storage, which became a bill that passed the entire system, signed by the President in the last Administration .

What it was, groups came together, American Rivers came together with Family Farm Alliance. And it is putting together, in my mind, the futures coalitions, where we put coalitions of people with vested interests, whether it be on the conservation side or on the production side, with plans that are long-term, plans with the resilience I talked about.

So in my view, the Corps needs to understand that there are multiple benefits and multiple needs, and how do we try to address them in a time when we have as many challenges as we have today. I hope that answers the question.

Senator CARPER. Mr. Brockbank, could you just take a few seconds, and essentially what I'm trying to get at is, how can the Corps work better with stakeholders in planning and managing its projects? Just very briefly.

Mr. BROCKBANK. So I will touch on regional sediment management, it is the concept that we need to manage sediment within a region, and that includes both the Army Corps as well as communities. Sometimes the Army Corps is dredging a project, and a local community wants that sediment. Those two communities need to be talking. One of our proposals in our written testimony was that each Corps district should have a 5-year regional sediment management plan that talks about where they are going to be dredging, where there are going to be sediment needs, and also specifically identifies all the stakeholder groups that are engaged in the sediment within that watershed or within that littoral system, so that officializes the collaboration between stakeholders and the Corps on sediment management.

Senator CARPER. All right, thanks. Mr. O'Toole, was that fellow's name Rock Salt or Rock Solid?

Mr. O'Toole. Rock Salt.

Senator CARPER. All right, thank you, for the record.

[Laughter.]

Senator BARRASSO. Senator Braun.

Senator BRAUN. Thank you, Mr. Chairman.

The topic of infrastructure across the board, roads and bridges, rail, air, shoreways, inland waterways, it is such a capital-intensive discussion. I am going to circle back to that classic thing we always grapple with here, how you pay for it. We haven't raised the user fee, gas and diesel tax, I think, since 1993. We did it back in Indiana in 2017. We can at least practically talk about how we might do things there, because we are in the context of being in the black. We have a balance sheet that, it is not hypothetical, how we would do our share of it.

User fees and general fund are kind of the ways that you generally pay for things. Both seem to lack that ingredient here, which is political will. Because everything we have discussed is going to be very expensive.

I know when the President and Schumer and Pelosi talked about infrastructure, and I started hearing trillion and two trillion, that is so disingenuous in a sense that with a balance sheet like we have here at the Federal Government, how do you pay for this stuff?

I personally think, you cited, Mr. Sanders, that bargain we get with moving things on waterways. Mr. Brockbank, you talked about all the GDP that is on our shorelines. However climate is going to paly into it, it looks like it is going to be aggravating rather than ameliorating. So I want to get some opinions on where you think States should enter into this and the private sector. Almost all States have solid balance sheets. They live with guardrails and guidelines and balanced budgets, statutes or amendments. Things work, you pay for it.

I know the private sector does, because you have the hard accountability of competition, and if you don't do things with the bottom line to where you are saving for the future and thinking about things like rainy day funds, investing in either a sinking fund or some way, we are basically here talking about it in hearings without having anything that is actually going to be feasible to put some of this to where you start moving dirt, as you mentioned.

So I would like to start with Mr. Sanders. This place is generally not known for the subject matter I just mentioned. If in fact we do keep running trillion dollar deficits, is it realistic to expect the Federal Government, where I think infrastructure ought to be the No. 2 priority, behind maybe defending the Country, and we have a portion of our budget, the mandatory spending on Medicare, Medicaid and Social Security, that just on autopilot is creating all these deficits, what is plan B in terms of actually paying for this stuff? I would like to know what your opinion is, because maybe it is something other than looking here to lead and pay for the preponderance of it.

Mr. SANDERS. Right off the top, the risk and the lack of reward in being able to be globally competitive, it is just, I think the risk is too great not to try every means possible to be able to fix our critical infrastructure. It is no secret; there are locks and dams that in a lot of cases are being held together by duct tape. Tennessee, I am from Tennessee, we are very blessed, we run a surplus in Tennessee.

Senator BRAUN. Do you see Tennessee being willing to chip in?

Mr. SANDERS. I do.

Senator BRAUN. And then do you think that the users of waterways are willing to pay more?

Mr. SANDERS. Absolutely. We use the waterways, we have grown, we have had four generations of our company and employees use the waterways. We realize how precious it is. And it is the way we make a living. We were 100 percent for the user fee increase previously. So, absolutely, I think we as users would be willing to do our part to make it happen. I think the States, just Chickamauga Lock, for instance, AECOM is there finishing that project, working on that project. It is critical to east Tennessee and middle Tennessee, the economy there.

So I think that the States should look hard and that, and it should be open. It shouldn't be anything locked in place to say, you can or cannot do something. All the stakeholders have to come together and be able and willing to do their part to get something done.

Senator BRAUN. I hope this committee does realize that we are disingenuous with the public when we do run our operation here in such a way. Because I am hoping that creative solutions involving States and the users of infrastructure start coming into play. Because to me, as a CEO and owner of a distribution and logistics company, I have more faith in that having relative emphasis, rather than grabbing out of our general fund here, that we borrow a trillion dollars a year to make it work currently. Thank you.

Senator BARRASSO. Thank you very much, Senator Braun. Senator Cardin.

Senator CARDIN. Thank you, Mr. Chairman.

Mr. Brockbank, I want to get you engaged in a discussion as to how we can have a win-win situation under WRDA, that is, projects that not only provide the economic incentives such as the maintaining the depths of our channels, but also have a positive environmental impact on cleaner water.

I give you this as way of background. Before I was elected to Congress, that is going back over 30 years ago, the sites of dredged material was the principal issue in a congressional campaign. It elected a Member of Congress, that single issue, because of the controversy over where dredged material would be located. He was opposed, the incumbent Congressman was opposed to a site. The challenger ran on that issue of the Port of Baltimore needing deeper channels.

We have come a long way since that debate. My predecessor in the U.S. Senate, Senator Paul Sarbanes, had an innovative proposal about 15 years ago, 20 years ago, which was to take a vanishing island in the Chesapeake Bay known as Poplar Island, which was at one time populated, which had been reduced to about two acres, to restore it through dredged material in a way that would become an environmental plus for wildlife and the Bay itself. Poplar Island is almost totally built out now, over 1,000 acres. It is an incredibly pristine facility, and has the total support of all the stakeholders. It is without controversy today, so much so that we now are on our second island, Mid-Bay, which has been fully funded and approved by this committee.

I say that because that is an innovative approach. There is another innovative approach that is being talked about today in regard to Blackwater Wildlife Refuge, which, as Senator Carper pointed out in his opening statement, is the restoration of wetlands is critically important to our environment. We have lost a lot of wetlands in the Blackwater Wildlife Refuge. We have found that if we used dredged material where we have lost wetlands, we can actually restore wetlands. In a pretty fast way, within one season, we have been able to do it.

It costs more money, and the challenge is, as we did with Poplar Island, we used an environmental restoration economic model rather than strictly a pure economic model. And it paid major dividends.

So my question to you, as we look at the next WRDA authorization, can you help us in how we can have those types of innovations built into our law, so that we cannot only maintain the economic importance of deeper channels and maintaining our channels, but we can also restore our wetlands and our environment?

Mr. BROCKBANK. Yes, thank you. Great question, great points. Poplar Island was one of my examples I was going to use, but you spoke eloquently to it. The ability to use dredged material to restore systems, to maintain systems, is essential. The thin layer placement that happens both on wetlands as well as occasionally placing it in near shore, in my written testimony I mentioned a location outside of Oregon where they are spreading dredged material from the Columbia River, five centimeters. That is not easy to do, to make sure that you are keeping dredged material placed at just five centimeters in the near shore, so that it can then naturally drift back up onto the beach to restore the beaches.

So that kind of innovative technique is more expensive, and I believe what needs to happen is to make sure that when the Corps is pricing out what their least cost disposal method is for dredged material, the valuation of that sand or that sediment is taken into account. So if Blackwater Refuge could use that sediment, that value that the sediment would provide to Blackwater Refuge needs to be included in the disposal cost. So that is going to create economic incentives for the Corps to actually beneficially use their dredged material, rather than just dispose of it. So it is really getting to that framework of, how do you switch from dredged material being seen as a spoil to dredged material being seen as a resource.

Senator CARDIN. The point that you are raising is critically important. We were able to that on Poplar Island by doing it first, by getting the Army Corps to put in the environmental restoration as the value, rather than the pure economic cost factors of disposal of dredged material.

I am suggesting, particularly as it relates to restoration of wetlands, we need to get that type of model developed. We may need language in authorization, in a WRDA bill, in order to be able to advance those types of projects. I would just ask if you could help us in trying to identify how we could make that a reality.

Mr. BROCKBANK. I 100-percent agree, and I look forward to working with you and your staff to make that happen.

Senator CARDIN. Thank you. Thank you very much.

Senator BARRASSO. Thank you very much, Senator Cardin. Senator Capito.

Senator CAPITO. Thank you, Mr. Chairman. Thank all of you for being here today. While we know that the Army Corps' critical mission is flood control and navigation, I do think that one of the sources of concern that I have in this Nation is the access to clean drinking water. Numerous reports and studies detail that our Nation's drinking water and wastewater needs, particularly those, are stemming from aging infrastructure.

In West Virginia, we had one report from a local newspaper that said that our State's water systems lose about 75 percent of their water in their water systems. This is an untenable situation. I think the Army Corps can play an important role here through their environmental infrastructure authorities, which can provide assistance for these water and wastewater projects.

So this is a little off of the waterways, but I think it is critically important, obviously, to all of us.

Mr. O'Toole, I would like to ask you, in your testimony you say that water is the lifeblood of our Nation. I have heard some of your testimony saying that storage, rather than just running it off, keeping it, is a valuable resource. Of course, over in my State of West Virginia, we have abundant water. We would like to pipe it out to California and make a lot of money off it, but we haven't quite gotten there yet.

Anyway, you are a former State legislator, you have probably experienced this area of local communities trying to contend and keep their wastewater and water projects current. How do you see this developing over time and where do you think WRDA and the Corps might be able to be helpful with their expertise in this?

Mr. O'Toole. Yes, ma'am, thank you for that question. I can speak more clearly about personal things we have seen in our community. We have a watershed that over 30 years has had a vision. For example, we turned a desert tributary into wetland that went from 29 species to 140 species of birds.

The thing that is interesting about that, and the river restoration, the integration of irrigation and fishery that we are working on, the people that are on the land doing those projects are the people in our community who are oil and gas people, with the equipment. What we have been able to do is integrate, through using both USDA and Interior, and I think it is really important to understand how those two agencies can benefit each other, both in terms of leveraging dollars and in sort of the philosophy of maintaining agriculture and clean water at the same time. What we have seen is by bringing in the community people with the equipment, we have created an economic development boom for them.

So in the oil field in Wyoming, there are periods of time when you cannot drill because of endangered species or other stipulations. This becomes another piece of the economic development puzzle for those people to stay in business with their equipment.

The thing that we have done that I think is important, our conservation district measures every tributary in our entire system. There are a lot of people that feel maybe knowledge isn't the best thing to have. We feel like knowledge is power. Our family has had consistently the cleanest system in a watershed. We are so proud

of that. But it is because we understood that there are things you can do.

We have done some amazing stuff in our riparian areas, without any negative to our agricultural production at all, because we have enough knowledge to realize that timing of grazing and how we utilize our lands has an immediate effect on water quality.

Senator CAPITO. Right. So weaving the balance of the economy and environment are what you are seeing the results of in your State.

I am going to switch to another topic. We have a lot of locks and dams going on the Ohio River. I just went with Colonel Evers to see the de-watering of the Robert C. Byrd Locks, very exciting. But you don't get an idea of how massive these projects are until you go all the way down in a de-watered lock and look up and see the massive opening and closing sand how expensive these are, and how important it is to maintain the infrastructure that we have and then to modernize what we don't have.

I was very pleased that the Lower Mon project has been fully funded in the budget. These are, some of them, 100-year projects and very important to us.

Mr. Sanders, in your testimony you highlight both the issues with pre-construction and construction phases. How do you weave that in with balancing that with the maintenance issue that I saw when I was at the Robert C. Byrd locks on the Ohio, in terms of being able to maintain our water system and keep it viable for the economics? Particularly in the Ohio River for my State it is absolutely critical for things like coal, chemicals, grains and other things.

Mr. SANDERS. Sure. As you very well stated, the locks and dams, the communities cannot survive without the commerce being able to easily go through those dams.

Senator CAPITO. Right.

Mr. SANDERS. That is critically important, to have that consistent, we have to have a consistent funding stream that is not related to, this Victoria Bend thing that I brought up a second ago, we just got through 9 months of flooding where barges were restricted, commerce coming from your area down the Ohio to New Orleans was restricted. The water finally goes down and we have the ability to move that efficiently on the Mississippi River, and here we are sitting behind the dredging areas that need to be dredged and traffic is stopped again.

It is devastating. It really is devastating to the economy. So when the water is right, when the projects can go, we have got to be able, and I will say it again, move dirt. The money has got to be there. It is too critical; the cost is too great from a global competitive standpoint. From the environmental side, the clean water side, there is nothing better for the environment that moving commerce in barges. It is the cleanest way of moving commerce that we have. So we have got to keep the funding consistent.

Senator CAPITO. All right, thank you very much. Thank you.

Senator BARRASSO. Thanks, Senator Capito. Senator Whitehouse.

Senator WHITEHOUSE. Thanks, Chairman. Welcome, everybody. We are getting a little tight on time, so I am going to be quite brief and simply ask you to respond to this as a question for the record,

if you have suggestions with respect to the problem that I am going to describe.

Mr. Chairman and Ranking Member, I think this is a matter that involves the whole committee. I just want to describe a few episodes.

You have heard me over and over again ask for information about the Flood and Coastal Storm Damage Reduction Account. We have asked for an explanation from the Army Corps why, over the past 10 years, the Corps has requested between 13 and 120 times more money for inland versus coastal projects. One hundred and 20 times as much for inland versus coastal is a big, big, big discrepancy. It is less than 1 percent for coastal.

I have asked for an explanation over and over again. We have never yet received an explanation. Year after year, I have asked. Year after year, they have simply ignored us.

Debris removal, we have asked to have the Corps support us in removing debris in harbor areas. They said they wouldn't do it, so we got authority in the 2016 WRDA so that they did have authority to do it. They still refused to do it.

So in the 2018 WRDA, we directed a report from the Corps on why they weren't using the 2016 WRDA authority. They had not even done the report. I sent a comment letter as recently as February. No report, no implementation guidance, no response.

On innovative materials, the 2016 WRDA included a study on the potential use in water resource projects of innovative materials, composites and things like that, that are less likely to rust. Wouldn't start the report because they said they didn't have an appropriation for it. So we, in the 2018 WRDA, said no, do the report. They haven't done the report.

On harbors of refuge, the 2018 WRDA included a request for the Corps to complete a study of the hurricane barriers and harbors of refuge in our region, so that we can get an update on whether they are safe for the traffic in and out of those ports and marine areas. They haven't even started that report from the 2018 WRDA.

So what I see here is an agency that comes to our committee that wants funding for all this great stuff and that doesn't pay a damned bit of attention to what we want to do. They think we are a bunch of chumps who throw them billions of dollars with which they get to do whatever the hell they want, whenever the hell they want to do it, without feeling any obligation to actually obey the law that we set out that requires them to do these things.

If it was one or if it was two, I would be upset. But at this point, it is essentially every damned time. What I think we need to do is set up some kind of a procedure where, when they are messing around like this and not following the law, we have a standard procedure in the committee where we call them back in here and get a darned explanation for what the heck is going on.

In court, I was a courtroom lawyer in the old days, you would do like a show cause hearing, in which you would ask the court to invite in the other party, and say, why are you not complying with this order. If you have a good reason for your non-compliance, we would like to hear it. If you are just being truculent and refusing to obey a lawful order of the court, well, then, you face some consequences.

I think we need to do something. I don't know what it is. A show cause hearing of some kind comes to mind, where members of this committee can say, here are the projects that concern me, here are the projects that the Corps is ignoring, despite repeated, in some cases, WRDA authorizations and requirements. And we have got to get some discipline into this organization. Otherwise, we are a useless committee. All we are doing is shoveling money down a spout, and people whose names we don't even know and who we have never heard of who are buried down in the bureaucracy are making the actual decisions about what gets spent where and when, and we are just ciphers.

That is not the Senator I got elected to be, not when things like harbors of refuge are at issue in Rhode Island. So if you all have thoughts about that subject, and about how we can be more effective, and how we can prevent the Corps from becoming a black hole in which all decisions are made by junior bureaucracy and none are made in Congress, then I would love to have your response to that as a QFR.

But I really want to flag it to the Chairman and Ranking Member. Because I think there is room for agreement amongst all of us on this committee that this nonsense has to end, and that when we have said something is to be come in a WRDA that has gotten all the way through Congress and passed into law, then by gum, they need to pay attention to that and do what they have been instructed to do.

Senator BARRASSO. And they have been instructed to appear here, and are scheduled to appear on October 23d. So we will have an opportunity.

Senator WHITEHOUSE. Well, this is my warm-up round.

[Laughter.]

Senator BARRASSO. Senator Van Hollen.

Thank you, Mr. Chairman and Ranking Member. Thank all of you for your testimony. Senator Cardin has covered a lot of territory important to the State of Maryland. I second all his comments about the Chesapeake Bay, the importance of Army Corps dredging for the success of Baltimore Harbor and the important connection between disposing of dredged materials, but also dealing with the habitat issues and prevention erosion, which is a win-win. So I am all in with what Senator Cardin said.

Mr. Brockbank, I would like to focus on some of your testimony here. It goes to the issue of how the Corps grades a particular proposed project, and whether that project is successful. You point out in your testimony with respect to flooding, for example, that the Army Corps will calculate the benefits derived from reduced flooding risk, but not the full recreational benefits nor any of the ecological or social benefits. So the project will not be designated to support the economy or habitat.

We have a similar issue in Maryland, I know others face this in other places around the Country, where one dimension may be measured in terms of economic benefit, but not others. So for example, commercial benefits are measured, as they should, right? So the Port of Baltimore has that.

But there are also really important economic benefits from the recreational boating industry, for example. In Maryland, it is $3.5

billion. We have an example in Anne Arundel County, Maryland, called the Rockhold Creek Channel, which is important for some commercial activity but also mainly for recreational boating, which supports that community and the livelihood of the community.

Can you talk a little bit about how we should reexamine, how we establish the cost-benefit ratio, especially on the benefit side?

Mr. BROCKBANK. Thank you. Yes, the title of this hearing is Improving Economic Competitiveness, and I think the core of what you are getting at, and what my testimony addresses, is the fact that we need to be getting more bang for the buck out of every dollar spent with the Corps. So if you are investing a dollar in flood risk management, you should be getting some flood risk management benefit, but you should also be getting economic development benefit, you should also be getting recreation benefit.

The social cohesion, the ability for a community to stay in place and health benefits provided by the recreational opportunities, all those are tangible values. Some of them are hard to quantify in economic terms, but they are actual values that are critical to a coast.

So changing that benefit cost ratio, which is a sort of blunt tool that the Corps uses to determine how projects get selected on the flood risk side, I think there need to be changes to that to either fully calculate all the economic values, and that is going to be challenging, because you are talking about putting an economic value on habitat, or putting an economic value on social cohesion, or putting an economic value on community health. Or you need to supplement that BCR with ways to incorporate value provided by the environment or habitat.

So yes, your point is well taken, and I think that BCR is too blunt a tool for a 21st century agency to be developing projects by.

Senator Van Hollen. Mr. Chairman, we put some language in the last WRDA authorization to try to provide a little more transparency in this process to allow the proponents of a project to make their case. But I think we need to go farther, both in transparency, but also reexamine this cost-benefit ratio.

Now, I agree that some of those dimensions you mentioned are hard to measure. But I can tell you what is not. It is not so hard to mention the economic benefit of the boating industry. There are clear figures on that. That is different than trying to measure the overall social impact and community well-being, which I think should be taken into account.

But there are some projects that are being denied, even though, if you look at their commercial benefit plus their recreational benefit, it is larger than a narrow view of a commercial benefit in another project. So it seems to me that when we are talking about taxpayer dollars and prioritizing those dollars, we should be investing them in a way that has the greatest economic benefit to the communities we are talking about. That is an important responsibility we have as stewards of taxpayer dollars.

So I would appreciate any specific suggestions going forward with respect to supplemental testimony or ideas any of you may have for the committee.

Senator BARRASSO. Thank you, Senator Van Hollen. Senator Gillibrand.

Senator GILLIBRAND. Thank you, Mr. Chairman.

I just want to continue where my colleague left off. I went to the field hearing in Iowa to talk about the horrible flooding in Glenwood, Iowa, and other communities. It was a perfect example of how the ratio is not working. Because it is a small populated rural area. But the farms were devastated. So we are not actually fully accounting for the value to the community and to the cost and how important agriculture is in this Country.

Similarly, in upstate New York, we have lots of small harbors, like in Oswego, that desperately need dredging for commercial benefit, but also for recreational benefit. We have Lake Ontario flooding, where these communities are being devastated because it is rural. The formula is not working.

So, Mr. Chairman, I would really love this committee to formally ask for a deep dive review of that formula and examples of projects that are being left behind because they are not being adequately valued. It is really disproportionately impacting lower population rural communities, like upstate New York, and like these farms in Iowa.

Mr. Sanders, how should the OMB benefit-to-cost ratio be changed to facilitate funding for more authorized projects, particularly low-income and rural communities?

Mr. SANDERS. Well, certainly we all need to be singing from the same sheet of music, to your point.

Senator GILLIBRAND. Yes.

Mr. SANDERS. I mean, it is kind of ridiculous for desperately needed projects to be gotten out there to build and you have the Chief's report looking at it from a one-to-one basis, then you have OMB looking at it too, and it is not taking into account, some of the things we have talked about today, which I agree with. I know that is difficult sometimes.

But to your point, I think that is a wise move to look at that. But I think at the end of the day, everybody needs to be singing from the same sheet of music and stopping the delays.

Senator GILLIBRAND. Thank you. Mr. Brockbank, could you elaborate more on the benefits that are currently not being adequately considered by the Corps and OMB when they are conducting their benefit-to-cost analysis?

Mr. BROCKBANK. Sure. For flood risk management projects, beach projects, whether it is the Hamptons or Rehoboth or Santa Monica, are assessed based on their flood risk value, and then at maximum 50 percent and no more than the equivalent of what the flood risk value is from the national economics.

So if a beach provides $100 million of flood protection and it provides $200 million of recreation, they are only going to count $100 million of that recreation, which has multiple impacts. One, it means those projects are not going to get competitively funded over other projects that are really single use, that only have flood risk value.

It also means there is no incentive to try to maximize the economic value. So if you could try to advance, you do a project that has even more economic value, there is no effort to design that. So you don't have those national economic benefits. Regional economic benefits aren't included at all. So if it is sort of helping——

Senator GILLIBRAND. That was an Iowa example. It was really, it is crippling these communities. Because to rebuild those farms is so expensive. If they can't produce, whether they are producing corn or ethanol or wheat or soybeans, it gets devastating to our overall economy.

Mr. BROCKBANK. And then of course, the ecological benefits have no value. Rockaway Beach, sea turtles nesting for the first time ever this year, no value added.

Senator GILLIBRAND. No value. So I would like a formal writing how we should fix this, and we will work on our next legislation to do that on a bipartisan basis.

My second issue, for Mr. Brockbank, I want to talk about our shorelines, because ensuring that we have healthy shorelines is really important to States like New York for tourism, recreation, economic development. And as we see increased risks because of sea level rise, and extreme weather events, we are seeing high and more damaging storm surges. It is a matter of life and death. It is a question whether our coastal communities will continue to exist as we know them.

So I would like to highlight the report that you submitted with your written testimony describing the damage prevented by the Army Corps projects that were in place when Superstorm Sandy hit the northeast. In the Army Corps New York District, coastal protections prevented an estimate of $1.3 billion in damage.

Can you speak a little more about the effect that having adequate shoreline protection can have on mitigating impacts of storm surge and flooding during major events like Superstorm Sandy?

Mr. BROCKBANK. Yes. Every time you see a dune that gets eroded by a coastal storm, that is a house that is still standing. Dunes erode and houses stand. Beaches get washed away and roads survived. It is much easier and much less devastating for communities to restore and rebuild their beaches and their dunes than restore and rebuild people's lives.

Senator GILLIBRAND. And what are out biggest barriers to implement the most effective strategies to achieve maximum shoreline protection?

Mr. BROCKBANK. Largely, it is funding. We wait until after a storm to fund flood risk management on the coast than we have been doing it ahead of time. Invest up front, you save money than investing afterwards.

Senator GILLIBRAND. Thank you, Mr. Chairman and Mr. Ranking Member.

Senator BARRASSO. Thank you, Senator Gillibrand.

Senator CARPER.

Senator CARPER. I want to say thank you. We really appreciate your taking the time to come here. For me, your comments were very helpful and very cogent. There is actually a lot of agreement among the three of you which was really helpful, very helpful.

Fortunately, my wife is from Boone, North Carolina, so I understood most of the words you were saying, Mr. Sanders.

[Laughter.]

Senator CARPER. When she goes back down there, she talks just like you.

Let me ask another question about what you just mentioned. I think it is important, and you raised the point that there seems to be a big problem with OMB to get projects moving. Mr. Chairman, you may want to ask OMB to join the Army Corps of Engineers in testifying. I would ask that you think about that.

Again, thank you all very, very much.

Mr. O'Toole. Mr. Chairman.

Senator BARRASSO. Yes.

Mr. O'Toole. If I may make one last comment, we have been talking about the Corps, and having spent 14 years getting permits for a small water project in Wyoming, the part of the Corps in the permitting part is really critical to understand. They can hold up a project for, we are at a time when we are looking at follow-through and getting projects done immediately, when needed. Even in State-funded projects, the Corps' ability to hold up the process is really important to understand. Thank you.

Senator BARRASSO. Thank you. I thank all of you for being here. Members may actually submit some written questions, some members had to head in and out. So the hearing record is going to stay open for 2 weeks. I want to thank all of you for being here. Thank you for your time, thank you for your testimony.

The hearing is adjourned.

[Whereupon, at 11:28 a.m., the hearing was concluded.]

[Additional material submitted for the record follows:]

Prepared Statement of Hon. James M. Inhofe, U.S. Senator from the State of Oklahoma

Mr. Chairman, thank you for holding this hearing to hear from the stakeholders who build and use our Nation's water infrastructure.

I want to take a moment to speak about the MKARNS the McClellan-Kerr Arkansas River Navigation System—which goes from Tulsa, Oklahoma, through Arkansas, reaching the Mississippi River. A Marine Highway route for waterborne commerce, the U.S. Department of Transportation upgraded the MKARNS in 2015 from a Connector to a Corridor route due to sustained, increased traffic volume. The MKARNS supports economic activity across a 12-State region, moving 10.9 million tons of commerce worth $3.5 billion annually.

MKARNS, the most western warm water port in the United States, is a vital corridor for agriculture commerce. Farmers and ranchers rely on the port's availability year-round to move crops to market in all seasons and transport fertilizer domestically in preparation of the growing season each year. Intermodal facilities at ports along the MKARNS streamline the transfer of agricultural and other commodities through landside infrastructure onto barges for their efficient movement down to the Gulf of Mexico and beyond.

With our Nation's surface land transportation networks experiencing increased congestion, we must expand the capacity of our inland waterways to move additional freight in a cost-competitive manner. However, we face some significant hurdles in doing so.

Today, the MKARNS is facing $225 million backlog in "critical" maintenance project needs. A maintenance project deemed critical

means that if the needed maintenance is not completed, there is a 50 percent chance of failure. Specific project in need of critical maintenance include: replacing Tainter gates at multiple locks throughout the system and repairing decade's old concrete structures with exposed rebar integral to dam operability. Should any one of these critical maintenance projects fail before it can be addressed, use of the whole system would be impossible.

Unfortunately, we already know the impact to Oklahoma if use of the MKARNS is not an option. Due to the terrible floods in Eastern Oklahoma this past May and June, tons of silt was deposited in the navigation channel of the MKARNS, necessitating the redredging of the navigation channel, an effort that likely will not be complete until this November.

As such, not a single barge has moved from the Port of Catoosa in Tulsa, Oklahoma since May 13. For 4 months and counting, the economic engine for 12 States has been silently impacting every stakeholder dependent on the MKARNS. Hundreds of people have been temporarily laid off as small businesses and manufacturing facilities have been forced to idle production or shift resources to pay for more expenses means of transportation.

That is 4 months on one part of the system. Imagine the economic impact if Congress fails to address the critical maintenance backlog on the MKARNS, or any other part of the inland waterways system, and this happens again.

So what can we do? We can make it easier to address the aging infrastructure and critical maintenance of our Nation's inland waterways system by reducing needless environmental reviews and costly repetitive permitting requirements imposed by numerous Federal agencies.

I was proud to support President Trump's Executive Order to create a "One Federal Decision" process for environmental reviews and authorizations for major infrastructure projects. Earlier this year, the Environment and Public Works Committee codified the president's "One Federal Decision" process for major surface transportation infrastructure projects in the America's Transportation and Infrastructure Act of 2019. We should extend those permitting reforms to inland waterway infrastructure projects. Today, multiple Federal agencies create and review endless reams of paperwork, delaying the start of any project to address the critical maintenance needs of our inland waterways. With "One Federal Decision" we would accelerate project delivery, allowing for the review, permitting, and approval processes to be conducted more efficiently, saving time and money when starting new infrastructure projects.

I look forward to working with my colleagues to ensure we address the critical maintenance backlog facing the inland waterway system in the next Water Resources and Development Act legislation.

CENAD-PD-P, Economics 19 November 2012

MEMORANDUM FOR RECORD

SUBJECT: Damages Prevented by Corps Projects, Hurricane Sandy

Tropical, Extratropical Storm ("Super Storm") Sandy struck the east coast of the United States at the end of October 2012, with impacts occurring within USACE North Atlantic Division (NAD) boundaries on October 29 and 30. All five NAD districts were impacted by the storm, and areas within New York District (NAN) were subjected to extensive damages. Super Storm Sandy has become the storm of record in many locations along the Atlantic coast of New York and New Jersey with respect to storm surge, wave height, and duration. Storm intensity was greatest along the shorelines of northern New Jersey and southern New York City. At the Battery, the southern tip of Manhattan, storm surges exceeded the historical record by three feet. Wave gauges in New York Harbor measured the largest wave ever recorded there (35 feet). The barometric pressure for Sandy was the lowest ever recorded in the region.

When a storm affects Corps civil works districts, district economists compile damages prevented by Corps projects by producing an estimate of what damages would have been if the Corps project had not been in place and subtracting from that the damages, if any, that occurred with the project in place. The damages prevented estimate for NAD projects from Super Storm Sandy is $1.9 billion, with the greatest proportion of these damages prevented attributable to projects in coastal New York and New Jersey, where the storm's impacts were the strongest. A district by district breakdown of estimated damages prevented is provided below.

District	Estimated Damages Prevented
New England	$ 31,252,000
New York	$ 1,363,731,000
Philadelphia	$ 259,110,000
Baltimore	$ 159,658,000
Norfolk	$ 90,779,000
SUM	$ 1,904,530,000

Estimating damages prevented is both art and science in that a damage prevented is one that has not happened so it cannot be directly observed. Furthermore, damages prevented are not the same thing as the National Economic Development (NED) benefits estimate on which the project is justified for authorization. The NED concept limits the benefit pools for coastal projects to depreciated values of real and personal property. While other damage categories, for example, delay costs or labor market losses are sometimes considered in Corps study efforts, the simplest way to justify a project is on the basis of depreciated replacement value of structures. With limited study resources, Corps planners usually focus on compiling gains in that category when seeking benefits data to be used for project justification. This occurs to the detriment of other real benefits that are less straightforward to measure, such as the protection of physical infrastructure like roads, water, and electric lines.

Determining Project Performance
Performance of the Corps' constructed coastal storm damage reduction projects depends on a number of factors: Storm intensity at the project location, project design, and its pre-storm condition. These considerations are taken, in turn, below.

Storm Intensity
While this was considered approximately a 25-year event in Baltimore, the intensity of the storm in northern New Jersey and New York City well exceeded that of a 100-year event and, in many areas, was closer to a 500-year event in terms of water surface elevation--one of the main determinants of damages in a coastal storm. Indeed, in New York District, the design level of all of the projects was met or exceeded. This explains some of the variation in the damages prevented estimates and damage assessments among the districts.

Project Design
Design of project is another factor that helps to determine the level of damages prevented. While a project may be "designed to an x-year level," the logical question to follow is "Level of what?" For example, there are several projects designed and constructed in the 1970s that do not include dune features because they were designed to protect against erosion, not against storm surge.

Condition of the Project Prior to the Storm
Many coastal projects require the repeated placement of sand (re-nourishment) to keep them at or near the design levels. Some projects were re-nourished to the design level at the time of the storm, while others were not. Furthermore, the design of beach nourishment features has evolved over time and projects that were designed before those designed with the benefit of experience may perform less efficiently under certain conditions.

The three factors described above help explain how damages prevented vary from district to district and from project to project within the districts--even for the same storm event. That said, the estimates themselves reinforce this explanation. The storm did not have the same intensity in all locations. The eye of the storm went over Atlantic City, in Philadelphia District, but the damages and damages prevented are concentrated in New York District – to the north and east of landfall (*i.e.*, the fourth quadrant), where storm intensity was the greatest. Beyond storm-specific factors, damages and damages avoided in New York District are far higher because those areas where the storm struck are very densely populated, comprised of several homes on small lots placed close together. Many also were used commercially, so more damage would be incurred than in a less crowded area.

Estimates of Damages Prevented
In all districts, the starting point for estimating damage prevented was the project authorizing report. In each district, engineering divisions made a preliminary estimate of the storm recurrence interval and indexed the damages associated with that level of storm to current values. This exercise does not take into account considerations that might change the damage pool. For instance, development is constant in many coastal areas and the without-project future condition of an authorizing report is a projection derived at one point in time made with specific assumptions that may or may not come to pass. The earlier the report was prepared, the more

likely it is that subsequent events have altered current conditions from those predicted when the report was written. In many cases, the authorizing reports underpredict damages that would have occurred if the project had not been in place. This possibility, compounded by the fact that Corps reports generally focus on a relatively narrow definition of damages avoided, makes it so that this prediction of damages avoided should be considered biased downward, if at all.

A Note on Areas that had Extensive Storm Damages

There is some difficulty in developing a credible estimate of damages prevented in areas where there were significant storm damages. This was particularly true for the estimates provided for New York District where the design level of all projects was met or exceeded. It must be remembered that the estimate of damages avoided does not preclude the fact that there may have been damages in an area where a project did exist, but that such an area would likely have fared much worse but for the project. For example, in areas of extensive overtopping, significant amounts of sand and water were transported landward and caused damage to many of the residential and commercial buildings behind the project. Although there was significant damage in these areas, the projects provided some benefit in the form of protection against wave attack as the sand absorbed the wave impacts, which limited to amount of pounding to which inland structures and infrastructure were subjected. In the absence of a project, in addition to inundation, there also would have been erosion of the immediate shorefront area and waves breaking immediately upon the shorefront infrastructure. In such cases, the sand absorbed the brunt of the storm, and protected the immediate infrastructure along the coast, leaving infrastructure to which to return.

Because determining what might have happened is particularly difficult in such areas, damages prevented estimates were based on the replacement value of infrastructure that remained protected that would not have, were it not for the project. This appeared to be the most credible way to count damages avoided, as the district had clear evidence that such infrastructure would have likely been destroyed in the absence of the project.. A breach was formed in Mantoloking, which abuts the Sandy Hook to Barnegat project area but does not have the benefit of a Corps project protecting it. The Mantoloking breach cut off the road and disrupted the infrastructure that the road protected. Damages avoided by the Sandy Hook to Barnegat project are the damages to the roadway and associated infrastructure that would likely have occurred were the project not in place. This approach was also taken for the Fire Island to Shores Westerly Project, and the East Rockaway to Rockaway 934 project.

Telling the Story of Damages Prevented – Coney Island and Sea Gate

The Coney Island Coastal Storm Damage Reduction Project performed well during the storm. As a result of the surge height and wave effects, sand was transported up and over the boardwalk; however, the impacts behind the constructed project were minimal. The project was designed to protect against storm surge and erosion, and has a top elevation of +13 ft NGVD. The project was at its design level prior to the storm. The Seagate area, immediately adjacent to Coney Island, was not included in the project, and suffered extreme damages.

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The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA

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As exposure to coastal hazards increases there is growing interest in nature-based solutions for risk reduction. This study uses high-resolution flood and loss models to quantify the impacts of coastal wetlands in the northeastern USA on (i) regional flood damages by Hurricane Sandy and (ii) local annual flood losses in Barnegat Bay in Ocean County, New Jersey. Using an extensive database of property exposure, the regional study shows that wetlands avoided $625 Million in direct flood damages during Hurricane Sandy. The local study combines these models with a database of synthetic storms in Ocean County and estimates a 16% average reduction in annual flood losses by salt marshes with higher reductions at lower elevations. Together, the studies quantify the risk reduction ecosystem services of marsh wetlands. Measuring these benefits in collaboration with the risk modelling industry is crucial for assessing risk accurately and, where appropriate, aligning conservation and risk reduction goals.

Coastal flooding causes a significant amount of economic damage globally[1]. In 2012, Hurricane Sandy hit the northeastern coast of the USA causing devastating flooding and became the second costliest hurricane in USA history[2]. The damage from storms in the northern Atlantic like Hurricane Sandy is largely caused by storm surges and is aggravated due to growing population, increasing urban development and rising sea-levels[3–5].

As the frequency and costs of flood damage from storms continue to increase, there is an imperative for a suite of strategies for risk reduction that are both physically sound and cost-effective[6–9]. This includes nature-based solutions that use natural ecosystems like wetlands and reefs[10]. Coastal ecosystems can – and often do – provide coastal protection but their ability to deliver these services is often undermined by direct human impacts and climate-change related stresses[11,12]. Further damage or loss of these ecosystems will aggravate coastal risk[13]. Over the past century parts of New Jersey such as Barnegat Bay have lost more than 25% of their salt marshes to infilling and development, though this loss has been limited since the 1970s by the New Jersey Coastal Wetlands law[14]. Structural defence measures like shoreline armouring can prove very costly as sea-levels rise[9] and often damage nearby ecosystems[15]. Hence, there is growing interest in risk reduction measures that include natural ecosystems and simultaneously support conservation efforts[16–18].

There is strong evidence that coastal ecosystems reduce wave energy and can also reduce inland flooding depths during storm surge events by providing resistance to the flow of water[19–22]. Observations of coastal water levels during Hurricanes Katrina (2005) and Wilma (2005) show that intact mangrove wetlands reduced surge heights by up to 9.4 cm/km inland[23]. Numerical models have shown that mangroves are better at reducing surge heights during faster moving storms (~40 km/hr). It has also been shown that this reduction varies non-linearly with wetland size. The majority of the surge or wave height reduction is achieved in the first few hundred metres, with the reduction extent decreasing exponentially after that[24,25]. There are a number of field and numerical studies that illustrate the capacity of mangroves for wave and surge reduction[26,27], though relatively fewer such studies exist for temperate wetlands like salt marshes. However, numerical and field studies suggest that temperate wetlands also have high potential for storm surge reduction[28,29]. For example, a field study in a large salt marsh along the Western Scheldt estuary in The Netherlands measured surge attenuation rates from 5 cm/km to 70 cm/km[30].

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State (State Code)	Damages: Wetlands Present ($)	Damages: Wetlands Lost ($)	Absolute Difference ($)	% Difference (total damages)
Connecticut (CT)	2,180,600,000	2,181,000,000	400,000	0.02
Delaware (DE)	228,100,000	251,900,000	23,800,000	10.43
Massachusetts (MA)	1,452,300,000	1,458,600,000	6,300,000	0.43
Maryland (MD)	15,500,000	20,000,000	4,500,000	29.03
Maine (ME)	17,600,000	17,603,000	3,000	0.02
North Carolina (NC)	9,400,000	8,800,000	−615,000	−6.47
New Hampshire (NH)	29,600,000	30,500,000	900,000	3.04
New Jersey (NJ)	14,014,600,000	14,443,300,000	428,700,000	3.06
New York (NY)	32,314,600,000	32,452,800,000	138,200,000	0.43
Pennsylvania (PA)	174,400,000	188,100,000	13,600,000	7.86
Rhode Island (RI)	72,100,000	72,400,000	300,000	0.42
Virginia (VA)	195,400,000	205,300,000	9,900,000	5.07

Table 1. State-wide wetland impacts. State-wide losses during Hurricane Sandy for two scenarios, "Wetlands Present" and "Wetlands Lost". The last column shows the state-wise difference in flood losses between the two scenarios as a percentage of the total damages for the scenario "Wetlands Present".

Simulations with idealised, representative marshes illustrate the effects of wetland continuity and bottom friction on reductions in flood heights[31]. The effect of wetlands on flooding thus depends on several other factors including storm characteristics, local topography and local landscape features. The effect of wetlands on property damages is additionally dependent on factors such as the presence and location of at-risk assets and their exposure to flood risk[32,33].

Assessing the economic value of wetlands requires estimation of their physical effect on flooding as well as the consequent effect on property damages. Though wetlands are usually included within flood models as elements providing frictional resistance to flooding, isolating their impact on overall risk and property damages is not common practice[28]. There has been little collaboration between the ecological modelling community and the risk modelling industry on measurements of the economic value of ecosystems[34,35]. Advancing collaboration between these sectors is important for ensuring that the risk reduction benefits of ecosystems are modelled and quantified in ways that meet the risk modelling industry's standards. Studies on the risk reduction services of wetlands generally use parametric and indicator-based models to estimate their costs and benefits, and usually in combination with other risk reduction measures[36,37]. However, there is a lack of high-resolution, large-scale assessments of the value of coastal wetlands for reducing property damages from flooding.

This paper aims to address this gap by quantifying the value of temperate coastal wetlands for flood risk and property damage reduction using high resolution models and databases used widely to quantify risk by the insurance sector. The work presented here can be subdivided into 2 parts. First, avoided property damages due to wetland presence are estimated regionally for Hurricane Sandy, a catastrophic storm event. Hurricane Sandy made landfall as a post-tropical cyclone in New Jersey in the USA on October 29, 2012. It caused at least 72 direct deaths in the USA and nearly $50 Billion in flood damages, and became the second costliest cyclone in USA history. The fatalities and damage from Hurricane Sandy were spread out across the Atlantic coast of the USA from Maine to North Carolina and were mostly due to storm surge flooding[2,38]. In this part of the study, the avoided damages due to wetlands during Hurricane Sandy are estimated by comparing flood heights and damages for two scenarios: a) Wetlands Present and b) Wetlands Lost. Next, the risk reduction benefits of salt marshes are examined locally on the Barnegat Bay shoreline in Ocean County, New Jersey (NJ) in terms of average annual economic flood losses. Together, the studies estimate the immediate economic benefit of coastal wetlands during Hurricane Sandy at the regional scale and provide insights into their services in reducing annual flood losses at the local scale.

Results

Regional Study: Impacts of Coastal Wetlands on Property Damage Reduction in 12 states affected by Hurricane Sandy. The study estimates that temperate coastal wetlands reduced flood heights and thus avoided more than US $625 Million in flood damages across 12 coastal states affected by Hurricane Sandy, from Maine to North Carolina (Table 1). In total, wetlands are estimated to have reduced a little over 1% of the flood damage from Hurricane Sandy though this value varies considerably between zip-codes (Fig. 1). Across the 707 zip-codes flooded, wetlands reduced flood damages by an average of 11%. Wetlands reduced flood heights and damages in 80% of the region and increased flood heights and damages in 20% of the region. In 382 of the 707 zip-codes (i.e. just over half), avoided damages exceeded 0.5% of the total. Across these zip-codes, the average reduction in damages due to wetlands was 22%.

At the state-level, with the exception of North Carolina, wetland extents were strongly correlated with avoided damages (Fig. SI 1, $R^2 = 0.8$, $p < 0.001$): higher wetland cover resulted in proportionally greater damage reduction. Among the four states with the greatest wetland cover – Maryland, Delaware, New Jersey and Virginia – wetlands are estimated to have reduced flood damages between 20–30%. North Carolina was the least affected by Hurricane Sandy. However, the one county that was flooded had higher damages due to wetlands, due to a situation with properties located between the wetlands and the shoreline (see Discussion).

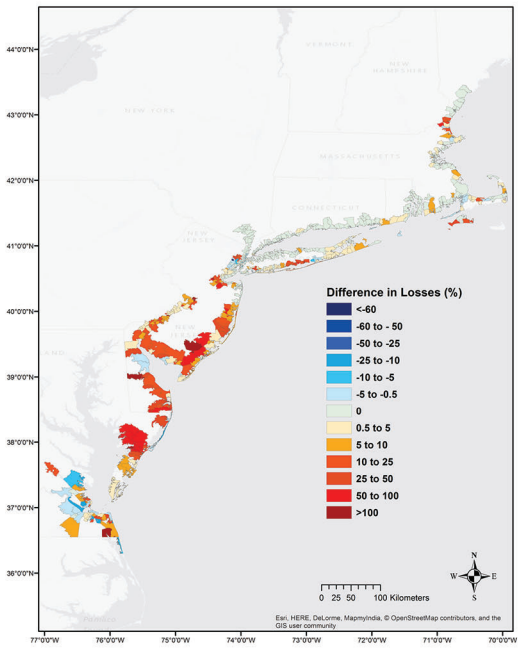

Figure 1. Regional impacts of wetlands on property damage during Hurricane Sandy. Map showing spatial variation in property damages during Hurricane Sandy if all existing wetlands were lost, as a percentage of the original damage. That is, loss differences are relative to the losses for the "Wetlands Present" scenario. Dark red areas benefit the most from having wetlands and dark blue areas, the least. Negative values indicate higher damage due to wetlands (i.e. loss reduction % is <0) and positive values indicate lower damage due to wetlands (i.e. loss reduction % is >0). The changes are shown across the 12 states on the US Atlantic coast affected by the hurricane. In the legend, '0' values refer to all areas where loss difference is $<0.5\%$ of the damage for "Wetlands Present". The map is produced with the results of the Regional Study using ArcGIS v10.4.1 software. Light Grey Canvas basemap is the intellectual property of Esri and is reprinted from Esri under a CC BY license with permission from Esri and its licensors, all rights reserved. Sources: Esri, DeLorme, HERE, MapmyIndia.

In highly urbanised areas wetlands had high absolute value despite low relative benefits. The majority of the flood damage from Hurricane Sandy (~US $46 Billion) occurred along the heavily urbanised coastlines of New York and New Jersey. In New York, where wetlands only cover 2% of the land area, they are estimated to have saved nearly US $140 Million or 0.4% of the state's total losses. In New Jersey, wetlands cover 10% of the floodplain and are estimated to have reduced damages by an average of 27% – nearly US $430 Million or 3% of the state's total losses.

Analyses of wetland benefits at higher resolutions (i.e. zip-codes) illustrate the various factors that affect wetland capacity for damage reduction. Many zip-codes with few wetlands, that are located at the upstream end of estuaries, received cumulative benefits from downstream wetlands that reduced flooding throughout the estuary.

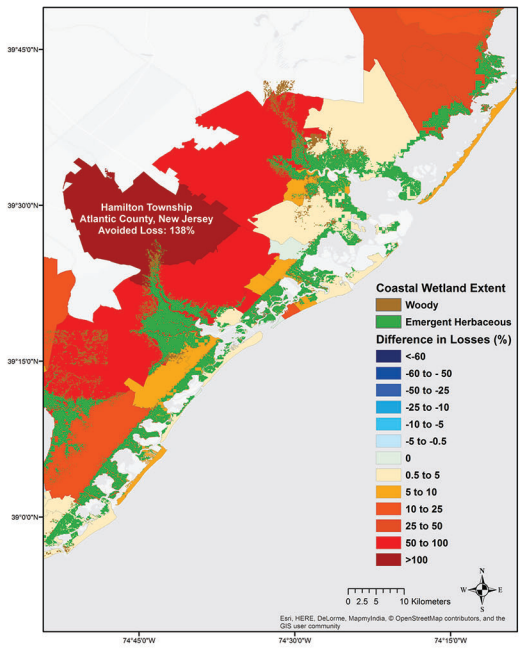

Figure 2. Upstream risk reduction effects of wetlands. Hamilton Township (dark red) would have had a 139% increase in property damages if the wetlands (green) between the township and the coastline had been lost. Here, though the township itself has very few wetlands within its boundary, it benefits from the cumulative flood reduction provided by downstream wetlands through-out the estuary. Negative values indicate higher damage due to wetlands (i.e. risk reduction is <0) and positive values indicate lower damage due to wetlands (i.e. risk reduction is >0). The map is produced with the results of the Regional Study using ArcMAP v10.4.1 software. Light Grey Canvas basemap is the intellectual property of Esri and is reprinted from Esri under a CC BY license with permission from Esri and its licensors, all rights reserved. Sources: Esri, DeLorme, HERE, MapmyIndia.

For example, places like Hamilton Township in New Jersey that have very little wetlands within their borders still saw significant damage reduction benefits from wetlands in adjacent, downstream townships (Fig. 2).

Wetlands also protected coastal roads from flooding during Hurricane Sandy (Table 2). Analyses of highways and major roads showed that wetlands reduced flood heights across 2000 km of roadways by 0.06 m on average. Maryland, Delaware and Virginia each had more than 400 kilometres of roads where wetlands reduced flood heights. Like the other wetland effects these flood height reductions on roads were highly variable. For instance, within New Jersey, wetlands reduced flood heights on roads by anywhere between 0.46 m up to 1.2 m.

Local Study: Impact of Salt Marshes on Annual Flood Losses to Properties in Barnegat Bay, Ocean County, New Jersey. In Barnegat Bay, Ocean County, locations with salt marshes had significantly

State	Length of Roads Protected (km)
Connecticut	30.26
Delaware	502.60
Massachusetts	94.63
Maryland	435.81
Maine	0.80
North Carolina	28.49
New Hampshire	40.07
New Jersey	333.13
New York	300.63
Pennsylvania	41.68
Rhode Island	17.06
Virginia	403.95
Total	***2228.94***

Table 2. Roads protected by wetlands during Hurricane Sandy. State-wide length of all major roads (i.e. highways and primary roads) where flood heights and extents were lower in the "Wetlands Present" scenario compared to the "Wetlands Lost" scenario.

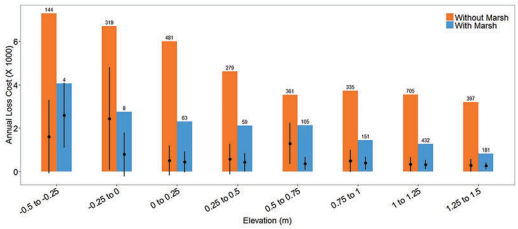

Figure 3. Annual loss costs from flooding for properties with and without marshes, by elevation class. Annual loss costs are shown for properties with marshes and without marshes, from −0.5 to +1.5 m above the NAVD88 sea-level datum. Coloured bars show the range of loss costs for each class. Black dots represent the mean loss costs and black bars represent one standard deviation from the mean. Numbers on top of each bar give the number of properties assessed. For full range of elevations see Fig. SI 3. Annual loss costs represent the losses to a property normalised by the insurable value of the property and expressed per US $1,000 (for the year 2012). Here all properties are assumed to have an insurable value of US $1,000,000. We do not show loss cost values less than 0.1 (i.e. annual losses less than $100 per $1,000,000 property).

lower annual flood losses compared to locations without marshes. Properties behind a marsh, on average, save 16% in flood losses every year compared to properties where marshes have been lost.

Salt marsh presence reduces maximum annual flood losses across all elevations. This reduction varies with elevation (Fig. 3). For properties at elevations from −0.5 m to +1.5 m relative to sea level, salt marshes reduce average annual losses by 18% on average and by up to 70% in some locations. For a very small number of locations (6 properties at −0.75 to -+0.25 m) marshes increase average annual losses. Marsh presence however still reduces maximum losses at these locations.

Elevation, on its own, predicts some of the flood risk across these locations (Fig. SI 2, $R^2 = 0.48$, $p < 0.001$). Loss costs for properties with and without marshes reduce as elevations increased (Fig. SI 3, Table SI 1). No correlation was found between distance to coast and annual risk (Figure SI 4, $R^2 = 0.0002$, $p < 0.001$).

Discussion

This paper presents a rigorous physical and economic valuation of wetland benefits for risk reduction. It demonstrates at regional and local scales the considerable role that coastal wetlands play in reducing risk and property damages from flooding. The contribution by wetlands to damage reduction was 1% of the total damage caused by Hurricane Sandy, but this still represents $625 Million in averted damages and a 11% reduction where wetlands remain. Wetlands were also found to reduce annual flood losses from storms in Ocean County by 16%. Wetland presence is one of many factors that influence flood risk; this paper highlights the utility and importance of isolating and measuring their role using industry-standard, risk modelling tools.

The benefits from wetlands in reducing flood damages depends both on their physical capacity to reduce flood extents, as well as the value of the assets they protect. Wetlands have greatest value where they are the most extensive (e.g., in Maryland) or in front of the greatest assets (e.g., in New York). The damages avoided in New York due to wetlands was 30 times higher in absolute value compared to Maryland. On the other hand, New York's total damages were reduced by only 0.4%, whereas in Maryland, wetlands reduced the state's total damages by nearly 30%. Evidence suggests that in Maryland, wetlands have high risk reduction potential in areas where they are abundant[39]. Highly urbanised areas on the other hand, are characterised by minimal wetland presence and high asset values. In these areas, despite low relative contributions to risk reduction, the few wetlands that remain can still have high absolute values[40].

In the local study, salt marsh presence in Barnegat Bay, Ocean County is shown to reduce annual flood risk by up to 70% across elevations and over a wide range of storm characteristics. These marshes also reduced the maximum annual risk to properties behind them at all elevations. The positive influence of marshes was most evident at the highest risk (i.e. lowest elevation) locations. At low elevations, areas with marshes have considerably lower numbers of properties which contributes to the lower average annual losses (Fig. 3). A better recognition of the high flood risks in these areas and thus the value of not developing over marshes can hopefully lead to more conservation and restoration[41].

These results also show the upstream benefits of wetland conservation. Townships at the upstream end of estuaries benefited from the cumulative surge reduction impact of wetlands several kilometres downstream. Even though these upstream townships often had few wetlands within their borders, their support for downstream wetland conservation and restoration could yield important risk reduction benefits. Other simulations of marsh effects in tidal channels have also shown that marsh die-off within the main channel can significantly increase flooding further up the channel[29].

While wetlands generally were shown to reduce flood damage, certain locations were estimated to have higher damages due to the presence of wetlands from effects of damming and channelisation (or redirection) of flow. Similar to artificial defences, marshes can increase water levels in front of them but reduce water levels behind the wetland[42]. For instance, properties situated between the wetlands and the incoming surge like those in Chesapeake Bay (Fig. SI 5) or northern North Carolina saw greater flood damages due to damming. Properties located at the edge of a marsh channel can also see an increase in flooding and flood damages[43]. A few low-lying locations in Barnegat Bay that had marshes in front saw higher average annual losses. Most of these locations tended to be immediately next to or within water channels and were thus more prone to flooding. These effects are observed with artificial defences; for instance, poorly designed seawalls and levees can aggravate flood damages and loss of life[44].

The regional and local studies make certain simplifying assumptions within their models. The regional study assumes that wetland loss is total and that all areas where wetlands are lost have the same friction coefficient as open water. While lost wetlands are indeed replaced by open water[45], they are often also replaced by other land uses such as housing or transportation – that might themselves provide friction to water flow and thus flood reduction (for properties behind)[46]. In these scenarios flood risk still increases because of increased exposure of assets. The local study uses a hypothetical, uniform property type and distribution to assess the influence of marsh presence on annual risk. Though this assumption does not provide information on the actual distribution of properties or their risk, it allows the isolation of marsh effects from other compounding factors such as property exposure or value. It is also important to note that these results are almost exclusively focused on private assets (except for the analyses on roads flooded). The benefits of these wetlands would increase if damages to public assets and infrastructure were more fully included. In future, these results can be combined with available damages data such as the US Federal Emergency Management Agency's (FEMA) HAZUS MH application, to assess the full extent of damages from hurricanes – and consequently, the full extent of the contribution of wetlands to damage reduction. The studies do not account for the ecological and geomorphic evolution of marsh habitats which will impact their risk reduction capacity[47]. Healthy wetlands have the ability to build land and increase elevations, so loss of these wetlands could result in a loss of land elevation which will further aggravate flood risk[48].

In the flood model, wetland presence is represented using a friction (Manning's) coefficient which is considered adequate for most situations[49]. This static friction coefficient only accounts for some of the effects of vegetation on surge. In particular, this may under-represent the relative amount of vegetation in the water column at low flood depths, leading to an underestimation of the frictional resistance[50]. For the same reason, this approach is not fully representative of the interactions between vegetation and waves. More detailed representations of these processes are needed, to provide a more complete picture of the effect of vegetation on waves[51–53].

These industry-based flood and loss models are widely used by governments and businesses across the US east and gulf coasts and in the EU and have been validated by third parties; nonetheless as in all models even better data should yield better results. The flood model performed well when validated for specific events (cf. Figs SI 6 and SI 7). No evidence of a systematic bias in modelled surge hazard was found during the model validation process, which involved extensive comparison of modelled and observed water levels at over 5,500 data points over 34 historical storm events. However, it should always be borne in mind that any small-scale inaccuracies in the data – for instance a misclassification of land cover in a given locality – can lead to inaccuracies in estimated losses at a local level. The loss model uses a damage function approach to estimate the dollar value of flood damage to individual properties. Though the damage-function approach is widely used, better and more detailed representations of the damage to structures due to flooding, wave-induced damage, debris, etc. will improve the results of this and similar studies.

These results show that coastal wetlands provide significant risk reduction services even where their distribution has been heavily impacted by human activity. Furthermore, these ecosystems provide additional benefits such as fish production, nutrient cycling, and carbon sequestration which will increase the economic value of these habitats[54]. However, across the northeastern USA, development over wetlands together with rising

Study	Purpose	Domain	Storm Event(s)	Wetland Scenarios	Key Outputs
Regional Study	To estimate savings in property damage during Hurricane Sandy due to presence of coastal wetlands	All Hurricane Sandy-impacted coastal areas of the northeastern USA	1 event: Hurricane Sandy	All coastal wetlands. Examination of damages with current wetlands ("Wetlands Present") and if wetlands were lost and became open water ("Wetlands Lost").	Flood heights and property damages for model scenarios with and without coastal wetlands.
Local Study	To compare variation in annual loss costs from many storms for properties where salt marshes have been conserved versus lost	Mainland shoreline of Barnegat Bay, Ocean County, New Jersey	2000 events: set of storms generated using historical storms between 1900-2011	Salt marshes only. Examination of loss costs to uniformly distributed properties either behind existing marshes ("With marsh") or where they have been lost ("Without marsh").	Average annual flood heights and damages for properties that are either behind a marsh or where marshes have been lost.

Table 3. Description of Model Scenarios. Names and Descriptions of wetland scenarios, domains, inputs and outputs for flood and loss model simulations for the regional (Hurricane Sandy) and local (Ocean County) studies.

sea-levels place critical facilities and infrastructure at great risk[55,56]. Rising sea-levels will further influence, and in many cases threaten, the future of these natural defences[57,58].

These results demonstrate that the risk reduction benefits of wetlands can be readily and explicitly evaluated within standard risk modelling exercises at regional and local scales. Wetlands are probably already included as land-cover coefficients within many flood models[54]. However, these habitats are typically not recognized explicitly as defences within these models and wetland-specific effects on risk reduction are not distinguished from the many other factors that influence flood risk and damages. Unlike artificial defences, which many model users (public and private) request to be explicitly modelled and evaluated at various scales[59,60], it is not yet common practice for wetland management scenarios to be assessed by industry flood risk modellers. Flood risk models and assessments by insurance providers and other private businesses have a significant influence on risk reduction measures and development choices in coastal areas[61,62]. Widespread and consistent use of such evaluations will greatly facilitate the consideration of nature-based solutions in risk management policy and practice[63–66]. Ultimately, the findings from this and similar studies can support the development and use of i) decision-making tools to assess nature-based solutions for risk reduction; ii) incentives for wetland restoration based on the value of their many services, including risk reduction and; iii) public programs to incentivize wetland conservation and restoration for coastal resilience.

Methods

Flood Risk Analysis Methodology. The impacts of coastal wetlands on flood risk to properties were examined in two ways (Table 3): (i) regionally across the entire northeastern USA coastline for a single storm event, Hurricane Sandy, and; (ii) locally for Barnegat Bay in Ocean County, NJ across several hundred storms. For all the scenarios described in these studies flood risk was estimated by a) determining the storm surge extents and peak heights for each event using a flood model and; b) the consequent losses at all flooded locations using a loss model.

The flood model is based on the Danish Hydraulic Institute (DHI) Mike-21 model, an unstructured mesh, 2-dimensional hydrodynamic model that calculates the propagation of storm surges from the coastal shelf on to land[67]. Mesh resolution is higher close to the shore and in areas of complex topography and coarser in open-sea areas where flow is more uniform. The model was forced by the wind over the domain and the tides at the open-sea boundaries. The wind field was based on the modification of a parametric wind-field model[68,69] and was calibrated using historical observed wind speeds. The flood model extends from the offshore continental shelf up to inland elevations which are well above the highest possible extent of flooding by storm surge. The bathymetry was generated using DHI's MIKE C-MAP product[70], which extracts bathymetric data from Jeppesen Marine's C-MAP Professional + digital nautical charts, a global navigational-quality vector chart database, to build the model bathymetry. Resolution was constrained by the model mesh element size, which typically reaches as low as 150 m close to the coast and in areas of high exposure. The land elevation dataset was obtained from the U.S. Geological Survey National Elevation Dataset at a horizontal resolution of 1 arc-second, subsequently aggregated to 100 m. The flood model solves the 2D shallow water equations, i.e. the depth-integrated incompressible Reynolds-averaged Navier-Stokes equations. The bed resistance to flow from coastal vegetation and other land-cover types were accounted for using a Manning's friction coefficient (or Manning's n) approach. In this approach the bed resistance, or bottom shear stress is determined by a quadratic friction law

$$\frac{\overline{\tau_b}}{\rho_0} = c_f \overline{u}|\overline{u}| \tag{1}$$

where $\overline{u}$ is the depth-averaged horizontal velocity, ρ_0 is the water density and c_f is the bottom drag coefficient, determined from the Manning's n as:

$$c_f = \frac{gn}{(h^{1/6})^2} \tag{2}$$

where h, is total water depth, n is the Manning's friction coefficient and g is gravitational acceleration. Higher values of Manning's n therefore imply greater resistance to flow due to higher bottom shear stress. Coastal land cover types were obtained from the U.S. Geological Survey National Land Cover Database. This database provides nationwide data on land cover for the USA at a 30 m resolution using imagery from the Landsat 5 Thematic Mapper[71]. Different land-cover types, classified based on remotely sensed satellite imagery, were assigned different friction coefficients[72]. Here, coastal wetlands were represented as herbaceous and woody wetlands with Manning's n values of 0.04 and 0.1 respectively, based on previous US Geological Survey guidance on selecting coefficients for densely vegetated floodplains[73] and following common practice in similar hydrodynamic models[28,72]. The maximum surge heights were interpolated on to a variable resolution structured grid with a maximum resolution of 100 m × 100 m for the areas with the highest number of properties and a minimum resolution of 5 km × 5 km for the least densely populated areas.

The loss model estimates property losses at all flooded locations. Using the computed surge heights and information from the property exposure database on the type of structure, the model applied flood damage functions to all exposed assets to estimate the total economic loss due to flooding. These damage functions were derived from observations of flood related damage compiled and developed by the US Army Corps of Engineers[74]. They describe the damage likely to a structure based on the flood height and the type of the structure. Wave-induced damages were implicitly included in the flood damage functions for specific locations known to be affected by storm waves.

Regional Study: Impacts of Coastal Wetlands on Property Damage Reduction during Hurricane Sandy. For the regional study, the flood model was run using Hurricane Sandy hydro-meteorological conditions to simulate surge extents and heights across the northeastern USA Atlantic coastline. Hurricane Sandy made landfall in New Jersey on the Atlantic coastline of the USA, after having crossed Jamaica, Cuba and the Bahamas. It was a fast-moving (~29 km/hr), extraordinarily large cyclone with a radius of maximum winds of about 1611 km (or 870 nautical miles) prior to landfall. Most of the damage from the Hurricane was from storm surge flooding[2].

For this study the flood model was run for two scenarios: (i) a "Wetlands Present" scenario with temperate coastal wetlands included as they exist today; and (ii) a "Wetlands Lost" scenario where all coastal wetlands were re-classified as having a friction coefficient of 0.02, corresponding to open water, with all other conditions unchanged. The impact on flood damages is therefore entirely due to the bed resistance effect of wetland cover on flood extents and heights.

The flood model was validated for the "Present" scenario in terms of model fit to observed water levels as well as flood extents based on FEMA inundation maps. The model shows very good agreement with tide gauge data and peak surge heights observed during the Hurricane Sandy surge event (Fig. SI 6). It has a low root mean square error of 0.61 m and a low mean error of −0.33 m, relative to the maximum observed flood heights of over 4.5 m[75]. The flood model was additionally validated for surge extents with available inundation maps from FEMA[76] (Fig. SI 7) and shows very good agreement in spatial extents and total flooded area. There is a 99.88% agreement in total flooded area between the model and FEMA inundation maps. The model over-predicts flooding in a few inland areas due to coarser resolution of the model grid in these areas.

The flood extents and heights for Hurricane Sandy were combined with data on asset locations from an insurance industry exposure database. These were input into flood damage functions to obtain the economic losses for all flooded properties. The difference in losses between the two scenarios, represents the risk reduction benefit provided by the wetlands. All losses were estimated in terms of 2012 US$. The maps of spatial variation in losses and the average loss percentage values are presented at zip-code resolution for clarity and ease of viewing.

The impact of wetlands on flooding of road infrastructure was also analysed. Flood heights from the two wetland scenarios were combined with publicly available data on primary and secondary roads in the Sandy-impacted states[77]. These roads were divided into segments and for each state, an assessment was done of the total length of road segments where flood heights are lower when wetlands are present. All analyses were done using ArcGIS v10.4.1 and RStudio v1.01.136 software.

Local Study: Impact of Salt Marshes on Annual Flood Losses to Properties in Ocean County, New Jersey. The impact of salt marshes in reducing annual flood losses from tropical storms was measured for the mainland shoreline of Barnegat Bay in Ocean County, New Jersey. Ocean County is densely populated and has lost large extents of marshes[78]. The results from the regional study show that, during Hurricane Sandy, damages in Ocean County made up 12% of the total flood damage in New Jersey. The marshes in Ocean County contributed to 36% of the estimated savings in damages to the state from wetlands. The mainland shoreline of Barnegat Bay is ideal for this test, because it contains areas that face similar levels of exposure yet vary by the presence of salt marsh along the coastline.in an alternating pattern from north to south (Fig. SI 8). This location was chosen for two reasons: (1) this is a high-risk coastline for coastal flooding, as witnessed during Hurricane Sandy,

and; (2) the coastline contains expanses of shoreline with salt-marsh present, adjacent to expanses of shoreline where salt-marshes used to exist but have since been lost to development.

To measure the protective role of these marshes the shoreline was first divided into areas with and without marshes. Next, annual flood height exceedance probabilities were estimated at all the locations for over 2000 events using the flood model. The loss model was then used to convert these flood heights into annual expected losses. Annual loss costs were thus estimated for around 5,600 properties with and without marshes. Finally, salt marsh impacts were estimated by measuring the difference in annual loss costs between properties with and without marshes. This process is explained in detail in the following paragraphs.

First, to identify areas with marshes, a two-step process was followed. The marshes were identified based on the 2011 National Land Cover Database. Then, a 'zone of influence' for each marsh was generated based on its upstream watershed. The watershed behind each marsh was delineated using the Watershed tool in ArcGIS. This delineation was done up to 5 m above the sea-level datum to capture upland regions that can potentially be flooded during a storm. Elevation data for this delineation were obtained from the New Jersey Department of Environmental Protection[79]. These data are reported in 0.3 m (1 foot) increments with a grid size of 10 m × 10 m. Generally, watershed delineation works on the principle that water flows downhill perpendicular to contour lines. Here, it was assumed that these watersheds also indicate areas in which the upland hydrology – and flood propagation – are affected by the downstream marsh. First the elevation raster was pre-processed by filling in sinks, excluding all areas greater than 5 m in elevation. Next, the flow direction was calculated for each cell of the elevation raster. Then, the marsh watersheds were delineated using the flow direction raster and assuming the marshes to contain the pour points – i.e. the lowest drainage points in the watershed. All elevations are measured with respect to the US national sea level datum, NAVD88.

After delineating the marshes and their watersheds, flood extents and heights were simulated for the entire domain using the flood model for a set of 2000 synthetic storm events. These events were generated using a large-scale North Atlantic statistical tropical cyclone track model which involves randomly sampling historical cyclone data, following the approach described in Hall & Jewson (2007)[80], to create a set of storms which are physically realistic and which are considered to span the range of all possible events which could occur[81,82]. The 2000 events considered in this study represent the subset of storms generated by the track model which impact Ocean County. Each of these events has an assigned frequency, which has been calibrated to match the observed frequency of storms in the county for the period AD 1900–2011. This approach follows a catastrophe modelling methodology widely used in the insurance sector[83]. Exceedance curves of flood heights were obtained at each location using the model. As in the regional study, the salt marshes were represented within the flood model as emergent herbaceous and woody vegetation land cover that provide frictional resistance to the flow of water. A loss model was then applied using the flood heights at each location with proprietary damage functions to estimate an expected annual loss for all flooded properties.

For the flood model, it was assumed that properties were uniformly distributed throughout the study region, with some exceptions (Fig. SI 9). The uniform property grid does not account for the land cover, when assigning property locations. Here, it was assumed that no properties exist inside a marsh, or directly on water, and all these locations were filtered out. In areas where the marshes were highly indented or fragmented, zones with no properties were determined by visual examination. The remaining properties were divided into two categories – "With Marsh" and "Without Marsh", based on whether or not they had a marsh watershed in front (i.e. between the property and the coastline). Finally, all "No Marsh" properties that were higher than the highest "Behind Marsh" property were removed, to ensure that flood risks were only compared for elevations corresponding to the marsh watersheds.

To account for the effect of property type and value on risk levels, the loss model assumed that all properties were identical structures (in this case, single-family dwellings) and had the same exposure (i.e. insurable value) of $1,000,000. The annual loss for each property was expressed as an annual loss cost. This is the ratio of the annual loss to the insurable value expressed per $1,000 units. For example, an annual loss cost of 5 implies an annual loss of $5 per $1,000 which translates to a $5,000 annual loss for a property valued at $1,000,000.

Finally, the annual loss costs for locations with marshes were compared to the loss costs for locations without marshes. In total around 1,300 properties were behind marshes and just over 4,000 properties had no marshes in front. The properties were further classified by elevation into 0.5 m intervals. For each elevation class, the loss costs for "Behind Marsh" properties were compared to the loss costs for "No Marsh" properties. The difference in mean loss costs between the two categories indicates the average impact of marshes on annual flood losses, at each elevation class. The direct relationship of annual loss costs with elevation and with distance to coast were also assessed for both categories of properties. All analyses were done using ArcGIS v10.4.1 and RStudio v1.01.136 software.

Data Availability. The topography, bathymetry and land-use datasets used in the regional and local studies are available via the sources described above. The data on asset exposure and damage functions used in the loss models are proprietary to Risk Management Solutions, Inc. (RMS) as they are developed for commercial purposes. All derived data such as differences in losses and flood heights between the two scenarios for the regional study, and flood heights and losses for the properties in the local study are available from the corresponding author on reasonable request and may be subject to a suitable Non-Disclosure Agreement.

Code Availability. The R and ArcGIS codes for analyses of the property losses by State for the regional study, and the wetland extents and annual losses for the local study are available from the corresponding author upon reasonable request.

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Author Contributions

S.N., M.W.B. and P.W. designed the studies. S.N. and C.C.S. conducted the analyses of wetland extents and effects on losses for the two studies. C.J.T., P.W. and A.G. conducted the analyses of flood and damage extents. S.N., M.W.B., P.W., C.J.T., C.C.S., B.G.R., G.F., J.C.I. and D.T. contributed to interpreting and analysing the results and writing the manuscript.

Additional Information

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The economic value of America's beaches — a 2018 update

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ABSTRACT

Travel and tourism (T&T) is America's largest employer and earner of foreign exchange, and beaches are its leading tourist destination. T&T jobs in the U.S. are difficult to offshore or automate, and their number has been growing at a rate 60% greater than overall job growth. America ran a trade deficit of $502 billion (one billion equals 1,000 million) in 2016, but T&T produced its largest trade surplus of $84 billion, including a surplus of about $28 billion with China. International tourists alone spend $245 billion annually in the U.S., which is more than the $190 billion value of the entire U.S. agricultural crop. T&T generates over $60 billion in local and state taxes that could pay the wages of every firefighter and police officer or every secondary school teacher in the country. Surveys show that beaches are by far the leading U.S. vacation destination with more day visits than are made to all national and state parks and government lands combined. However, the federal government's Office of Management and Budget (OMB) gives low budgetary priority to beach tourism and opposes beach nourishment, despite beach tourism supporting 2.5 million jobs, generating $45 billion annually in taxes, and returning $230 in federal taxes for every $1 the federal government spends on beach nourishment. In contrast, OMB gives high priority to navigation channel dredging that allows foreign products to enter the country more cheaply, costing millions of American jobs and billions in taxes. Foreign countries are increasing T&T infrastructure investments, including beach nourishment, at a faster rate than the U.S. and are grabbing an increasing share of the world market.

ADDITIONAL KEYWORDS: Beach nourishment, recreation, travel and tourism, economic development, jobs.

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Houston (1995; 1996; 2002; 2008; 2013a) highlighted the economic value of America's beaches, noting that the travel and tourism (T&T) industry is becoming increasingly dominant in economies throughout the world. However, few realize that T&T is among America's largest industries, is its largest employer, and produces its largest trade surplus. Moreover, beaches are by far America's leading tourist destination. High-technology industries grab the news, but the U.S. runs a trade deficit in these industries and their jobs are increasingly "offshored" or automated. T&T is difficult to automate or offshore and is providing economic growth, jobs, and a trade surplus that makes the U.S. competitive in a world economy. However, tourists have choices, and the U.S. is neglecting T&T tourist infrastructure investments, including beach maintenance and restoration, in comparison with competing countries. This paper updates Houston (1995; 1996; 2002; 2008; 2013a) and further supports his conclusions on the economic importance of beaches to America's economy.

T&T AND THE ECONOMY

T&T is the world's largest industry, contributing $7.6 trillion in 2016 to the world's Gross Domestic Product (GDP) and exceeding the GDP of all countries other than the U.S. and China (World T&T Council 2017a; International Monetary Fund 2017). Similarly, T&T contributes $1.5 trillion to America's GDP (World T&T Council 2017b). David Scowsill, President of the World T&T Council, said that "the U.S. is a beautiful and strong tourist destination. It currently ranks No. 1 in the world in terms of the sector's contribution to GDP." (World T&T Council 2017c). This $1.5 billion contribution represents 8.1% of U.S. output and makes it the third largest contributor to GDP behind real estate (12.1%) and manufacturing (11.7%) (U.S. Department of Commerce 2017a; World T&T Council 2017b). T&T produces $157.8 billion in annual tax revenue for all levels of government in the U.S., and without this revenue each household would pay $1,250 more in taxes (U.S. Travel Association 2017a). Local and state tax revenue of over $60 billion from T&T is sufficiently large that it could pay the wages of every firefighter and police officer or every secondary school teacher in the U.S. (U.S. Travel Association 2014). T&T in the U.S. is projected grow at an annual rate of 3.7% from 2017-2027 versus overall GDP growth of 2.2%, making it one of the economy's healthiest sectors (World T&T Council 2017b; Congressional Budget Office 2015).

T&T MEANS JOBS IN AMERICA

T&T is both the world's and America's largest employer, providing 298 million jobs throughout the world (9.7% of jobs) and 15.3 million jobs (10.4% of jobs) in the U.S. (World T&T Council 2017a; U.S. Department of Labor 2017a; U.S. Travel Association 2017b). In contrast, all U.S. manufacturing industries from General Motors to Boeing to Intel employ only 12.5 million people, having steadily lost 1.7 million jobs in the past ten years (U.S. Department of Labor 2017b). The worldwide future of manufacturing from 2016-2030 is grim with projected job declines due to automation of 32% in the U.S., 22% in China, and 36% in Japan (McKinsey Global Institute 2017). States compete to attract manufacturing, especially high-technology manufacturing, but few have policies to attract T&T businesses. However, high-tech companies have been moving manufacturing jobs overseas, and since 2004 about 85% of R&D employment growth in U.S. multinational corporations has been abroad (National Science Foundation 2012).

Not only are manufacturing jobs in a long-term decline, but many service-sector jobs face "offshoring" and automation. More than 25% of American service-industry jobs are at risk of being

Figure 1 (right). T&T is America's leading employer and has a job growth rate that is projected to be over 3.5 times greater than the average for all jobs.

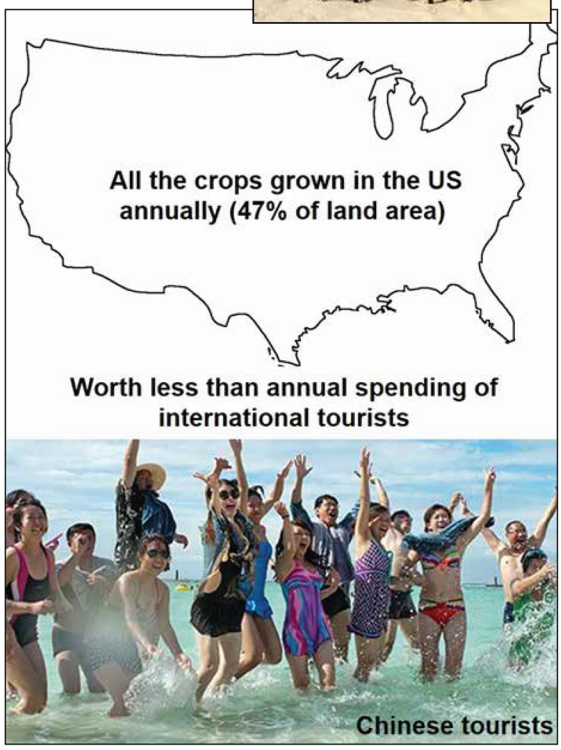


Figure 2 (below). The annual value of the entire U.S. agricultural crop is about 30% less than annual spending by international tourists in the U.S.

offshored (Ball State University 2017), and automation is projected to reduce the number of U.S. jobs by 23% in the next 15 years (McKinsey Global Institute 2017). T&T is a rare industry where offshoring or automation is difficult. There can be intense competition among countries for tourists, but if a tourist wants to experience Venice Beach in Los Angeles or South Beach on Miami Beach, the tourist must go to Los Angeles or Miami Beach.

T&T is the No. 1 U.S. small-business employer and has grown jobs from 2010-2016 at a rate over 60% greater than the average job growth (U.S. Travel Association 2017c; U.S. Department of Labor 2017c). T&T is projected to grow jobs over the next 10 years at an annual rate of 2.5%, which is over 3.5 times the overall projected annual job growth of 0.7% (Figure 1;World T&T Council 2017b; U.S. Department of Labor 2017c). The T&T industry is sometimes said to have low salaries, but the majority of those employed in T&T "earn middle class wages or better" (U.S. Travel Association 2017b). Moreover, the first job of almost a quarter of Americans is in the T&T industry, and they eventually obtain an average career salary of $81,900, which is significantly higher than that of workers whose first jobs are in manufacturing, healthcare, or most other industries (U.S. Travel Association 2017b). Nearly 40% of workers who began their careers in T&T now earn an annual salary of more than $100,000 (U.S. Travel Association 2017c).

T&T IS KEY TO INTERNATIONAL COMPETITIVENESS

The U.S. is a major player in the international T&T industry. International tourists, who represent 10-15% of U.S. tourists and over 15% of tourist spending, spent $245 billion in the U.S. in 2016 (U.S. Travel Association 2017c; U.S. Department of Commerce 2017b). Amazingly, as seen in Figure 2, this is almost 30% greater than the $190 billion in cash receipts for all U.S. agricultural crops, which are grown on over 2 million farms that cover 47% of the area of the continental U.S. (U.S. Department of Agriculture 2017a, b). Moreover, spending by international tourists is an export and is greater than the combined value of exports in the main areas where the U.S. has significant exports – all agricultural products, aircraft, industrial machinery, and medical equipment (Figure 3; U.S. Department of Commerce 2017a; U.S. Census Bureau 2017a). The U.S. ran a trade deficit of $502 billion in 2016, but T&T produced a trade surplus of $84 billion with international tourists spending more in the U.S. than U.S. tourists spend abroad (U.S. Department of Commerce 2017c; U.S. Census Bureau 2017b). This trade surplus is almost $15 billion more than the combined surplus in the main areas where the U.S. has significant exports (Figure 4). The U.S. ran huge 2016 trade deficits with China, Japan, and India of $347 billion, $69 billion and $24 billion respectively, but ran T&T surpluses with them of $27.6 billion, $11.8 billion and $10 billion respectively (U.S. Department of Commerce 2017b, d). China had the world's largest tourism trade deficit of $216.7 billion in 2016, whereas the U.S. had the world's largest tourism trade surplus (World Tourism Organization 2017). China is the world's export champion, but

the U.S. is the world's tourism champion. China sees the need to grow its tourism industry to offset its large tourism deficit, and it spent over 30% more than the U.S. on infrastructure investments in 2016 to attract international tourists (Statistica 2015).

International tourists visiting the U.S. produced estimated tax revenues in 2016 of $23.1 billion (U.S. Travel Association 2017c). Federal and state governments receive 52% and 33% respectively of the tax revenues generated by domestic tourists, but local governments receive only 15%, despite local governments providing most of the infrastructure that supports tourism (U.S. Travel Association 2015). Assuming the federal government receives the same percentage of taxes generated by international tourists as it does from domestic tourists, it received $12 billion in taxes from international tourists in 2016.

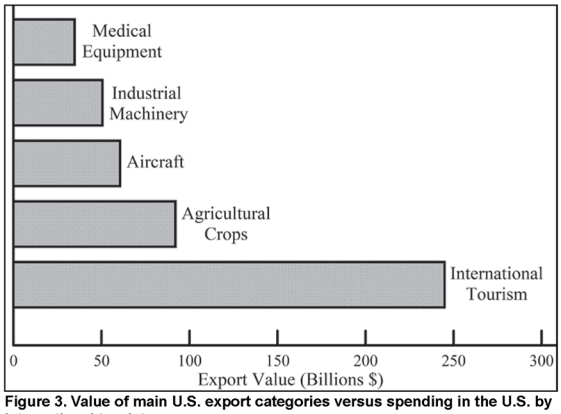
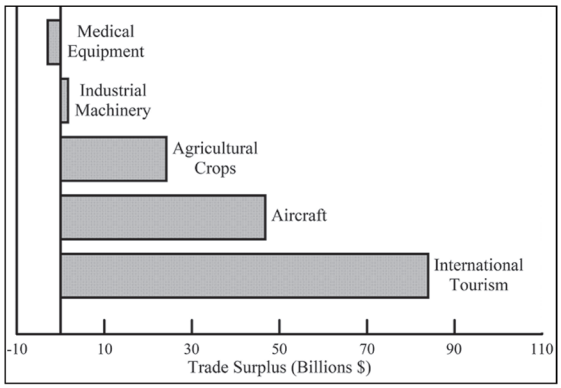


Figure 3. Value of main U.S. export categories versus spending in the U.S. by international tourists.

Figure 4. U.S. trade surpluses and deficit in the categories in Figure 3.



BEACHES ARE KEY TO U.S. T&T

Beaches are the leading U.S. tourist destination. John Morrey, general manager of Expedia.com, noted "year in and year out, travelers tell us that there's no vacation they prefer more than one at the beach. When they leave the beach, they immediately begin dreaming of their next visit" (Expedia 2016). An Expedia survey showed beaches are the most popular U.S. vacation destination, outranking historical sightseeing, visiting friends and family, theme parks, skiing, adventure sports, and spectator events (Expedia 2016). About 46% of Americans said they had taken a beach vacation in the past 12 months and 48% said they intended to do so in the next 12 months (Expedia 2016).

These results are like those of an earlier survey that found 72% of Americans expressed a favorable opinion of beach summer vacations, spent 40% of their allotted vacation days at the beach, and 52% planned a holiday at the beach in the next 12 months (ABC/*Washington Post* 2012). TripAdvisor (2017) found that 17 of the 25 most popular summer vacation rental locations were at beaches (TripAdvisor 2017). Beaches also are the world's most popular vacation destination, based on an international survey of 11,115 adults (Expedia 2016). The survey found that 56% of respondents said they had taken a beach vacation in the past year and 75% said they would likely take a beach vacation in the next year. John Morrey, said that "the beach is the world's most popular travel destination by a considerable margin" (Figure 5; Expedia 2016).

Klein *et al* (2004) performed a detailed analysis of tourism in the U.S. and concluded there was "…strong evidence for the unique quality of the coastal zone as a magnet for tourism." Although there are many interior attractions from Yellowstone to the Grand Canyon and from Las Vegas to Branson, Missouri, the popularity of beaches dominates tourism. For example, Los Angeles County beaches had 70 million day visits in 2015 (Los Angeles County 2017). This is twice as many day visits in 2016 as day visits to many of the most popular national parks as seen in Figure 6 (National Park Service 2017a). Houston (2013b) used Florida government data to estimate there were 820-million day visits to Florida beaches in 2012. This compares with 331 million day visits in 2016 to all 388 National Park Service properties, which includes national seashores and monuments and buildings such as the Lincoln Memorial, Washington Monument, and White House (National Park Service 2017a). It has been estimated that approximately 180 million Americans made 2 billion visits in 2001 to beaches (Save Our Shoreline 2001; Clean Beaches Council 2017). Assuming beach visits increased

Figure 5. Beaches are America's leading tourist destination and "the world's most popular travel destination by a considerable margin" (Expedia 2016).

in proportion to the U.S. population increase of 14.4% from 2001 to 2017, about 205 million Americans made 2.3 billion day visits to beaches in 2017 (U.S. Census Bureau 2017c, d). As seen in Figure 7, this is almost 40% more visits than the combined 1.67 billion day visits made to National Park Service lands (331 million), Bureau of Land Management lands (62 million), all state parks and recreation areas (759 million), Corps of Engineers recreation areas (370 million), and all theme parks in the U.S. (148 million) (National Park Service 2017a; Bureau of Land Management 2015; National Association of State Park Directors 2017; Office of the Assistant Secretary of the Army for Civil Works 2016; Themed Entertainment Association 2017). Moreover, many visits to state parks were visits to beaches. For example, state beaches in California account for only 2.7% of California state parks, but account for 72% of visits (King 1999).

Beaches make a large contribution to America's economy. The California Department of Boating and Waterways and Coastal Conservancy (2002) estimated tourists made 659 million day visits to California beaches in 2001 and spent $61 billion. This is 750 million day visits and $93 billion in 2016 dollars when the increase in California's population from 2001-2016 is included along with inflation (Statistica 2016; U.S. Department of Labor 2017d). Multiplying the contribution that California beach visitors make to the national economy ($93 billion) by the ratio of visitors to national beaches (2.3 billion) and to California beaches (750 million) yields an estimate that visitors to all U.S. beaches made $285 billion in direct spending in 2017. This is 28.8% of total tourism direct spending of $990 billion (U.S. Travel Association, 2017c). From section "T&T and the Economy," tourists pay $157.8 billion in taxes. With beach tourists making 28.8% of direct spending, beach tourists generate a proportionate $45 billion in taxes. Local, state, and federal governments receive $7 billion, $15 billion, and $23 billion respectively from beach tourists, using the percentages in the previous section. In addition, direct expenditures by tourists support 8.6 million jobs directly and 15.3 million jobs including direct, indirect, and induced impacts (U.S. Travel Association 2017b). Again, using the 28.8% share, beach tourists support 2.5 million jobs directly and 4.4 million jobs including direct, indirect, and induced impacts.

BEACH RESTORATION PROVIDES A STRONG ECONOMIC RETURN

Beach erosion is the No. 1 concern that beach tourists have about beaches (Hall and Staimer 1995), and it has been a concern to coastal managers in tourist areas for decades (Alexandrakis *et al.* 2015). With about 20,000 mi of eroding shoreline and 2,700 mi of critically eroding shoreline (U.S. Army Corps of Engineers 1994), beach erosion is a serious threat to the nation's beach tourism and, therefore, a threat to the national economy.

Restoring beaches through beach nourishment can greatly increase their attractiveness to tourists. For example, a New Jersey poll in 1989 found that 74% of respondents said that the New Jersey shore was "going downhill." By 1998, only 27% thought the New Jersey shore was in decline with 86% saying that the shore was one of New Jersey's best features (Zukin 1998). The difference in perceptions from 1989 and 1998 was due to construction of what was then the world's largest beach nourishment project that extended from Sandy Hook to Barnegat Inlet, New Jersey (U.S. Army Corps of Engineers 2001).

The New Jersey beach nourishment project not only attracted millions of tourists but provided critical protection during Hurricane Sandy. Dr. Stewart Farrell, director of Stockton College's Coastal Research Center, has made measurements of New Jersey shoreline position for 25 years and reported after Hurricane Sandy: "Where there was a federal beach fill in place, there was no major damage – no homes destroyed, no sand piles in the streets. Where there was no beach fill, water broke through the dunes" (Associated

Press 2012). The *New Jersey Star-Ledger* (2012) reported that at locations on Long Beach Island, New Jersey, where there was no beach nourishment "the destruction was complete. Older homes were ripped from foundations and tossed about as the ocean met the bay." Based on a damage survey following Hurricane Sandy, Barone *et al.* (2014) concluded that "the presence of maintained federally designed beach nourishment projects including engineered dunes played a significant role in protecting landward structures and infrastructure as the projects absorbed the impacts of the storm waters." Long Beach Township, NJ, Mayor Joseph Mancini, said that had a Corps of Engineers beach nourishment project been in place at the Township prior to Hurricane Sandy (as were projects at adjoining townships that were damaged substantially less), damage at the Township would have been reduced by a remarkable $500 million (*New Jersey Star-Ledger* 2012).

Miami Beach is an example of the economic benefits of beach restoration. Miami Beach had virtually no beach by mid-1970 (Figure 8). As a result, facilities were run down and by 1977 *Time* (1977) magazine reported that "so rapidly has the seven-mile-long island degenerated that it can be fairly described as a seedy backwater of debt-ridden hotels." Beach nourishment from 1978 to 1983 rejuvenated Miami Beach and opened its beaches to the public (Figure 9). Beach attendance, based on lifeguard counts and aerial surveys, soared from 8 million in 1978 to 21 million in 1983 (Wiegel 1992). Klein and Osleeb (2010) noted that tourist spending at Miami Beach increased by 56% or $290 million in the year after completion of the beach nourishment project. This increase was more than five times the $51 million cost of the 1978-1983 beach nourishment (Wiegel 1992). Beach nourishment transformed Miami Beach with visitors to the Greater Miami area in 2016 identifying beaches as Miami's most liked feature and 77.5% visiting its beaches (Greater Miami and the Beaches 2017).

It is insightful to compare the cost of beach nourishment at Miami Beach with benefits. The total cost of beach nourishment at Miami Beach from 1978 to 2017 was about $168 million in 2017 dollars, and the federal share was about 50% or $84 million (Western Carolina University 2017; Miami-Dade County 2017). This cost is spread over 40 years, so the federal cost has been $2.1 million/yr. Overnight tourists at Miami Beach spent $14.2 billion in 2016, including $8.6 billion spent by international tourists (Greater Miami and the Beaches 2017). Therefore, international tourists at Miami Beach make an annual direct contribution to the economy that is about 4100 times the annual federal cost of $2.1 million.

The $4100 in foreign exchange for every $1 of the federal share of beach nourishment contrasts with the U.S. corn crop trade surplus of $11.0 billion that was supported with $4.5 billion in crop subsidies in 2017, yielding a return of $2.44 in foreign exchange for each $1 of federal subsidy (Congressional Budget Office 2017; U.S. Census Bureau 2017a). International tourist spending at Miami Beach produces a greater foreign exchange minus subsidy than the U.S. corn crop. But as seen in figure 10, corn was planted on 142,000 square miles of land (U.S. Department of Agriculture 2017c) and used large quantities of non-renewable resources such as fossil fuels and fertilizers, whereas spending by international tourists was within the

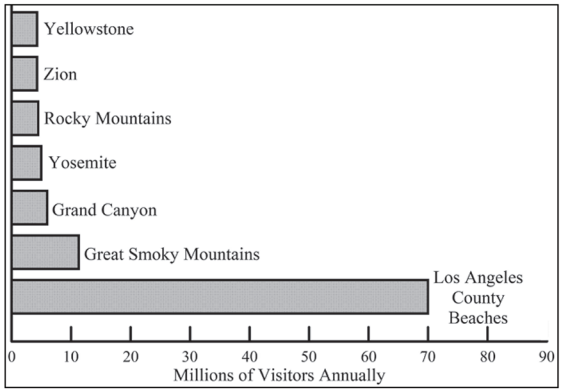


Figure 6. Day visits to Los Angeles County beaches compared with day visits to major national parks.

Figure 7. Day visits to U.S. beaches compared with day visits to parks and lands.

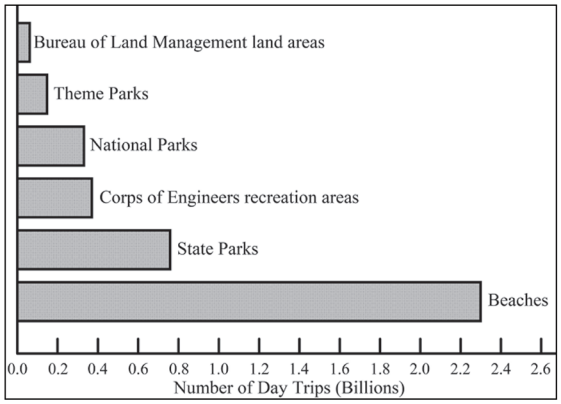


Figure 8 (below). Miami Beach in mid-1970s.

Figure 9 (right). Miami Beach today.

25 square miles of Miami Beach and used comparatively little nonrenewable resources, making tourism very sustainable.

Miami Beach also provides a remarkable return on investment to the federal government in the form of tax revenue. Out-of-state tourists to Florida had $108.8 billion in direct expenditures and generated $13 billion of tax revenue to the federal government in 2015 (Tourism Economics 2016). The number of tourists increased 5.9% from 2015 to 2016 (*Orlando Sentinel* 2017), so these tourists spent about $115.2 billion and generated $13.8 billion of federal taxes in 2016. The $14.2 billion that tourists spent at Miami Beach in 2016 was 12.3% of Florida tourist expenditures, and so it generated a proportionate $1.7 billion in tax revenue to the federal government. Therefore, for every $1 that the federal government spent on beach nourishment at Miami Beach ($2.1 million annually), it received $810 in tax revenue from tourists at Miami Beach. International tourists account for about 61% of total spending at Miami Beach, so they generate about $1 billion annually in tax revenues to the federal government.

It is revealing to compare the national investment in beach nourishment versus tax revenues generated by beach tourists. Currently the federal government spends about $100 million annually on beach nourishment (Alden Street Counseling 2017), and local and state governments pay 50% of costs, accounting for another $100 million (U.S. Army Corps of Engineers 2003). As shown in the previous section, beach tourists generate about $7 billion, $15 billion, and $23 billion annually in local, state, and federal taxes respectively. Figure 11 compares the cost of beach nourishment with taxes generated by beach tourists. For every $1 spent on beach nourishment, $230 in federal taxes are generated by beach tourists.

OMB HINDERS BEACH NOURISHMENT

The American Shore and Beach Preservation Association said in Congressional testimony that "for the past several years, the White House Office of Management and Budget (OMB) has produced an annual attack on the Federal Beach Nourishment Program." (U.S. Government Printing Office 2006). Regardless of the party in the White House, OMB has opposed federal spending on beach nourishment since about 1980. OMB's opposition appears based its beliefs that recreation is not a national priority and recreation is the primary benefit of beach nourishment. However, this is outmoded thinking because recreation drives tourism, and tourism is one of the fastest growth sectors of a modern economy (Deloitte 2018).

Water resource development is guided by principles and guidelines that say the objective of the development is to contribute to national economic development (U.S. Water Resources Council 1983). However, in the case of beach nourishment by the Corps of Engineers, OMB takes the unconventional and inconsistent position that any new economic activity within a beach community can only occur at the cost of economic activity elsewhere in the nation. Therefore, there is no net national economic gain due to restoring a beach (Robinson 2002). OMB says that if one beach disappears, tourists can go to another. Presumably, if all beaches disappear, tourists can play golf or tennis at the country club. However, OMB does not take the same position on other water resource projects including Corps of Engineers' port dredging and flood protection. OMB does not take the position that if one of the 99 ports in the U.S. closes (American Association of Port Authorities 2015), ships can just go to another. It does not say that the federal government should abandon flood protection because people can go to hundreds of thousands of other neighborhoods that are already protected or do not flood.

King and Symes (2003) examine OMB's assumption that people would spend money elsewhere if California's beaches were eliminated, creating no net economic or tax impact for the federal government. They show there is a significant net loss to California and the federal government from a failure to maintain California's beaches. Surveying 2,719 households, they concluded that "a significant number of beach visitors would, in fact, travel outside of California and outside of the U.S. if there were no beaches in California." They estimate that beach goers would instead spend about $3.1 billion in other states and $2.4 billion outside the U.S. Using standard techniques from the U.S. government's Bureau of Economic Analysis, they show that the unavailability of California beaches would produce annual economic losses of $8.3 billion and $6 billion to the California and national economy respectively. Their analysis also shows that for every $1 of federal expenditures on shore

protection for California, the federal government avoids tax losses of $41 to $62.

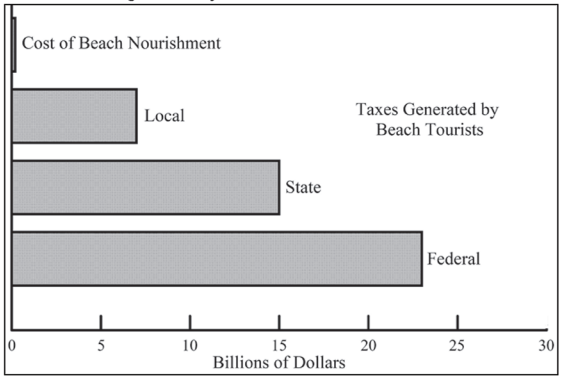
OMB also unreasonably restricts the inclusion of recreation benefits in cost/benefit calculations for Corps of Engineers' coastal projects. The California Coastal Commission (2013) notes that OMB has a policy that "recreation benefits are limited to 50% of the total benefits required for justification to ensure recreation is incidental to plan formulation." Therefore, recreation benefits must be incidental, and if storm-damage reduction benefits are less than 50%, OMB is opposed to the project.

OMB relegates beach recreation to a lower priority than navigation in the Corps of Engineers, and this is archaic thinking that contributes to America's disadvantage in world markets and costs jobs (Figure 12). For example, OMB assigns a high priority to the dredging of deeper channels in the Ports of Los Angeles and Long Beach in Los Angeles County to allow larger ships to bring in goods at lower prices. From January-October 2017, China was the main country using these ports with $151.6 billion in imports to the U.S. and only $15.1 billion in exports to China for a trade deficit of $136.6 billion — a pace that would result in a full-year 2017 deficit of $164 billion (USTradeNumbers.com 2018 a, b). This deficit is 47% of the $347 billion trade deficit with China that has cost America 3.4 million jobs and, therefore, has caused a proportionate loss of 1.9 million jobs (U.S. Census Bureau 2017e; Alliance for American Manufacturing 2017). OMB's policy subsidizes China in competition with American companies and puts Americans out of work. In contrast, OMB assigns a low priority to restoring recreational beaches in Los Angeles County, even though Chinese tourists alone spent $11 billion in Los Angeles County in 2016 (Figure 12) (*Los Angeles Times* 2017; *China Daily* 2017). Each $1 million in tourist spending supports nine jobs (U.S. Travel Association 2017b), so Chinese tourist spending alone supports 99,000 jobs in Los Angeles County.

Ninety percent of the benefits due to the beach nourishment at Miami Beach from 1978-1983 were recreation benefits, and the project would have not have proceeded had the current OMB opposition to beach nourishment been in place (Wiegel 1992). Yet, international tourists spend

Figure 10. Trade surplus minus subsidy for corn crop compared with international tourists spending minus beach nourishment subsidy at Miami Beach.

Figure 11. Annual cost of beach nourishment compared with annual local, state, and federal taxes generated by beach tourists.



$4,100 dollars annually at Miami Beach for every $1 of the federal annual cost of this beach nourishment. If Miami Beach had remained in the condition shown in Figure 8, it is not credible that 100% of the $8.6 billion that international tourists spend at Miami Beach (and $1 billion in federal taxes) would all be spent elsewhere in the U.S. As was the case for California, there are many competing beaches outside the U.S., and the U.S. would have lost billions in tourist spending at Miami Beach had the beach not been nourished.

OMB relegates beach recreation to a low priority in the Corps of Engineers but assigns a high priority to lake and river recreation projects that require far more funding for operation and maintenance than is required to maintain beaches. The Corps of Engineers (2017a) notes that "the U.S. Army Corps of Engineers is one of the nation's leading federal providers of outdoor recreation with more than 400 lake and river projects in 43 states." There are 4,628 Corps' recreation areas with 110,735 marina slips; 90,773 camping sites; 33,105 picnic sites; 2,022 playgrounds; 959 swimming areas; 3,671 boat ramps; and 367 fishing docks (U.S. Army Corps of Engineers 2013). The President's 2018 budget provides $932

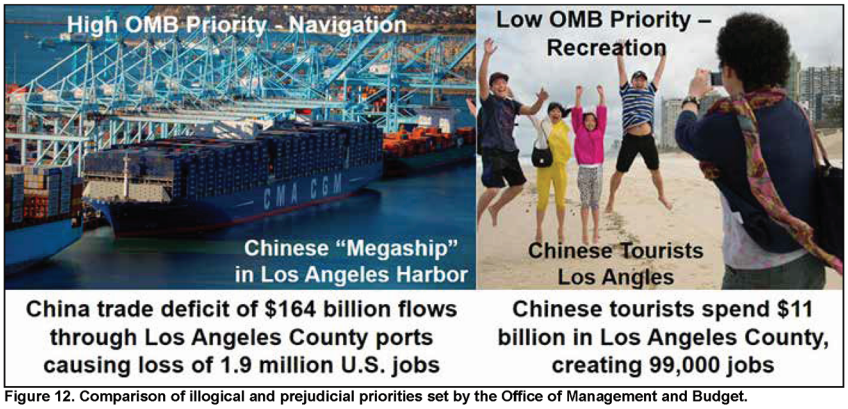


Figure 12. Comparison of illogical and prejudicial priorities set by the Office of Management and Budget.

million in operation and maintenance funding ($542 million for operations and $390 million in maintenance) for recreation facilities on about 270 Corps' lakes that were formed during construction of flood-control projects (U.S. Army Corps of Engineers 2017b).

With 370 million annual day visits and a budget of $932 million, the federal government spends $2.52 for each day visit to a Corps' lake. The National Park Service has 331 million day visits and a budget of $4.3 billion (National Park Service 2017b), yielding $12.99 per day visit. Beaches have 2.3-billion day visits and the annual federal contribution to beach nourishment averages about $100 million, yielding a cost per day visit to the federal government of $0.04 (Figure 13). If beach recreational benefits were included in Corps' projects on at least an equal footing with navigation and recreation associated with flood control, benefit/cost ratios for beach nourishment projects would be large, leading to more U.S. jobs, a decreased trade deficit, and enhanced recreational benefits for Americans.

WORLDWIDE COMPETITION FACING THE U.S.

Houston (1996) noted that America's economic competitors know full well the importance of T&T to their economies, employment, and international competitiveness. Germany and Japan have out spent the U.S. in infrastructure investment for decades, including spending freely to maintain their beaches as infrastructure investments (Houston 2013a). Spain has extensive beaches and is a major competitor of U.S. tourism. The U.S. and Spain were tied in 2016 in the number of international tourists visiting each, but Spain's tourism was up 10.3% from 2015 to 2016, whereas the U.S. tourism declined 2.4% (Figure 14; World Tourism Organization 2017). Spain ranked number one in the world in T&T competitiveness from 2015-2017, whereas the U.S. slipped from ranking fourth in 2015 to ranking sixth 2017 (World Economic Forum 2017). In the early 1990s, Spain conducted a five-year program to both restore existing beaches and build new ones, spending more than the U.S. spent for beach restoration over a 40-year period (Ministerio de Obras Publicas y Transportes 1993; Houston 2013a). Spain continues restoring beaches, placing an annual average of 13.1 million yd^3 of beach nourishment (ClimateChange-Post 2017). In contrast, despite having a coastline more than twice that of Spain, Florida has averaged annual placement of only 5.7 million yd^3 of beach nourishment (Western Carolina University 2017). The wisdom of Spain's extensive beach restoration is seen in the fact that Spain is experiencing a tourist boom with one sixth of its economy linked to tourism (Tourism Review 2017). Almost 90% of international tourists to Spain choose coastal regions for their vacations (Yepes and Medina 2005).

U.S. LOSING LEAD

In the early 1990s the U.S. was dominant in world T&T. The U.S. T&T Administration (1993) said that "there is probably no country in the world that has a greater comparative advantage in tourism than the United States." The *Wall Street Journal* (1994) highlighted the U.S. domination of world T&T, noting that the U.S. received over 45% of the developed world's T&T revenues and 60% of its profits. However, in 1996 Congress abolished the U.S. T&T Administration, whose primary function was marketing U.S. tourism internationally. The National Oceanic and Atmospheric Administration (1998) noted because of the abolishment that "the U.S. is (the) only country in the developed world without a government-funded National Tourism Office and (it) bodes badly for the country's future tourism growth."

The decline of the dominance of the U.S. T&T industry started playing out in earnest in the 1990's as America's share of the global inbound tourism market dropped from 45% to 35% from 1993 to 2005 and to 17% from 2005 to 2016 (Houston 2013a; World Tourism Organization 2017). Had the U.S. maintained its 35% share of the global tourism market in 2005, it would have had an additional $245 billion of spending and $23 billion in taxes annually from international tourists (U.S. Travel Association 2015; U.S. Travel Association 2017b; U.S. Department of Commerce 2017b).

There are many alluring tourist attractions worldwide that give consumers ample choices and produce stiff worldwide competition. If Florida beaches become rundown, European tourists can choose Spanish or Greek beaches. If Hawaiian beaches decline, Japanese

tourists can choose Australia's Gold Coast beaches that have been extensively nourished. In fact, there is evidence that international tourists are shifting away from U.S. beaches. From 2015-2016, the number of international tourist visits to Spain grew by 10.5%, whereas the number of international tourist visits to Florida dropped 5% (World Tourism Organization 2017; VisitFlorida 2017). Waikiki Beach, Hawaii, has had severely eroding beaches, and the number of day visits by Japanese tourists in 2015 was less than the number in 1990 despite an increase of over 60% in the number of Japanese tourists traveling abroad (Hawaii.gov 2017; JTB Tourism Research and Consulting Company 2017). In contrast, Australia, has many nice beaches and forecasts the number of Japanese tourists visiting Australia will increase about 50% from 2017-2025 (Tourism and Events Queensland 2017). Hawaii was spurred into action to address eroding Waikiki beaches when a study showed that if the erosion continued, there would be an annual loss in tourist revenues of $2 billion and tax revenues of $150 million (Hawaii Tourism Authority 2012).

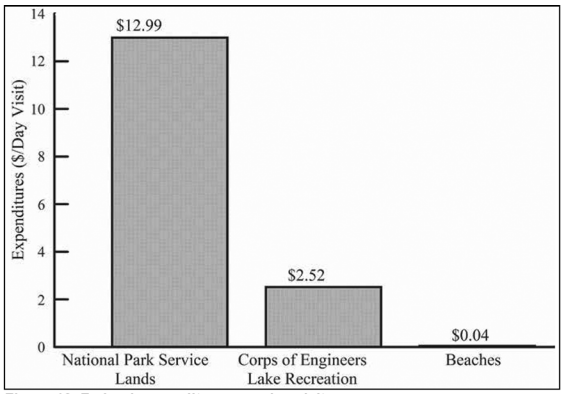
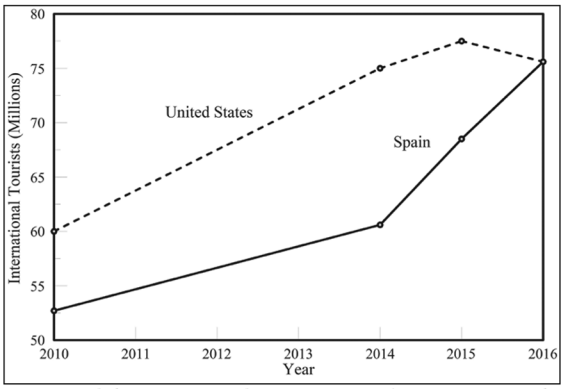


Figure 13. Federal expenditures per day visit.

Figure 14. Growth in number of international tourists visiting the United States and Spain.



THE FUTURE

The World T&T Council has found that "a very strong and positive relationship exists between T&T Investment and T&T demand" (World T&T Council 2014). It noted that the U.S. and Canada currently have good T&T infrastructure, but of the 27 countries in the Americas, only the U.S. and Canada were at risk of complacency because of insufficient plans for future investment in T&T infrastructure. Spain already has a higher T&T infrastructure rating than the U.S. (World T&T Council 2014, World T&T Council 2017d). The U.S. in 2016 was No. 1 in the world in the contribution of T&T to its GDP, T&T capital investments, and T&T export surplus. However, in projections from 2017-2027, the U.S. ranks 136 of 180 countries in the world in expected growth in the T&T contribution to GDP, 117 in T&T capital investments growth, and 124 in T&T export surplus growth (World T&T Council 2017e). The future of T&T in the U.S. is not rosy because of its insufficient projected T&T investment including maintenance of beaches. Although the U.S. has been the world's leading tourist draw, it has less than half projected leisure tourism spending growth from 2017-2027 compared to countries with few attractions such as Uganda, Tonga, Benin, and Niger (World T&T Council 2017f).

CONCLUSIONS

T&T is a key and growing driver of the U.S. economy. It is America's largest employer and earner of foreign exchange and beaches are its leading tourist destination. Maintaining beaches through beach nourishment provides a remarkable return on investment to all levels of government. However, OMB works against beach nourishment while at the same time supporting navigation channel dredging that reduces the cost of imported goods, thereby costing American jobs. OMB also supports significant operation and maintenance costs for recreation at Corps' lakes but opposes beach nourishment that supports coastal recreation at much lower costs. OMB's archaic and illogical economic policies continue to jeopardize America's competitive advantage in T&T that is led by America's beaches.

The main conclusion one draws today is the same as that noted by Houston (1995): "Without a paradigm shift in attitudes toward the economic significance of travel and tourism and necessary infrastructure investment to maintain and restore beaches, the U.S. will continue to relinquish a dominant worldwide lead in its most important industry."

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Increasing Beneficial Use of Dredged Material

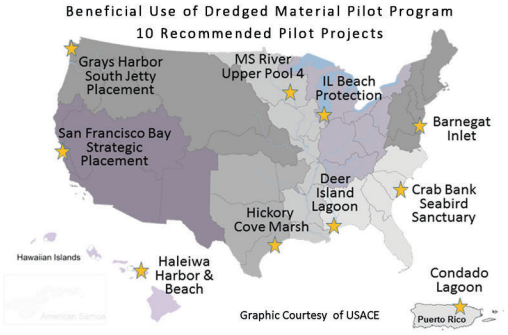
WRDA 2016 Section 1122 authorized 10 pilot projects to use dredged material from Federal navigation projects by covering 100% of the additional costs related to transportation and placement in excess of the Federal Standard.

These 10 projects exhibit multi-beneficial qualities and an opportunity to explore regional sediment management solutions.

Cardiff Beach, CA
2018 ASBPA Best Restored Beach
Recipient of Beneficial Use of Dredged Material

EXPAND the Beneficial Use of Dredged Material by:

- Appropriating $15 million for Regional Sediment Management and Beneficial Use of Dredged Material in FY20 & FY21
- Choosing an additional 10 projects as authorized in Sec. 1130 of WRDA 2018
- Streamline the process for non-federal interest to implement BUDM projects that mimic federally authorized projects.



Why support Beneficial Use of Dredged Materials?

- Reduce storm damage to property and infrastructure
- Promote public safety
- Protect, restore, and create aquatic ecosystem habitats
- Promote recreation
- Stabilize stream systems and enhance shorelines
- Support risk management adaptation strategies; and
- Reduce the costs of dredging and dredged sediment placement

Understanding Regional Sediment Management

Sediment can be adaptively managed as a RESOURCE through a WIN-WIN collaboration

- Regional Sediment Management (RSM) is a systems approach using best management practices for more efficient and effective use of sediments in coastal, estuarine and inland environments.
- Through an improved understanding of operational efficiencies and natural exchange of sediments, projects can be linked and leveraged across authorities and business lines.
- Managing sediment as a resource to benefit a region potentially lowers costs, allows use of natural processes to solve engineering problems and improves the quality of the environment.
- RSM has been shown to lead to significant cost savings, value, and benefits. All U.S. Army Corps of Engineers Districts should adopt RSM practices and budgeting.
- Breaking barriers in bureaucratic policies to allow for the beneficial use of dredged material can be integral to economic and environmental vitality.

(Learn more at: http://rsm.usace.army.mil/)

Often, the most cost-effective way to restore a beach or coastal system is to use the dredged sediment from a navigation project

asbpa
American Shore & Beach Preservation Association
Advocating for healthy coastlines

Founded in 1926, the American Shore and Beach Preservation Association (ASBPA) is a 501(c)3 nonprofit that advocates for healthy coastlines by promoting the integration of science, policies and actions that maintain, protect and enhance the coasts of America.

For more information please visit www.asbpa.org,
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