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# Benefits and Beneficiaries

of the Nation's  
Inland Waterways

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## About the Eno Center for Transportation

The Eno Center for Transportation (Eno) was founded in 1921 by William Phelps Eno (1859-1945), who pioneered the field of traffic management in the United States and Europe. Mr. Eno sought to promote safe mobility by ensuring that traffic control became an accepted role of government and traffic engineering became a recognized professional discipline. As a non-profit 501(c)(3) organization, Eno can look back on a long and proud history as a thought leader in national transportation policy with a strong training and leadership program.

The leader in its field for nearly a century, Eno provides government and industry leaders with timely research and an independent voice on policy issues. Eno publishes rigorous, objective analyses on the problems facing transportation and provides ideas for, and a clear path toward possible solutions. In addition, for nearly two decades, Eno Transportation Weekly (ETW) has been the premier federal transportation policy publication for transportation leaders across the country.

Through its professional development programs, Eno cultivates creative and visionary leadership by giving public and private transportation leaders the tools and training they need to succeed together. Since its inception, Eno has instructed over 3,500 transportation professionals.

Eno enjoys a truly unique position as the hub of a network of transportation industry leaders with a smart and dedicated staff and a solid reputation for credible, independent, and impactful work.

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## Executive Summary

The Europeans settled the United States via waterborne transportation. Settlements, and then cities, first arose where there were natural seaports. They later developed along rivers as far upstream as the boats of the time could manage. Beginning in the Jacksonian era, the federal government took on responsibility for keeping those inland waterways navigable and properly maintained.

Today, this commercially navigable waterways system, under the supervision of the U.S. Army Corps of Engineers and other federal agencies, currently extends almost 12,000 miles and transports over 500 million tons of goods annually, including bulk, oversize, and overweight commodities.

This federal support for inland waterways yields significant societal benefits in a variety of areas, completely aside from the obvious freight movement advantages. Using case studies, this report describes 14 benefit areas derived from federal support for inland waterways, grouped into three categories: (1) economic development, (2) energy and sustainability, and (3) safety, security, and resiliency.

### Category 1: Economic Development

- **Industrial property development** – Some cargo is more cost effectively moved via barge while others are too bulky for land transportation. Regardless, this cargo is frequently transferred from barge to oceangoing vessel (or vice versa) in a port, and sometimes, the end recipient is also located by the water. These areas often also have rail, highway, and sometimes pipeline connections. We look at the Port of Orleans and the surrounding area, which exports over 50 million tons of grains and legumes per year and supports almost 50,000 direct and indirect jobs.
- **Commercial property values and waterfront development** – Many cities are undergoing a redevelopment of waterfront property, reintegrating rivers into the identity of their cities. In some cases, this property is being repurposed due to waning need for industrial property, and in others, this property is simply able to be better utilized by riverfront development. Regardless, there are opportunities for massive commercial and mixed-use redevelopment to take advantage of the scenery and convenient urban locations. We examine Nashville’s “Imagine East Bank” project to redevelop 550 formerly industrial acres along the Cumberland River into a mixed-use development with community parks and a new performing arts center.

- **Residential property values** – For most waterways, an inherent side-effect benefit of maintaining navigability is flood control and the maintenance of relatively constant water levels. We examine Kentucky Lake and the adjacent Lake Barkley, dammed for inland waterway navigability but creating lakeside residential property now worth over \$125 million.
- **Jobs and community impact** – Improving waterways attracts business and creates jobs. We examine the Southern Indiana Maritime District along the Ohio River, where river-related industries support 60,154 jobs and produces over \$9 million in personal income per mile of shoreline. We look at the Port of Memphis, which supports 2.5 percent of the jobs in the county and has an economic impact of \$6.25 billion per year. And we discuss a new steel facility that is located in Osceola, Arkansas to be accessible to barge service, which has hired over 500 Mississippi County residents for high-paying jobs.
- **Tourism and recreation** – We look at the Quad Cities, where the navigation improvements of a century ago yielded tremendous recreation and tourism benefits, driving over 6 million visitors per year to the area today. We also reference broader benefits from the boating and fishing sector, the renewed popularity of domestic river cruises, and the historical importance of rivers to different cities. Many cities lining the Mississippi River, such as Dubuque, Iowa and Memphis, Tennessee maintain numerous museums and landmarks spurred from river related migration, commerce, and other activities.

## Category 2: Energy and Sustainability

- **Hydropower** – Along with flood control, hydropower is another inherent benefit that stems from building the facilities necessary to ensure that large vessels can navigate between upriver and downriver. The U.S. currently has 101 gigawatts of installed hydropower – carbon-free electricity that can be drawn at night, when solar production is impossible and wind drops off drastically – and much of it is on the controlled inland waterway system. We examine the specific benefits of inland water hydropower in the Pacific Northwest and the Tennessee Valley.
- **Irrigation** – About 80 percent of the water used in the U.S. is for irrigation, and the control of the water supply necessary to support inland waterways also helps keep water storage constant so that it is available for irrigation when needed. We examine the specific agricultural benefits along the Columbia River-Snake River system, where 350,000 acres of irrigated farmland produce enough food to feed tens of millions of people.

- **Water supply** – Just as water levels controlled for navigation supports irrigation, it also helps municipalities provide drinking water, industrial, and other public water supply for its citizens. The Mississippi River Division of the Corps manages 1.2 million available acre-feet of water storage with benefits of over \$500 million per year. Around 20 million people live in the over 120 counties that directly border the Mississippi River, who directly benefit from the river. A controlled water supply is a key part of the National Water Reuse Action Plan as well.
- **Cooling** – Water is several times more efficient than air at cooling and having a steady supply of cool water close at hand is a necessity for industries both old and new. We examine how a Google data center in Oregon and a new xAI supercomputer in Memphis cool their facilities with water made available from the inland waterways system.
- **Beneficial uses of dredged materials** – Dredging a waterway to maintain minimum depth involves scooping up solids and placing them outside the navigation channel. Fortunately, there are new and emerging uses for this dredged material other than landfills. We look at how dredged material is being used to create healthy marine habitats in the Upper Mississippi River system.

### Category 3: Safety, Security, and Resiliency

- **Transportation safety and congestion alleviation** – Although the specific benefits of waterborne freight movement are outside the scope of this study, that movement provides benefits to other modes of freight transportation. The rail and highway modes have the option of diverting some of their cargo on some routes to inland waterway barges in times of congestion. And, conversely, where existing barge traffic is disrupted, the diversion of that additional cargo to other modes would cause significant congestion and delays on those modes. We cite studies showing that diversion of all waterways traffic to trucks would increase daily truck traffic per lane on urban Interstate segments by 138 percent. And if grain barges along the Mississippi were to divert their traffic to trains, average train velocity would drop by almost 10 miles per hour due to the additional traffic.

- **Flood control** – Flood control became a central mission of the Corps of Engineers after the disastrous Mississippi River flooding of 1927, which killed hundreds and flooded a half-million people out of their homes. Today, the 13,500 miles of federal levees and floodwalls yield over \$250 billion per year in benefits. Specifically, we examine Chickamauga Dam, near Chattanooga, which has prevented over \$5 billion in flood-related damages since 1940 and provided the security which allows several of the aforementioned benefits to be enjoyed.
- **National security** – Physical control over the entrance points to the inland waterways system has always been a cornerstone of U.S. national defense, at first to prevent invasion, and later to ensure that the materiel to support American troops overseas can be shipped as quickly as possible. Much of the missile and rocketry industry settled in the Southeast because of easy waterway access, and the report examines NASA’s use of inland waterways to bring rocket components from New Orleans to Cape Kennedy. We also look at the role of river and hydropower access in the siting of the Manhattan Project and the development of Oak Ridge National Laboratory (the Oak Ridge complex consumed one-seventh of all U.S. electrical energy during World War II).
- **Global competitiveness** – The relative efficiencies of transport by inland waterway versus other modes has long been obvious. In 2022, Eno produced a study showing that other economic competitors (China, Brazil) were increasing their investment in inland waterway transport by significantly more than the U.S., hurting American competitiveness in global markets. Lagging maintenance and delayed construction on the U.S. system still persist, which particularly holds back U.S. agricultural exports.

The original federal mission was to make inland waterways safe and secure for navigation by large vessels. But the nature of the infrastructure needed to provide those navigational benefits also provided hydropower and flood control benefits at the same time in many areas, using the same infrastructure, and Congress seized that opportunity.

The combination of easy river navigational access, cheap electricity, and a controlled water levels with little danger of flooding has made possible a host of economic, energy and environmental, and safety and security benefits from the controlled inland waterways system. Many of these benefits are not directly related to the system’s core navigation function but are significant assets for the nation. But those benefits also still depend on the federal government continuing to do the maintenance work to keep the inland waterways system as a whole functioning as close to peak efficiency as possible.

## Inland Maritime Transportation System

Within the United States, there are 25,000 miles of inland waterways. Of these, 12,000 miles are commercially navigable, revenue generating miles which comprise the U.S. inland maritime transportation system (IMTS). The IMTS serves 38 states directly and includes waterways and numerous major rivers, river tributaries, and canals.<sup>1</sup> Some of these components include the Gulf and Atlantic Intracoastal Waterways and the Mississippi, Ohio, Tennessee, Missouri, and Columbia/Snake Rivers, among many others. The full IMTS map can be seen in Figure 1.

FIGURE 1: US INLAND WATERWAY MAP



Source: United States Army Corps of Engineers, 2000

The IMTS has been a vital asset for the U.S. for national security and for the movement of people and goods. During the nation's establishment, locations along the inland waterways served as advantageous positions for military forts due to the natural barriers created by the rivers for gainful positioning and the river access for the movement of supplies. Later, with the proliferation of technology in shipping, such as the steamboat, the waterways became even more critical for the movement of people and goods.

The necessity of the IMTS drew attention from state and federal officials, and during the late 18<sup>th</sup> and early 19<sup>th</sup> centuries, there was significant development of waterways infrastructure, including navigable canals, undertaken and funded at the state and national levels. In 1824, initially tasked with the mission of facilitating navigation, the

U.S. Army Corps of Engineers (USACE) took on the first waterways projects to improve safety on the Ohio and Mississippi Rivers, as well as at several ports.<sup>2</sup> Decades later, through the Rivers and Harbors Act of 1899, USACE was given the authority to regulate navigation obstructions.<sup>3</sup> Today, USACE maintains and operates the infrastructure along the 12,000 miles of inland waterways, overseeing dredging activities as well as planning, constructing, and maintaining locks and dams. These activities support the overall goal of facilitating navigation through the waterways for the safe, reliable, and economically efficient movement of vessels and cargoes.

While USACE continues to focus on enhancing navigation, the Agency's purview has expanded over time to include additional elements. Primarily concerned with the regulation of privately constructed dams for electricity production, USACE took on dam oversight in the late 1800s. Decades later, following World War I, USACE began integrating hydroelectric power production into projects where able. Around this time, the Agency also began taking on projects to mitigate severe flooding in some regions through strategies like damming rivers to create reservoirs and managing water levels along rivers.<sup>4</sup> In doing this, USACE not only created a more friendly environment for navigation, but these added infrastructure elements enhanced safety and livability along the nation's waterways. USACE continues to maintain these projects and focus on goods movement, with the added goals of outdoor recreation provision, environmental conservation, and flood risk mitigation.

## System Benefits

There are a multitude of benefits which have emerged from the IMTS. Amongst the more notable and well-documented benefits are those related directly to the movement of goods like carried tonnage and direct job creation, but the impacts of the IMTS extend far beyond these immediately linked uses. While the navigation-related, or mobility, benefits are discussed briefly, this study is focused on providing a greater understanding of the far-reaching benefits provided by the IMTS. Some of these benefits can be felt more directly within a community, like benefits related to irrigation or outdoor recreation, but many of these benefits provide an astounding impact to the nation as a whole.

## Mobility Benefits

As it pertains to goods movement, the IMTS transports more than 500 million tons of goods annually, which is equal to about 14 percent of all intercity freight.<sup>5</sup> The waterways offer a cost-effective means of transporting goods due to the fuel efficiency and carrying capacity of barges. These vessels are also a highly useful means of moving bulk, oversize and overweight commodities. In some situations, barges transport heavy security and energy equipment such as military tanks or windmill blades, but most bulk commodities being moved include grain and other agriculture products, steel, iron, petroleum, coal, aggregates, chemicals, and others.

Beyond the obvious benefits for freight movement, the IMTS and its various ports and port regions employ a vast number of individuals across numerous port-related sectors. Not only do the ports create well-paying jobs, but most ports are surrounded by industrial parks, and other similar land use zones, which rely on the connectivity and other benefits offered by the port.

## Societal Benefits

As Congress directed USACE to include other missions, such as flood risk management, recreation, and environmental protection, the agency undertook the monumental task of not only making the waterways navigable by managing water levels to facilitate vessel movements but also using infrastructure to control natural shifting of some waterways as well as water levels to decrease impacts to adjacent land from flooding. The infrastructure constructed to further these goals has served these purposes and resulted in additional benefits. These benefits have created opportunities along the country's inland waterways for non-transportation gains, able to be capitalized upon for energy, agriculture, recreation, economic development, and other uses.

While these uses are each unique and challenging to characterize comprehensively, there are numerous instances in which these additional IMTS-related benefits are present across the country. In some locations, the addition of locks and dams has enabled the generation of hydropower. In other regions, these structures have created the pooling of water sources to enhance navigability and create hotbeds of economic activity. Comprehensively, the most critical and overarching impact has been the role of infrastructure improvements in mitigating impacts from flooding, allowing for numerous types of development on waterway-adjacent land.

While the transportation uses have been covered more thoroughly in many studies, these additional societal benefits are discussed less frequently in the conversation about the U.S. inland waterways. This paper characterizes these added benefits by providing descriptions of the benefits using short case studies which serve as examples of where these gains exist within the IMTS. The case studies are not intended to be comprehensive but are geared toward providing tangible examples of how infrastructure and waterways management has transformed communities along the nation's inland waterways, providing extraordinary benefit to the environment, economy, and security of the country.

Within this study, the research team has identified 14 benefit areas which are grouped into three larger categories – all of which fall under the broad group of societal benefits. The categories and benefits are the following:

- **Economic development**
  - industrial property development
  - commercial property values and waterfront development
  - residential property values
  - jobs and community impact
  - tourism and recreation
  
- **Energy and sustainability**
  - hydropower
  - irrigation
  - water supply
  - cooling
  - beneficial uses of dredged material
  
- **Safety, security, and resiliency**
  - transportation safety and congestion alleviation
  - flood control
  - national security
  - global competitiveness

The four or more benefits included under each of these broad categories are often not exclusive to the category under which they are grouped. For example, hydropower generation is included under sustainability, but hydropower generation also creates economic impact and contributes to security and resiliency. Elements of economic impact have obvious financial links, but economic prosperity contributes significantly to national security. The inability to exclusively link a benefit to a category reflects the

overarching importance of each of these benefits and the necessity of safeguarding the infrastructure which leads to the existence of these considerable societal benefits.

## Societal Benefits

### Economic Development

Under the umbrella of the economic impact category is the array of benefits tied to the use of waterway-adjacent property. This land is appealing to a variety of users for many purposes including industrial, recreational, commercial, and residential uses. Waterway access for these properties not only provides a quick link for transportation, but the other elements like hydropower, water supply, and cooling also attract certain businesses and industries. The many types of facilities provide significant benefit to the nation as a whole, but the commonality amongst the uses of the waterway and adjacent property is the ability to develop this land.

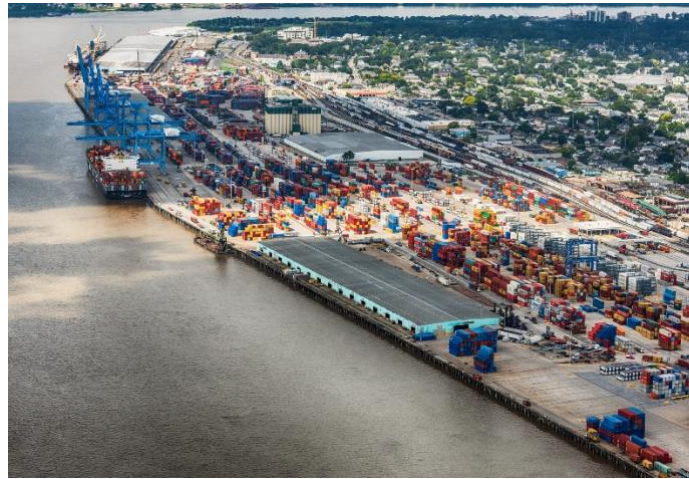
While certain regions may attract greater level of industrial development, like the New Orleans Port Region along the Mississippi River, the damming of the Cumberland River in Tennessee has enabled the commercial development of Nashville, and the reservoirs created in Kentucky have led to the lakeside communities of Kentucky Lake and Lake Barkley. When USACE undertook the task of better managing the waterways with the added infrastructure elements like locks and dams, these components not only enhanced goods movement on the IMTS, but this management brought about the sweeping benefit of decreasing risk from flooding and unpredictable water levels – creating an array of societally beneficial uses. The safe integration of the waterways into communities across the country has brought about broad economic development, largely attributable to this infrastructure, in the forms of industrial, commercial, and residential development, as well as related tourism and recreation impacts.

### Industrial Property Development

There is obvious appeal for industrial purposes in acquiring, through purchase or lease, property near an inland port. Access to the waterway can provide for efficient and cost-effective transportation of various products. Additionally, port regions frequently maintain multi-modal connections, which includes access to Class I railroad lines and various major highways. These options, coupled with enhanced safety from mitigated flooding risks, allow for the development of thriving industrial regions which contribute significantly to local, regional, and statewide economic well-being.

## The New Orleans Port Region

The New Orleans Port Region is a primary example of the benefits of industrial development along the IMTS. The port region includes a cluster of multiple neighboring ports that span the length of the Mississippi River from Baton Rouge to Myrtle Grove, Louisiana.<sup>6</sup> Located in such close proximity, these ports and port facilities can have the appearance of one continuous port, connected by the waterway and sometimes pipelines and other modes of movement due to the advantage of this immediacy.



*Port of New Orleans, Louisiana*  
*SOURCE: Art Wager, 2018*

In distance, the New Orleans Port Region spans approximately 228 miles upstream of the mouth of the Mississippi River which enables oceangoing vessels to access a span of ports upstream.<sup>7</sup> Due to the location along the Gulf Coast, this region handles a significant amount of petroleum, petrochemical, and chemical products critical for the U.S.'s energy sector, but the region is absolutely vital due to its role in agricultural exports. In 2022, the New Orleans Port Region exported more than 58 million metric tons of agricultural products, accounting for 39 percent of the U.S.'s total agricultural exports. Primarily moved in bulk waterborne vessels (99 percent), the majority of these goods were grain products and soybeans – more than 27 million and 25 million metric tons respectively.<sup>8</sup>

Of the foreign markets reliant on these exports from the New Orleans Port Region, the greatest importers included China (33 percent), Japan (12 percent), Mexico (12 percent), and Colombia (7 percent).<sup>9</sup> The ability to move these goods efficiently through this region at the low cost enabled by inland waterway and oceangoing maritime shipping allows U.S. agriculture to remain economically competitive globally, generating a ripple of economic impact across the U.S.

## The Port of New Orleans

Positioned at the mouth of the Mississippi River at the convergence of the River and the Gulf of Mexico, specifically the Gulf Intercoastal Waterway, the Port of New Orleans (Port NOLA) is an essential element within the New Orleans Port Region. Port NOLA

serves as a gateway, moving goods to and from the IMTS and loading goods onto larger oceangoing vessels for global trade.

The port spans three counties, known as parishes in Louisiana – Jefferson, Orleans, and St. Bernard – and operates as a landlord port. As a landlord port, the port authority owns the property within port jurisdiction, and is responsible for capital equipment and infrastructure, but does not operate any terminals. This industrial property is leased to stevedores for operation, and this funding, in combination with other generated revenue, allows the port authority to reinvest in equipment and improvements for the port region without requiring any state funding.<sup>10</sup>

In early 2024, the port was leasing this industrial property for approximately \$23,000 per acre per year and the river property was booked to capacity, reflecting the high demand for the waterways and other modal connectivity for shipping.<sup>11</sup> Each year, the port generates approximately \$100M in revenue which they are able to reinvest into the port for equipment and infrastructure improvement needs, such as the new terminal planned in St. Bernard Parish. The port plans to begin construction on the \$2 billion terminal project in 2025 which will allow larger vessels to berth and further increase port capacity.<sup>12</sup>

Beyond the lean model through which the port operates, the economic impact is immense. The port's most recent economic impact analysis, completed in 2019, estimated 8,800 direct port jobs, 19,050 jobs related to port activity across the tri-parish region, and 21,700 related jobs created statewide as well as \$2.3 billion in economic output from the port directly.<sup>13</sup>

## Commercial Property Values and Waterfront Development

Many early U.S. cities emerged along waterways throughout the country. The access for travel and goods movement, as well as the convenience of a nearby water source, made these ideal locations for population centers. With the proliferation of the steamboat and the reliance on the waterways for shipping, much of the land bordering waterways was slated for industrial use.

These locations were convenient for the production-to-transportation process and proved highly cost-effective, but these areas were often perceived as dangerous due to a lack of predictability for water levels and flood related incidents – making these areas overall less appealing for non-industrial uses. The increasing frequency of flood-related incidents in the early 20<sup>th</sup> century sparked a necessary overhaul for the inland waterways. During this period, USACE began integrating flood control into the agency's

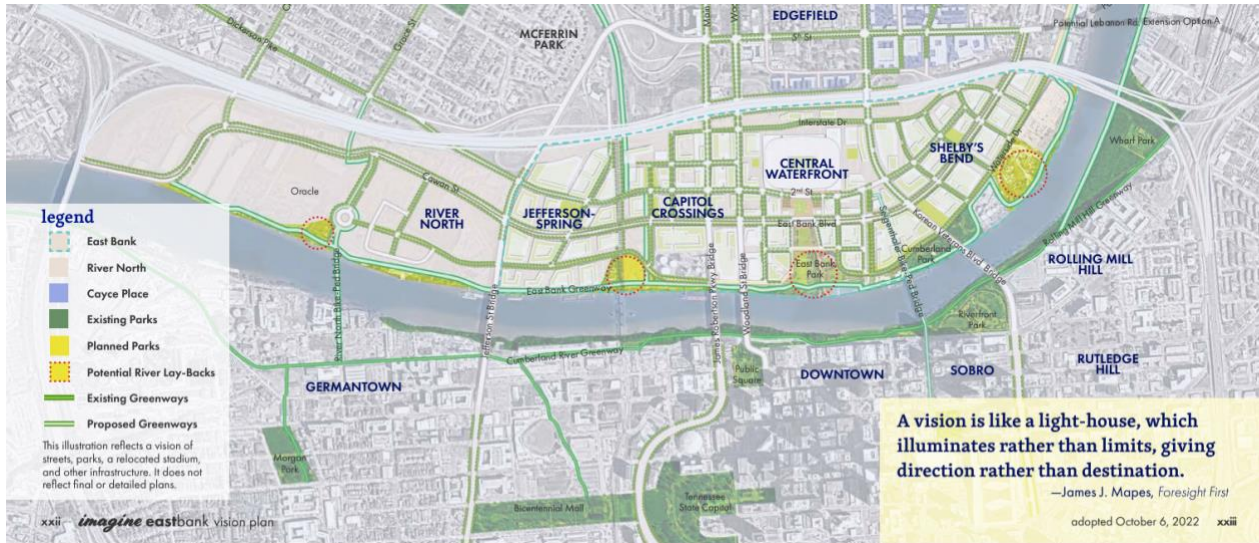
mission, and this action, paired with efforts to clean up and revive the nation's waterways, jumpstarted the transformation of the country's rivers into the city focal points often seen today.<sup>14</sup>

### Nashville, Tennessee and the “Waterfront Experience”

While there is an extensive list of cities across the country revisiting their waterway property, one of these cities seeing riverfront revitalization is Nashville, Tennessee. In 2022, the Nashville metropolitan region saw a population increase of more than 35,000 people, and the city is often mentioned as one of the fastest growing of its peer cities in the U.S.<sup>15</sup> The city is seeing widespread investment, but there are few locations attracting more interest than the banks of the Cumberland River, which cuts through the heart of the city near downtown. The development along the river, funded through public and private dollars, is an effort to reintegrate the river and its history into the community, while creating a “waterfront experience” for residents and visitors.

Of the multiple waterfront areas seeing investment, one of the most compelling is the public-private partnership the city has dubbed “Imagine East Bank.” Billions of public and private dollars are being allocated to this project which has the end goal of repurposing 550 acres of primarily parking lots and industrial facilities into a mixed-use community with the Cumberland River as a main attraction.<sup>16</sup> Some of the developments include a new Oracle Corporation campus envisioned as a park integrated into the community, a mixed-use development of office, residential, and commercial spaces to be named *Station East*, and green space with terraces and outdoor seating. Additionally, the development plans include moving Nissan Stadium, home of the Tennessee Titans, further away from the river to enable better river access, as well as the relocation of the Tennessee Center for Performing Arts from its current aging home on the west side of the river near the Tennessee State Capitol.<sup>17</sup> A high-level rendering of the plans for “Imagine East Bank” can be seen in Figure 2.

FIGURE 2: ILLUSTRATIVE PLAN, OPTION A, IMAGINE EAST BANK DEVELOPMENT



SOURCE: Nashville.gov, 2022

With a focus on mobility, public health, and walkability, and considerations for affordability and equity, the redesigned waterfront district will tie the Cumberland River back into the city while enhancing the connectivity between the city east and west of the river.

### Residential Property Development

While there are many documented benefits stemming from spending time near natural bodies of water, the prospect of living along one of these bodies is not always appealing. Elevated risks from flooding and changing water levels can lead to a lack of predictability for establishing a residence in these areas. While natural elements do not always lend themselves to predictability, USACE infrastructural improvements have enhanced navigability and decreased flooding impacts in these regions. The ability to raise and lower water levels, or in some cases create lakes for water pooling, allows USACE to monitor and exert greater control to mitigate these potential flooding impacts.

Because of these adaptations, waterway residents are better positioned to develop thriving communities along the nation’s system of rivers. While USACE maintains projects all over the country and not solely along the inland waterways, comprehensively, the more than 400 river and lake projects across the country attract more than 260M visitors each year and generate \$12.3B in visitor spending.<sup>18</sup>

## Kentucky Lake and Lake Barkley

In the early 20<sup>th</sup> century, the region in Western Kentucky where the Ohio, Tennessee, and Cumberland Rivers meet was highly susceptible to flooding, including a flood in 1937 where water levels rose to 60.8 feet and caused an estimated 27,000 residents to evacuate.<sup>19</sup> Simultaneously, the region faced higher levels of poverty, particularly in rural areas where many residents did not have electricity. To benefit the region and increase navigability along the segments of these rivers, the Tennessee Valley Authority (TVA) dammed the Tennessee River which created the reservoir now known as Kentucky Lake in 1944.<sup>20</sup> While the goal of the project was enhanced navigability as outlined in the USACE mission, the project had the added benefit of generating electricity and controlling the flow of the river which has impacted flood control.

Following the opening of the Kentucky Dam, the neighboring population along the Cumberland River began requesting a similar project. Decades later, in 1964, Barkley Dam was officially opened creating Lake Barkley parallel to Kentucky Lake. The construction of Lake Barkley required significant planning including the relocation of entire communities, such as Kuttawa and Eddyville, whose former sites are now submerged.<sup>21</sup> The portion of land between these two bodies of water was acquired by TVA during this process, and this 170,000-acre parcel is a National Recreation Area known as “Land Between the Lakes.”<sup>22</sup> The projects have had significant impact on the region economically, creating economic opportunity and highly sought after residential space.

The damming of the rivers in these regions has controlled river flow and enhanced navigability, while generating electricity and creating economic and recreational opportunities for the region. For Kentucky Lake alone, a recent economic impact study connected more than 700 jobs to the lake.<sup>23</sup> Additionally, nearby waterways related industry, such as specialty chemical production in nearby Calvert City, have added to the job opportunity pool for the region. These industrial and commercial employment opportunities for residents, and the tourism draws, have added to the overall economy in the region, increasing salaries and the value of property in the region as well. The total value of property along the residential portion of Kentucky Lake is estimated at \$61.3M, and the estimate for Lake Barkley is a total value of \$65.5M. Revenue generated in property taxes and commercial activity provides the community and state with opportunities to further develop and enhance the area.

## Jobs and Community Impact

Waterways, and their corresponding ports and industrial facilities, have immense impact on cities, regions, and states. Access to the waterways for shipping creates opportunities to move goods in a highly cost-effective manner, increasing competitiveness and facilitating opportunities for industry. By default, opportunities trickle down to communities through job availability, competitive wages, and other economic impacts. Between tax revenue derived from wages and taxes levied on business operations, the inland waterways and related jobs serve a critical role in expanding the economy and providing opportunities for a large portion of the country's workers.

### Jobs: Southern Indiana Maritime District

The Ohio River spans 981 miles largely crossing the Midwestern U.S. The river begins where the Allegheny and Monongahela rivers conjoin in Pittsburgh, Pennsylvania, and it meets the Mississippi River in Cairo, Illinois.<sup>24</sup> While the river borders multiple states, Indiana sees significant economic impact from its river-related industries. An economic impact study released in 2023 estimated that the “Southern Indiana Maritime District,” composed of all counties bordering the Ohio River and 356 total miles of shoreline, generated 60,154 jobs for the state. Along with these jobs, there was more than \$3.3 billion produced in personal income and \$505 million in state and local tax revenue.<sup>25</sup>

### Jobs: The Port of Memphis

Along the Lower Mississippi River, the Port of Memphis reflects the importance of the inland waterways for this region. A medium-sized port, it is ranked 53<sup>rd</sup> for tonnage moved among all U.S. coastal and inland ports. The Port's water jurisdiction includes a portion of the river and three slack-water harbors, and port property comprises two major industrial parks. It is designated as a Port of Entry and Foreign Trade Zone, meaning it can receive international shipments for inspection. Additionally, three highways and five Class I railroads serve the city, and a major cargo airline, FedEx Express, is based there.<sup>26</sup>

Like Port NOLA, the Port of Memphis operates as a landlord port, where the port owns the property in its jurisdiction and leases space for port operations, creating direct port jobs. Additional indirect and induced jobs are created from port operations and can include vendors, business services, retail, transportation, and other related industry jobs. In the Port's most recent economic impact study released in 2022, an estimated 5,361 direct and 8,494 indirect jobs were supported in Shelby County – accounting for

2.5 percent of all jobs in the county. With the 8.6 million short tons handled in 2020, the port produced an estimated economic impact of \$6.25 billion for the year.<sup>27</sup>

### Jobs: U.S. Steel in Osceola, Arkansas

While large port regions generate major economic impact, waterways' access in smaller communities can create competitive opportunities for industries and transformative economic impact within these communities. Now owned by U.S. Steel, in July of 2014, construction began on Big River Steel in Osceola, Arkansas. In selecting the 1,300-acre location for the mill, the late founder and CEO of Big River Steel, John Correnti, opted for Osceola due to the Mississippi River access and BNSF Railway connection – referring to the location as “Steel Mill Heaven.”<sup>28</sup>

Operations began in early 2017, and a second mill is under construction and slated for completion in 2024. U.S. Steel operations are highly reliant on the waterway, moving approximately 30 percent of their products by barge. For 2024, the mill is expected to receive more than 1.6 million tons of material via barge while shipping 780,000 tons of finished goods out by barge. Upon completion of the second facility, expected inbound and outbound products via barge will approximately double to more than 3.2 million tons of inbound material and 1.56 million tons outbound.<sup>29</sup>

While the impacts of Mississippi County, Arkansas being the largest steel producing county in the country are significant for the state economy, the effects on the community are noteworthy and growing. For the last 20 years, the county has seen largely stagnant wages and a declining population. While the steel operations are newer developments, Big River and U.S. Steel operations in the region have created new and well-paying job opportunities for residents in Mississippi County and neighboring counties. Through their incentives agreement with the state (Amendment 82), Big River Steel reported 1,266 direct and indirect jobs to the state. Big River Steel alone accounted for 811 of these positions, and the company currently employs 501 Mississippi County residents (direct). As of fiscal year 2022, the average salary of those employed was \$134,300.<sup>55</sup><sup>30</sup>

Beyond the competitive jobs and wages, U.S. Steel is partnering with the county and other industry participants to bring new development into nearby communities. In the program called “*Work Here, Live Here*,” U.S. Steel and others contribute to provide homebuying assistance and incentives to employees. Under the program, a participant can obtain a forgivable loan of up to \$50,000 for new construction or \$25,000 for an existing home under an agreement to maintain employment with the same entity for four years.<sup>31</sup> In March of 2024, U.S. Steel had 70 employees who had opted to participate in the program, and in Osceola alone, a new subdivision with 26 completed home and 75 home sites in development was underway.

The neighboring city of Manila had four subdivisions under construction with 260 available house sites.<sup>32</sup> Participating companies and community leaders envision these efforts as rebuilding the communities in this region, upgrading available housing and enhancing public schools and other services.

## Tourism and Recreation

Tourism is an economic engine for waterways regions. Because many large cities emerged along the nation's waterways, these cities often have deep historical and cultural roots with attractions tied to their early history and the migration of people. The added amenities related to the rivers and availability of outdoor recreation activities attract visitors from around the country, and sometimes globe.

While the presence of a river in itself is an appealing feature, there is often limited understanding of the impact of infrastructure on these river-related tourism regions. In some situations, like that of the already discussed Kentucky Lake and Lake Barkley, lakes were formed by added USACE infrastructure which eventually created these communities and economies that are largely lake and outdoor recreation based. Numerous other areas, such as the Quad Cities, have experienced similar changes and river-related economic booms due to infrastructure and river management practices. The beneficiaries, composed of tourists and the community residents, have vested interests in the protection of infrastructure as well as the waterways, as these are a source of enjoyment for the former and sometimes livelihood for the latter.

### Waterway Tourism: Quad Cities

In examining the impact of infrastructure on waterway communities, there are few better examples than the Quad Cities. The area was originally made up of four cities: Davenport, Iowa; Rock Island, Illinois; Moline, Illinois; and East Moline, Illinois. The region later expanded to also include Bettendorf, Iowa and is described generally as a metropolitan area on the upper Mississippi River.<sup>33</sup>

The Quad Cities lie at the meeting point of the Rock River with the Mississippi River, and it is the only location in which the Mississippi flows directly from the east to the west. While the history of the region involves early indigenous settlement, with later conflict and land dispute issues with the U.S., the first urban settlement patterns largely emerged due to the river and steamboats.<sup>34</sup>

During this period during the late 1800s and early 1900s, the Mississippi River flowed without infrastructural improvement to manage water movement. At this time, the 14-mile stretch from LeClaire, Iowa to Rock Island contained what is known as the Rock Island Rapids, which was well-known as a challenging section for vessel passage. The depth of the river averaged around three feet, and this portion of the Mississippi was notorious for its shifting sand bars and shoals.<sup>35</sup>

In response to the difficulty in passing through this area, communities emerged on each side of the stretch of rapids where docking to store goods before the passage was feasible.

After attempting without long-term success to demolish rapids using underwater blasting, in 1905, the U.S. government authorized the construction of the Moline Lock in the River and Harbor Bill of March 3, 1905. The lock, which was 325 feet long, 80 feet wide, and 6 feet deep, opened on December 23, 1907. The lock increased the safety and ease of passage but was eventually replaced in the 1930s by the current lock and dam system which maintains the required 9-foot minimum depth.<sup>36</sup> With these infrastructure improvements, the former canal area transitioned to an area for recreational boating use, and the larger Quad Cities portion of the Mississippi River became a safer and more intertwined part of the community.

Because of these changes, the Quad Cities region has developed a thriving tourism industry which is critical to the livelihoods of its residents. Not only can residents take advantage of the health and wellness related aspects of water activities, and added infrastructure like trails on the riverbanks, but the revenue generated by visitors is vital to the economy. Each year, the Quad Cities estimates more than 6.1 million visitors to the region, driving \$1.3 billion in spending and the creation of 9,097 jobs.<sup>37</sup>

The area maintains more than 100 miles of riverfront trails for bicycling or hiking, and the region as a whole has placed significant emphasis on enhancing connectivity from the Quad Cities to neighboring communities. In the coming years, there are plans to extend waterfront trails the more than 50-mile stretch from Rock Island, Illinois to nearby Savanna, Illinois. Additionally, the community has stressed the need to join communities across the Mississippi. In 2017, work began to replace dual bridges, including the I-74 bridge, which were originally constructed in 1960 and 1936. The new I-74 bridge opened in December of 2021 and not only includes vehicle lanes, but there is now a 14-foot-wide bicycle and pedestrian crossing, which connects to paths in Bettendorf and Moline on either side, and a scenic Mississippi River overlook.<sup>38</sup> Beyond the Quad Cities' Mississippi River identity, the better-managed waterway allows for tourism activities which are tied to or originate from the river, including outdoor recreation and fishing, water activities and boat rentals, river cruises, and even gaming.

While these river-related tourist activities are seen in the Quad Cities, the impact of these activities in various regions across the country is immense – with much credit attributed to infrastructure and the efforts of the USACE.

## Outdoor Recreation, Fishing, and Boat Rentals

While the total impact of tourism on various regions can be difficult to quantify, an analysis of the Lower Mississippi Region from 2014, which included the Mississippi River portion from Southern Illinois to the Gulf of Mexico, estimated \$15.5 billion in economic impact and 190,000 jobs created. The same analysis estimated approximately 38 million trips, \$1.3 billion in economic impact, and 54,000 jobs created specifically by outdoor recreation activities. Activities in this category can include fishing, hunting, wildlife watching, and other outdoor activities.<sup>39</sup> While these figures are now dated, outdoor recreation spending has only increased in the last decade, specifically during and following the COVID-19 pandemic.

Within outdoor recreation, fishing is a major revenue generating activity. The main waterways arteries and tributaries attract millions of visitors annually for commercial and recreational fishing activities. In many instances, lock and dam projects delivered by USACE have facilitated the success of this sector. In the Upper Mississippi River region, USACE maintains a series of 37 locks and dams which enable the movement of commercial and recreational fishing boats. With these navigation projects, USACE estimated about \$1 billion in economic benefits from boating, fishing, and other uses in 2021.<sup>40</sup>

For local areas like the Quad Cities, the region is able to capitalize on river access for these areas of outdoor recreation. The Children's Therapy Center hosts an annual fishing tournament to support costs not reimbursable for therapy needs, and in October, the region is hosting the Bass Fishing League Phoenix Regional Championships. This event will bring in up to 400 anglers and generate an estimated \$840,000 in direct economic impact to the area.<sup>41</sup>

The Quad Cities also see significant numbers of watercraft rentals each year, which can include boats, kayaks, canoes, and tubes. There are numerous companies which offer rentals in these outdoor recreation seasons each year, and the largest organized floating event is called Floatzilla. Event organizers claim Floatzilla as the largest floating event on the Mississippi River, and the event brings in approximately 2,500 attendees each year with an estimated economic impact between \$150,000 to \$200,000.<sup>42</sup>

## Cruises

While the IMTS rivers attract tourists to many cities, one of the most direct ways in which river-related tourism can be measured is river and waterway cruises in the U.S. The river cruise industry has seen a significant increase in recent years. The largest river cruise operator in the U.S., American Cruise Lines (ACL), is currently operating 21 vessels and anticipates the construction of five more U.S. ships between 2024 and 2025.<sup>43</sup> Of these ships, seven are specifically utilized for inland waterway cruises on the Columbia and Snake Rivers and the Mississippi River.<sup>44</sup> These ships are constructed at Chesapeake Shipbuilding in Salisbury, Maryland – a facility which was expanded during the COVID-19 pandemic.<sup>45</sup> In April of 2024, ACL announced the cruise lines biggest opening season on the Columbia and Snake rivers in the Pacific Northwest with five riverboats operating and numerous trip itineraries available.<sup>46</sup>

For Mississippi River cities, the impact of the cruise industry generates major tourism spending. New Orleans, which has location access needed for Mississippi River and Gulf of Mexico-bound cruises, returned to pre-pandemic levels for 2023 seeing nearly 1.2 million cruise passenger movements. While many of the cruises out of New Orleans are oceangoing, there is a fleet of nine river cruise vessels which port there. An estimated 90 percent of cruise passengers are out-of-state visitors who typically spend one to two days in New Orleans prior to or following their cruise. This accounts for an estimated 300,000 plus hotel night stays and more than \$125 million in local spending each year.<sup>47</sup>



*American Cruise Lines Vessel, American Constellation,  
sailing in the Pacific Northwest*  
SOURCE: American Cruise Lines, 2017

For the Quad Cities, the region maintains a strong relationship with Viking Cruises – a cruise line which maintains its operating headquarters in Basel, Switzerland. The cruise line’s Mississippi River vessel, the *Viking Mississippi*, ports in New Orleans and offers various cruises up the Mississippi River. The longest cruise traverses all the way to St. Paul, Minnesota offering glances into numerous areas of American history including the Civil War, the Civil Rights Movement, and various types of music rooted in the U.S. like jazz, folk, and soul music. Amongst the many stops along the cruise route is a stop into the Quad Cities to explore the history and outdoor recreation of the area. The economic development bodies in the Quad Cities, like Visit Quad Cities, credit Viking Cruises with

helping to spread word of what the Quad Cities region has to offer to international tourists.<sup>48</sup>

## River Identity and Related Attractions

Amongst the many uses of the IMTS and its recreational and economic importance, there is also a sense of connection with the waterways that many communities maintain. In many cities, various rivers which run through were key parts of how these communities came to exist. Between the historical and modern connections, rivers become symbols of communities. In few areas is this connection stronger than in Mississippi River communities. Multiple museums have emerged along these waterways to commemorate the role of the river in the formation of these cities and the nation as a whole.

### **Memphis, Tennessee**

In 1982, the city of Memphis opened a park called Mud Island. This park included an 18-gallery museum dedicated to highlight the role of the Mississippi River in the Civil war and U.S. history.<sup>49</sup> Outside the museum was a scaled model of the Mississippi River, and when the museum opened, it attracted about a million visitors.<sup>50</sup> While the park was shuttered in the late 2010s following years of economic difficulties and issues with vandalism, a recent \$17 million proposal by Mayor Paul Young has sparked hopes of reviving the park.<sup>51</sup>

### **Dubuque, Iowa**

Just up river from the Quad Cities, the National Mississippi River Museum & Aquarium is situated in Dubuque, Iowa. The museum is run by the Dubuque County Historical Society and is focused on telling the stories of the county and region blended with the role of the nation's rivers.<sup>52</sup> According to the museum, in 2023, there were 198,004 visitors with an estimated economic impact of \$16 million to the city and county.<sup>53</sup>

## Energy and Sustainability

The energy and sustainability category includes a variety of benefits that, in some ways, are harnessed from the waterways themselves and the associated waterways infrastructure. Cities and towns exist along rivers for transportation of goods and people, but also for drinking water, power, and agricultural production. The waterways act as natural habitats and contain the resources to preserve natural habitats. Additionally, flowing water can be used for cooling systems. These benefits reflect the

importance of waterways themselves and the associated waterways infrastructure for the communities that have been built around them.

Communities across the country that are connected to the waterways experience some or all of the energy and sustainability benefits of the waterways. The waterways are a multi-functional system. A river can provide hydropower, water supply, cooling capacity, and irrigation all at the same time. The Mississippi River, for example, provides transportation, energy, and economic development for its communities. The different examples used to highlight each benefit is done to show the capacity of the waterways to provide energy and sustainability for communities across the country. In some cases, there is a particular benefit that stands out, like in the case of using dredged sediment for environmental rehabilitation along the Upper Mississippi, hydropower supplied from dams throughout the Tennessee Valley, or irrigation used for agricultural production in the Pacific Northwest.

Each of the benefits related to energy and sustainability are built on the idea that waterways are a significant resource and foundation for communities across the country. The infrastructure associated with waterways further enhances or facilitates these benefits. Beyond the ability of the waterways to provide navigable paths for transportation exists the ability to provide energy and sustain life. These benefits include hydropower, irrigation, water storage, cooling, and beneficial uses of dredged sediment.

## Hydropower

Among the many types of renewable energy, hydropower represents a premier resource that has utilized the power of the waterways for the benefit of communities across the country. Hydropower plants capture the energy of falling water to generate electricity. Sufficient hydropower is generated with head (vertical distance the water will fall) and streamflow of the waterway.<sup>54</sup>

Hydropower plants are spread out across the inland waterways system and provide a reliable source of energy.<sup>55</sup> While river streamflow is varied, hydropower provides energy throughout the year, with 101 gigawatts of installed hydropower across the United States.<sup>56</sup> If a hydropower plant has access to a water source, hydropower as an energy source provides constant power for a community. During power outages, hydropower can help restart power systems without support from the transmission grid, making hydropower a reliable source of energy during times when power is limited. Hydropower is also carbon-free, making it an attractive source of energy for transportation and construction, at a time when carbon neutrality is top of mind in the

fight against climate change. Human-made reservoirs are six times more efficient at carbon burial than natural lakes.<sup>57</sup>

Hydropower as a source of energy can also be flexible to energy demand. During times when an area is using less energy, the hydropower plant can reduce the streamflow thereby reducing the power output. Hydropower plants can provide power when needed, and not produce energy waste.

Some hydropower plants provide ample storage capacity with large reservoirs, which can store water for long periods of time. Additionally, the reservoirs provide a space for recreation and wildlife refuge. Hydropower plants provide significant benefits for the community through power generation and recreation. Recreation is the most common secondary purpose for reservoirs at power-generating dams.

### Hydropower in the Pacific Northwest

In 2019, 6.6 percent of the Nation's generated electricity came from hydropower. The Pacific Northwest (PNW) generated half of the country's 247 billion hydroelectric kilowatt-hours.<sup>58</sup>

The Grand Coulee Dam is the largest dam in the Columbia River Basin with a total generating capacity of 6809 megawatts and an annual energy output of 2300 megawatts (enough power to supply two cities the size of Seattle). While not a navigable structure along the waterways, the Grand Coulee Dam provides irrigation and flood control capabilities, along with its hydropower capacity.<sup>59</sup>



*Lower Monumental Dam in Washington on the Snake River*  
*SOURCE: iStock, stevenlenzphoto, 2020*

### Hydropower in the Tennessee Valley

There are 29 power-generating dams along the Tennessee River system. There are also eight dams on the Cumberland River that provide power for the region, operated by USACE. The Tennessee Valley Authority (TVA) produces 5,200 megawatts of hydroelectric energy. The main navigable channel of the Tennessee River runs 652 miles between Knoxville and Paducah, Kentucky. Commercial navigation also exists along 61 miles of the Clinch River, 29 miles of the Little Tennessee River, and 22 miles of

Hiwassee River. Most of the power generating dams exist along these stretches of navigable waters.<sup>60</sup>

The Chickamauga Dam includes four generating units, supplying 119 megawatts of power and the accompanying reservoir has a flood-storage capacity of 345,300 acre-feet. The Chickamauga Dam reservoir is a popular spot for boating, swimming, and fishing, with several public boat ramps.<sup>61</sup>

The Fort Loudoun Dam includes four generating units with a summer net dependable capacity (i.e., the amount of power a dam can produce on an average day, minus the electricity used by the dam itself) of 151 megawatts. The accompanying reservoir has a flood-storage capacity of 111,000 acre-feet, and is a popular recreational destination known for bass fishing and bird watching.<sup>62</sup>

The river system throughout the TVA system is a critical part of hydroelectric power generation, among other functions of the TVA including flood mitigation, water storage, navigation, water quality, and recreation. The river provides a constant source of power and provides flexibility in power generation. When demand is higher, the hydropower facilities can meet the higher demand by increasing energy output and adjusting to decreased demand by reducing energy output when demand is low. The flexible nature of hydropower energy demand response is a function of the river system. The streamflow of the river can be adjusted to meet demand. Being along the river allows the TVA to serve its industrial customers, who use the river for various purposes.

According to a report from the U.S. Department of Energy, the benefits of focusing on the existing hydropower infrastructure and adding new hydropower capacity are long lasting. Between 2017 and 2050, the reduction in greenhouse gas emissions from hydropower use nationwide is estimated at 5.6 billion metric tons, saving \$209 billion in avoided climate change-related damages.<sup>63</sup> Additionally, an estimated \$58 billion was saved in impacts related to air pollution from SO<sub>2</sub> (sulfur dioxide), NO<sub>x</sub> (nitrous oxide), and various particulate matters. Focusing on hydropower infrastructure is projected to boost the economy with 195,000 jobs across the country over the next several decades.<sup>64</sup> A continued focus on the hydropower infrastructure maintenance along the inland waterways system is projected to have significant benefit for the nation's economy and societal well-being.

Beyond the benefit of providing sustainable and renewable energy, hydroelectric power generation creates a list of additional benefits. The reservoirs created from the hydroelectric dams create a space for recreational use and water storage for surrounding communities. In the case of the Tennessee Valley Authority, its hydroelectric dams support flood mitigation, water quality, navigation, and recreational use. The river

system is the platform that allows hydroelectric power in the United States to provide its necessary and beneficial functions. Consistent streamflow can be manipulated to meet energy demands. Hydroelectric power takes advantage of the established benefit of the river system and enhances the capability of the river system to provide benefit for the communities that live near it.

## Irrigation

During droughts and other emergencies, water supply storage is critical to provide water to communities when it is needed most. Around 80 percent of water consumed in the United States is used for irrigation, and water supply is critical to sustain the irrigation of crops, to feed livestock, and to produce other agricultural products that provide for the country's population. USACE has approximately 480,306 acre-feet of storage space across Western states that support irrigation efforts.<sup>65</sup>

### Irrigation in the Pacific Northwest

In the Pacific Northwest, five percent of the Columbia River Basin's water is diverted for agriculture. In Washington state alone, 300,000 acres of farmland depend on irrigation provided by the Columbia-Snake River system.<sup>66</sup> Growers who depend on the irrigated land in the area produce alfalfa, small grains, vegetables, fruits, and wine grapes, among other agricultural products. The 50,000 acres of irrigated land served by the Snake River alone produce enough apples to food 18.5 million people, enough sweet corn for 19 million people, and enough potatoes to feed 6.5 million people.<sup>67</sup>

The Columbia-Snake River system is a leading trade route for agricultural products, and its trade route is built on the irrigated farmland provided by the river. The irrigation system contributes to feeding the region's population but is also part of the supply chain. The irrigated farmlands across the Columbia-Snake River system allow farmers to produce the agricultural products that contribute to the millions of tons of cargo and the economic well-being for the region. The inland waterways are a crucial foundation for irrigation in the region and the agricultural output that feeds the region, keeping farmers in the global supply chain. Irrigation provides the basis for the goods that move along the waterway and is a crucial element of the agricultural sector in the Pacific Northwest.

The river system is a critical resource for sustaining human life. The number of gallons stored, number of people that can be fed, and acreage of irrigated land are all measures of how the river is a constant source of sustaining life. Farmers depend on the river for irrigation of crops, for feeding the nation's communities, and for economic growth.

Water supply from the river system highlights the system's ability to provide multiple functions at the same time. The river is a sustainable system of supplying water for agricultural goods and moving those same agricultural goods to where they need to go.

## Water Supply

### Water Storage

Water is a critical resource for human life and well-being. USACE provides water supply storage in its multipurpose reservoirs across the country and provides water in partnership with state and local interests. In 2021, there were 136 reservoirs with municipal and industrial (M&I) water supply supplying 6.1 billion gallons from contracted water supply across 6.2-million-acre feet contracted water supply storage.<sup>68</sup> USACE draws water into its reservoirs from multiple sources, including the inland river system.

USACE plays a role in managing water supply across its divisions, by supporting water supply improvement projects. Various water supply projects across eight USACE Mississippi Valley division reservoirs in Arkansas, Illinois, Iowa, Mississippi, and Missouri account for 446,110 acre-feet and the total economic benefit of these water supply projects is estimated at \$229.1 million.<sup>69</sup> Around 20 million people live in the 123 counties that border the Mississippi River, who directly benefit from the river's water supply.<sup>70</sup> The larger Mississippi River Basin is home to almost 70 million people.

Water supply improvement projects in the Northwestern Division includes 17 projects in Iowa, Kansas, Missouri, North Dakota, Oregon, and Washington. Total storage space for these projects equals 779,906 acre-feet and the total economic benefit of the water supply is estimated at \$274.4 million.<sup>71</sup> For the many cities that lie along the waterways, the river is an integral part of life and provides cities with a source of water supply which can be used in myriad ways. Water storage is key for cities because it provides a stable source of water that the city can use for municipal drinking water, industrial use, or recreation. In times when water supply is critical, the reservoirs storing water become a critical asset for the communities who rely on it. The inland waterways provide a constant source for the reservoirs, making the inland system a crucial part of water storage. Moreover, the reservoirs created from damming the river are generally large. Thousands of communities reside along the waterways, so the need for large amounts of water storage is necessary, and the river system provides that capability.

Water supply comes from sources beyond the river system, including tapping the underground aquifers. The river system is not the only source, and as such the benefit of

water storage is not unique to the river system. However, the reservoirs created from the river system account for a significant amount of the water supply. For example, in the Tennessee Valley, the total flood storage capacity for reservoirs along the main navigable channel (these reservoirs include Kentucky, Pickwick Landing, Wilson, Wheeler, Gunterville, Nickajack, Chickamauga, Watts Bar, and Fort Loudoun) between Knoxville and Paducah is around 5,870,00 acre feet and a total water surface area of 454,170 acres.<sup>72</sup> Improvements in the navigable channel infrastructure ensure the reservoirs are in good condition and can provide the necessary water storage and recreational use enjoyed by the surrounding communities.

## Water Supply in the Lower Mississippi River Region

Surface water taken annually from the Mississippi river by people living in the Lower Mississippi region, which comprises of counties surrounding the Mississippi river in Illinois, Missouri, Kentucky, Arkansas, Tennessee, Mississippi, and Louisiana totals 11.8 billion gallons of water. Public use of surface water supply is varied.<sup>73</sup> Public use includes firefighting, street washing, municipal building use, parks, swimming pools, and water treatment facilities. Commercial use includes use for hotels, restaurants, civilian/military facilities. Public water supply accounts for three percent of total water supply use, at 385 million gallons of water per day.<sup>74</sup>

The majority of surface water supply is self-supplied, which means the water is taken from a groundwater or surface water source rather, which is used by thermoelectric, farming/irrigation, and industrial facilities. Industrial facilities used about 2.3 billion gallons of water per day, with Louisiana as the largest industrial consumer of water in the Lower Mississippi River region, accounting for 96 percent of total self-supplied industrial water supply consumption.<sup>75</sup> The water supply (and sewage) sectors generated an estimated \$385 million in revenues in 2011.

## The National Water Reuse Action Plan

Investments in water supply are a critical part of maintaining access to healthy water and building resiliency in the water supply. The U.S. Environmental Protection Agency's National Water Reuse Action Plan is guided by several principles including the promotion of public health, environmental protection, recognition of challenges to water supply. The plan serves as a framework for policy initiatives that improve water supply across the country, which has lasting benefits for the population. Benefits of improving water supply infrastructure include improving access to good quality water, ensuring a continual and adequate supply of water, and the ability of water supply infrastructure to withstand various threats and retain the ability to provide water.<sup>76</sup>

## Cooling

One of the many uses of water is in cooling. Various industries rely on cooling methods to keep operations stable and prevent overheating, which can arise with work such as nuclear power or data processing. Compared to other methods of cooling, water-based cooling is preferred, since water-based cooling can move more heat per unit and is more efficient than air cooling.<sup>77</sup> For industries to use water for cooling, a source of water is required, and requires the industry to be located close to a water source.

Over the years, data centers have become an increasingly relevant part of society. Data centers house the servers, storage systems, and other equipment used for computing, artificial intelligence, gaming, streaming, and data analytics, creating demand for data centers.<sup>78</sup> Companies like Google and Microsoft have large data centers around the country that are critical pieces of infrastructure to keep the digital world moving. These data centers process large amounts of information, and their operations require cooling methods to keep servers and systems operating without overheating. Data centers use around 40 percent of their power for cooling.<sup>79</sup> Data centers require copious amounts of water to ensure systems are properly cool, and rank among the top ten water-consuming industries in the United States.<sup>80</sup>

### Google Data Center: The Dalles, Oregon

The inland waterways provide a source of water-based cooling for various industrial sites such as data centers and nuclear power plants. The Google Data Center in The Dalles opened in 2006 and has contributed \$1.8 billion for the community over the years. In response to growing data consumption, Google is planning a \$600 million extension at The Dalles Data Center, which used around 355 million gallons of water in 2021.<sup>81</sup> With a planned expansion, the need for water to assist with cooling will be paramount. The Data Center uses water from the Columbia River for its cooling system and is a large consumer of water for the city. The area around The Dalles receives less rainfall than other areas of Oregon, so the Columbia River plays a critical role in providing the water necessary for cooling systems.<sup>82</sup>

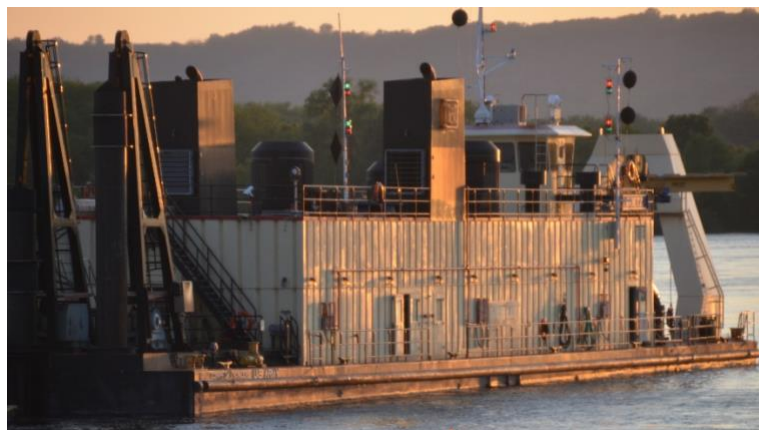
### xAI Supercomputer: Memphis, Tennessee

In Memphis, the city will be home to a new xAI supercomputer facility. The company xAI is an artificial intelligence company created by Elon Musk as a competitor to OpenAI, the creator of ChatGPT. The new facility will require one million gallons of water per day for its cooling towers.<sup>83</sup> The amount of water required for the new facility's cooling towers may put a strain on the municipal water supply. However, as Memphis sits along

the waterway, the river provides a source of water that can be used for cooling. Moreover, the river is a sustainable water source that the facility can use for cooling and then return to the source without harm. By using greywater facilities that reuse municipal water, the new supercomputer facility can provide cooling in a sustainable fashion and reintroduce the water back into the system. The construction of a greywater facility that the supercomputer will use for cooling could also service other industries in the city. The new facility will accommodate around 320 new jobs and add 150 megawatts to the local electrical grid's capacity.<sup>84</sup>

## Beneficial Uses of Dredged Material

USACE dredges around 200 million cubic yards of material annually from federally constructed and maintained navigation channels.<sup>85</sup> The process of dredging navigational channels ensures the continued safe passage of vessels along the navigational waterways across the country. Dredged material comes in the form of rock, gravel, sand, silt, clay, organic material, or some combination of these sediments.



*USACE completes emergency dredging on Mississippi River  
SOURCE: St. Paul District USACE, 2014*

Traditionally, dredged material would be disposed of at designated disposal sites. However, with shortages in storage sites and environmental concerns of dumping dredged material, USACE is working to repurpose dredged material through “beneficial use.” Beneficial use is defined as “productive and positive uses of dredged material, which cover broad use categories ranging from fish and wildlife habitat development to human recreation, to industrial and commercial uses.”<sup>86</sup> Currently, around 85 percent of all dredged material can be used for beneficial use, and of that available material, around 30-35 percent is used for environmental, societal, and economic benefits.<sup>87</sup>

Among the functions of beneficial use dredged material is habitat restoration. Natural habitats and ecosystems in and around the rivers provide for a healthy environment and preserve the diverse array of life that call the rivers home. These habitats can be impacted severely by many forces, including sedimentation. Sedimentation is the process of sediments settling to the bottom of the water. This process can affect the

natural habitat and reduce the number of fish and wildlife in an environment. Various USACE projects in the Upper Mississippi River region are using dredged sediment to repair and enhance wildlife habitats impacted by sedimentation. The Upper Pool 4 rehabilitation project, for example, will take dredged sediment from the Mississippi River navigation channel and build peninsulas, shoreline protection, and additional islands in the St. Paul District of the Upper Mississippi River.<sup>88</sup> The goal of the project is to enhance and maintain a healthy habitat for native fish, wildlife, and aquatic plants. The additional island created will add \$21 million in value to the region.<sup>89</sup>

## Upper Mississippi River Region

The Upper Pool 4 project is part of the Upper Mississippi River Restoration (UMRR) Program, which seeks to ensure the viability of the Upper Mississippi's diverse fish and wildlife resources. The Upper Mississippi River region is home to a diverse array of fish and wildlife, who rely on the habitats along the river and environment around the river.<sup>90</sup> This diversity in life is part of what makes the Mississippi River system a natural treasure for the region and country. Rivers provide a home for species of fish, wildlife, and aquatic plants, creating an ecosystem that makes the land thrive and healthy. A healthy ecosystem full of life has natural benefits, including healthy soil, natural pest control, pollination, and climate stabilization. Projects under the UMRR program are efforts by USACE to rehabilitate areas around the river by installing new infrastructure, using dredged material to combat sedimentation, or re-introducing plants species.

The Cottonwood Island Rehabilitation Project is a completed project that excavated parts of the Cottonwood Chute, planted trees, and manipulated the flow of sections of the upper Mississippi river in Missouri. The project was aimed at improving the natural habitat of the area, which was impacted by dissolved oxygen levels, which can impact the fish and wildlife living in the river.<sup>91</sup> Dredged sediment pulled from the river was used in this project to provide the base for planting trees.

Maintaining a healthy habitat is crucial for the many fish, wildlife, and plants that make up the diverse ecosystems across the country. Deteriorating habitats reduce the number of fish in the water which impacts the fishing industry. Without healthy habitats, the natural environment suffers and threatens the balance of the ecosystem. Maintaining healthy habitats ensures a healthy planet.<sup>92</sup> In the fight against climate change, efforts to maintain the health of the planet are critical, for all life. The dredged sediment from the navigable waterways is a resource that can enhance habitats, and the work being done will ensure the diversity of the Mississippi River ecosystem, which is rich in fish and wildlife. The river is not only the place where these habitats exist but can be a resource for habitat restoration. Beneficial use of dredged sediment is a sustainable use of

resources that come from the river and return to the river, strengthening it as a healthy environment.

## Safety, Security, and Resiliency

The safety, security, and resiliency category includes a series of benefits that highlight the continued relevance of the waterways as a crucial backbone to the nation's transportation system, national security and protection, and global competitiveness.

The benefits of hydropower, water storage, or recreation exist through the support of waterways infrastructure. Flooding can be a destructive force, and efforts to tame the waterways have created a built-in resiliency from the waterways. The added benefit of flood control are the dams and reservoirs that bring about these other benefits like hydropower, water storage, or recreation. These benefits do not exist separately but are all part of a multi-functional waterways system.

Waterways were the primary form of transporting goods before the rise of rail and trucking. While a significant portion of goods movement is done by road and rail, the ability of the waterways to move large quantities of bulk commodities can ease the strain of increased freight movements on roads and rails. Waterways also provide a means of transporting items related to military uses, NASA, and national research, thereby strengthening the national security apparatus of the country.

## Transportation Safety and Congestion Alleviation

Much of the cargo moved along the inland waterways system is bulk commodities such as crude oil, coal, and agricultural products. Inland shipping represents one mode of bulk commodity shipping, and the ability for inland shipping to move large amounts of bulk commodity cargo lifts potential congestion from the nation's roads and railways. However, the ability to ship cargo along the inland waterways can be hindered by navigation lock delays and closures.<sup>93</sup> A closed lock's impact can vary depending on the closure's nature. A planned lock closure, which is done to conduct routine maintenance, can allow shippers to reroute or adjust schedules to work around the closure. Planned closures are important to keep the infrastructure of the waterways in a state of good repair. However, instances of unplanned closures can cause significant delays in traffic shipping and increase congestion on other modes of transportation.

Research indicates that inland waterways transportation provides a freight transportation option that can reduce congestion on roads and rails. The capacity of one barge is 16 railcars or 70 trucks for dry cargo. For liquid cargo, one barge carries the equivalent of 46 railcars or 144 trucks.

### St. Louis: The Ag Coast of America

The port of St. Louis and the surrounding St. Louis metropolitan ports are a centrally located port system along the Mississippi River. They are a collection of five ports serving 70 miles, and within that exists a 15-mile stretch known as the “Ag Coast of America.”<sup>94</sup> The Port of St. Louis by itself only accounts for eight percent of the Mississippi River, yet it carries one third of the river’s total freight. The port system is one of the nation’s largest inland port systems and saw 427, 000-ton miles moved by the inland ports, remaining one of the highest tonnage ports in the country. In 2021, around 6 million tons of corn and 3 million tons of soybeans moved through the St. Louis area ports.<sup>95</sup> Given the equivalent number of railcars or trucks needed to move one barge worth of cargo, which is around 1,500 tons, the cargo moved along the waterways through the St. Louis metro ports is a key part of the transportation network. Without the waterways, the six million tons of corn moved in 2021 would have required around 64,000 railcar loads or 285,000 truckloads. The waterways are more than an alternative mode for goods movement, but a critical part of the transportation network.

In Missouri, of the total 985 million tons of freight moved in 2018, four percent was moved by water, or 39.4 million tons of freight, valued at \$7.6 billion. While the waterways moved the smallest share of the total freight movement in 2018, it is a significant amount of freight that did not have to be taken on by road or rail. In 2017, Missouri’s public ports generated around \$100 billion in annual economic activity.<sup>96</sup>

### Congestion Impact Modeling

Research conducted by the Texas Transportation Institute aimed to understand the impact of inland shipping on road and rail congestion. The research focused on an “all or nothing modal assignment principle.”<sup>97</sup> This means the scenarios looked at the amount of congestion if all inland shipping was moved to trucking or rail. Therefore, the congestion impact in this research is theoretical, but it highlights the importance of inland waterway shipping as a contribution to reduced congestion on highways and railroads.

Compared to highway traffic, tonnage from the Mississippi, Ohio, Tennessee, Cumberland, Columbia, Snake, and Gulf Coast systems was used to determine the equivalent annual truck loads, trips and vehicle miles traveled. In total, cargo in 2018 carried on inland waters equaled 43 million truck trips annually. In a scenario where all inland waterways traffic shifted to trucking, that would increase Weighted Average Daily Combination Trucks per Lane on urban interstate segments by 138 percent.<sup>98</sup>

The estimate of increased congestion on the rail network was based on the impact of a closure on the inland waterway system and the diversion of traffic from barges to rail. Grain traffic is a good example to illustrate the impact of moving inland shipping to rail, since grain is shipped by both. Total grain tonnage on the national railroad system was 165.7 million tons. The diversion from barge grain traffic would increase railroad grain tonnage by 38 percent.<sup>99</sup>

The research then focused on grain traffic along the Mississippi river diverting from barge to the Union Pacific (UP) and Canadian National (CN) railroads, which operate alongside the entire river and account for 22 percent and 5 percent of national grain movements, respectively. In 2019, UP moved 363,310 grain carloads, with average train velocities of 23.5 miles per hour. In the diversion scenario, UP would take on an additional 465,994 carloads of grain or a 146 percent increase in grain traffic. At 829,304 carloads, the average velocity would be 13.4 mph. Assuming grain trains are 110-car trains, UP would see 4,236 more train movements per year or 11.6 added train movements per day on UP lines.

In 2019, CN moved 85,611 grain carloads. In the diversion scenario, CN would take on an additional 109,808 carloads of grain or a 139 percent increase in grain traffic. For the total 195,419 grain carloads (and assuming 110 car trains with each car holding 110 tons of grain), CN would see an additional 998 train movements per year or 2.7 added train movements per day on CN lines. In their current state, railroads could struggle to respond to a diversion of grain traffic from barge to rail, seeing lower train velocities and a large increase in carloads, which may strain the network's capabilities and capacity.<sup>100</sup>

The exercise of measuring increased congestion in the "all or nothing modal assignment principle" is only a theoretical measure. Ideally, there would be no scenario where one mode would take on the movement of one commodity like grain. However, the exercise demonstrates the inland waterways' ability to serve as an important tool for transportation congestion alleviation. Shipping by barge provides a competitive advantage for shippers in regions like the Pacific Northwest.

## Flood Control

Flood control is an essential part of protecting habitats and communities from the effects of flooding. Flooding can impact a community's ability to move freely, damage the surrounding natural environment, and pose threats to life and property along the river. Part of the USACE's core mission includes Flood Risk Management (FRM).<sup>101</sup> USACE works to make communities aware of flood risks, analyze and address flood risks, and adjust approaches to ensure proper maintenance of FRM infrastructure. Flood control infrastructure includes levees, dams, and floodwalls/floodways, all of which work together to protect navigation and the natural environment from flooding.

The 1928 Flood Control Act helped to establish much of the flood risk control infrastructure, particularly for the Mississippi River region. Following catastrophic flooding in 1927 along the lower Mississippi river which flooded 16 million acres of land, killed 250-500 people, and displaced 500,000 people from their homes, the Flood Control Act established the Mississippi River and Tributaries Project. This initiative focused on levees and dams to confine flood waters, but also floodways and channels to disperse flood waters into designated areas.<sup>102</sup> In 2020, riverine FRM projects provided an estimated benefit of \$257.9 billion, and benefits are calculated based on flood damages that FRM infrastructure project prevent. In total, there are 13,500 miles of federally authorized levees and floodwalls.

The 1944 Flood Control Act built on the previous legislation, and introduced a multipurpose approach, including the construction of dams along the Missouri River which provided for flood control, but also hydropower, recreation, irrigation, and water supply.<sup>103</sup> The multipurpose nature of the flood infrastructure acted as a precursor for many other benefits that inland waterways provide today. The dams along the inland system are crucial pieces of infrastructure that keep the rivers from flooding the communities that rely on the water, but also facilitate hydroelectric power generation and recreational use.

### Chickamauga Dam

At one time, Chattanooga, Tennessee had one the most serious flooding problems in the country. The city suffered from various flooding events in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, and flooding was a part of life for communities living in the Tennessee Valley. Flooding was responsible for destroying crops, livestock, homes, and human lives. The Chickamauga Dam was constructed by the TVA in 1940, and the dam prevented nearly \$5 billion in flood damage over its lifespan for the people of Chattanooga.<sup>104</sup> The reservoir created by the dam is 58.9 miles long with 810 miles of shoreline.

In 2023, system-wide runoff in the Tennessee Valley Authority system was lower than normal due to fewer significant rainfall events, but the above normal amounts of rain in the winter and spring allowed for the low-cost generation of hydropower. It also supported TVA's work in flood mitigation, which prevents approximately \$309 million dollars in flood-related damages annually. Over its history, flood mitigation efforts have prevented \$9.7 billion in flood related damages.<sup>105</sup> The TVA can model the impact of flooding, based on data collected from past flooding events. The TVA uses the models to determine the impact of flooding and can predict the economic value of flood-related damages. This modeling is critical because it allows the authority to understand the risks and identify areas where flooding is prone. The data informs the TVA on what improvements are necessary to keep areas safe during times of heavy rains and other flood-risk periods.

TVA reservoirs can hold 11 million acre-feet of water between the early winter and late spring, and about five million acre-feet during the summer months. The practice of flood water storage is an important strategy that keeps rainwater in reservoirs and prevents the river from increasing to dangerous levels. The measure of the total capacity of reservoirs during the winter and summer seasons is an indication of how much the system can hold and is a quantifiable measure of the TVA's strength in flood management. The measure of prevented economic cost is important because it highlights the amount saved from flooding-related damages. The cost a city would have to pay for flood-related damages could impact the city's ability to fund important and desired projects, services, and operations of the city. That cost is prevented, keeping the desired budget for the city.

### Green Infrastructure

"Green infrastructure" initiatives, or nature-based infrastructure, which are strategies in flood control that involve floodplain and habitat restoration, are being discussed to accompany traditional flood control infrastructure to improve the nation's ability to manage flood risk in a sustainable manner. Improvements in flood control infrastructure, through maintaining traditional infrastructure and new "green" initiatives are important to ensure safety and ensure the waterways can continue to operate. These improvements ensure cities along the rivers continue to benefit from the waterways.<sup>106</sup>

## National Security

Along with the numerous ways the IMTS enhances the US, including elements like economic impact, energy production, and the other categories listed above, there are specific ways in which the waterways are directly linked to US national security. The waterways have long been considered the steady and reliable natural backbone for the country as it relates to goods movement. The waterways have always maintained a unique position in their ability to move oversize and overweight products, like military equipment, supplies for the National Aeronautics and Space Administration (NASA), and energy production equipment like nuclear reactors. Barges are a vital piece of the supply chain in getting these products to various facilities across the country, and the added benefit of being located on a waterway provides access to energy generation and water supply resource.

## Strategic Military Uses

Since the country's inception, the IMTS has been critical for military purposes. During early wars, many forts were constructed along waterways for utilization of various rivers as a natural protective barrier and for the movement of supplies. The military continues to use the IMTS for the movement of heavy machinery which would otherwise be challenging to move on other modes. The efficiency of the system allows for easy movement of equipment such as tanks and other heavy items.



*United States Army equipment moving by waterway to  
Central Louisiana Regional Port  
SOURCE: Cannon, 2020*

Additionally, the IMTS offers an enhanced level of security due to regulations on the movement of goods between U.S. ports. In 1920, the U.S. passed the Jones Act which requires goods moved between U.S. ports to be transported by U.S. built ships with U.S., or permanent resident, crews.<sup>107</sup> This decreases some level of threat from international interference with national security-related equipment.

## NASA Waterway Uses

Aside from the use of the waterways for military purposes, the IMTS is also used for the movement of equipment like NASA rockets for various missions, including deep space missions. NASA has maintained a fleet of barges for waterways transport for decades. The barges *Poseidon* and *Orion* were utilized to move portions of Saturn rockets and hardware during the Apollo Program, and in 1999, the barge *Pegasus* was constructed to replace the previous barges.<sup>108</sup>

*Pegasus* traversed the route from NASA's Michoud Assembly Facility in New Orleans to the Kennedy Space Center on Merritt Island, Florida using the Gulf Intracoastal Waterway and Gulf of Mexico. The *Pegasus* was renovated beginning in 2014 to increase the barge's carrying capacity in order for the agency to have the capability of moving the newer, and significantly heavier, deep space designed rockets. The *Pegasus* has since been utilized to move equipment from Michoud to various NASA facilities, including sites in Huntsville, Alabama and Bay St. Louis, Mississippi, among others.<sup>109</sup>

## National Labs

Within the national security conversation is the use of the IMTS for national lab activities. The Oak Ridge National Laboratory is located in Oak Ridge, Tennessee along the Clinch River – a tributary of the Tennessee River. The lab has long been reliant on waterways and generation of hydropower for electricity needs. During the period from 1943 to 1945, the District Engineer of the Manhattan Engineer District claimed that Oak Ridge consumed one-seventh of energy in the U.S.<sup>110</sup> Oak Ridge continues to specialize in energy today, including nuclear energy which requires significant amounts of water. The pool size for a single reactor ranges from approximately 8,000 to 110,000 gallons.<sup>111</sup>

## Global Competitiveness

Related to global competitiveness, the IMTS is not only critical for military and national security purposes, but the system is also essential for maintaining the competitiveness of U.S. exports. In 2022, the Eno Center for Transportation produced a report evaluating the competitiveness of the U.S. IMTS compared to peer river systems abroad, including South America, Asia, Europe, and Africa. In studying each of these systems, the report identified various strengths and challenges related to governance, needed infrastructure, and investments. Rivers like the Yangtze in Asia and the Amazon in South America have seen significant growth within the last decade. The Yangtze shipping volumes increased 8.2 percent from 2016 to 2017, and the Amazon saw a 6.7 percent increase annually from 2010 to 2019. Due to Chinese economic competitiveness

and the potential for strengthening connectivity to Europe, as well as the agricultural production of goods like soybeans which compete with U.S. exports, maintaining the IMTS is vital for global economic positioning.<sup>112</sup>

While the U.S. has invested in the IMTS in recent years, most recently through an influx of funding included in the IIJA, lagging maintenance and delayed construction persist. On the export front, some of the primary goods moved include agricultural products shipped from the Midwest to external markets. Delays and blockages in the IMTS decrease shipping capacity which drives up the cost of moving various commodities. For goods like these agricultural products, increases in shipping cost have a much larger impact on profit margins, making this export realm particularly sensitive to IMTS impediments.

## Conclusion

The scale and significance of the nation's network of inland waterways is not easily characterized. The system has been a vital asset for the U.S., bolstering the economy and providing economic and strategic military advantage, since the country's founding. As the movement of goods and people has evolved over time, the IMTS has evolved simultaneously. While fewer people move via waterway, and options for shipping have expanded, the waterways continue to serve as critical assets for the country.

At the most basic level, the nation has been able to tap into the waterways for things like irrigation, water supply, and cooling benefits. With the addition of locks, dams, and other USACE tools, the waterway has become a managed resource with a plethora of uses and an array of beneficiaries. This added infrastructure has allowed for energy generation while also creating a greater element of reliability as it pertains to rapidly changing water levels. These flood management tactics have facilitated the safe and economically beneficial development of waterway adjacent land, creating opportunities for industrial, commercial, and residential development, as well as the ability to better utilize these areas for recreation. Systemically, the waterways have become safer, on the actual waterways and alongside them, leading to nationwide gain.

As the waterways hold steadfast in the goods movement category, turning profit in areas like agriculture and securing global competitiveness, it is clear that the benefits extend far beyond the original understanding of waterway utilization. And while the many users and beneficiaries, direct or indirect, continue to rely on this system for maintaining quality of life, the system requires adequate maintenance to sustain these benefits enjoyed and relied upon by so many.

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