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16. Abstract This report addresses the benefits of maintaining the GIWW both in totality (5 States) and specifically between Texas and Louisiana since their coastal regions have been identified as a potential U.S megaregion. The chapters include a historical background and current conditions, the opportunities for raising barge productivity and safety, the challenges of increasing GIWW funding, the introduction of articulated tug barges (ATBs) which may have diverted some GIWW traffic, and finally summaries both findings and recommendations. It argues for sharply focused improvements and protecting system integrity for future technologies and barge designs.					
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**Impact of the Gulf Intracoastal Waterway (GIWW) on Freight Flows in the
Texas-Louisiana Megaregion**

by

Robert Harrison

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Impact of the Gulf Intracoastal Waterway (GIWW) on Freight Flows in the Texas-Louisiana
Megaregion

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Table of Contents

Executive Summary	vii
Acknowledgements	x
Disclaimer	x
Chapter 1. Background and Report Outline.....	1
1.1 Report Outline.....	4
Chapter 2. Demand for GIWW Services	7
2.1 Potential Growth Areas on the GIWW	9
2.1.1 Port of Victoria	10
2.1.2 The Port of Beaumont.....	11
Chapter 3. Current GIWW Needs	15
Chapter 4. GIWW Financing and Funding.....	21
Chapter 5. Articulated Barges: A Major Factor Reducing Current GIWW Demand?	27
Chapter 6. Study Findings and Recommendations	33
6.1 Findings	33
6.2 Recommendations.....	33
References	37
Appendix A: “Evaluating Reinvestment in Inland Waterways: What Policy Makers Need to Know”	41
Appendix B: Selection of ATB Images.....	42

List of Tables

Table 1.1: Milestones in the U.S. Waterways and GIWW Development.....	1
Table 1.2: GIWW Dimensions and USACE District and Division Locations	4
Table 3.1: Multistate GIWW Priorities in 2013.....	17
Table 3.2: Critical Issues Reported in the TxDOT 2014 GIWW Master Plan	18
Table 4.1: Fuel Tax, O&M, and Ton-miles on the GIWW, Ohio, and Mississippi Rivers	24
Table 4.2: Potential Texas GIWW Funding Strategies.....	24

List of Figures

Figure 1.1: GIWW: U.S. States, Ports, and Texas Counties.....	3
Figure 2.1: Forty Years of GIWW Tonnage Data	8
Figure 2.2: U.S. Diesel and Gas Fuel Oil production 2004–2012 (EIA, n.d.).....	8
Figure 2.3: Oil Exports from the Port of Victoria in 2013.....	10
Figure 2.4: GIWW Liquid Bulk Barges Loading at Jefferson Terminal Port of Beaumont.....	12
Figure 4.1: Inland Waterways Actual and Projected Trends 2007–2033 (Stern, 2013).....	22
Figure 5.1: ATBs and GIWW Barges on the Main Channel at the Port of Corpus Christi, Texas	28
Figure 5.2: 2010 Image of a 160,000 Barrel ATB Barge Built by EMI for Express Marine	29
Figure 5.3: Tug “Freedom” Built for Express Marine Inc. to Match the Barge Shown in Figure 5.2	30
Figure B.1: A Crowley 550 ATB demonstrates a tight turning radius	42
Figure B.2: Crowley 650; to the casual observer, an ATB looks like a ship.....	42
Figure B.3: The Crowley 650 ATB in deep water.....	43
Figure B.4: Traditional single GIWW-T barge.....	43

Executive Summary

Background

The Gulf Intracoastal Waterway (GIWW) links five U.S. States—Texas, Louisiana, Mississippi, Alabama, and Florida—and played a role in their economic development, although its utility has waned since the end of World War II. The current condition of the GIWW system is arguably the result of long-term neglect based on a failure to undertake increases in capital investment and maintenance expenditures. Federal neglect is predictable as the GIWW is considered a coastal system and treated separately from the U.S. inland waterway system, which has a greater national economic impact and greater political support. Its inclusion in the coastal category also puts GIWW needs in direct competition with Gulf deep water port improvement projects that support U.S. global trade growth. Many commodities transported over global routes are doing so in larger ships offering higher economies of scale. However, larger ships require deeper port and terminal channels that are expensive to dredge and maintain on the Gulf continental shelf. Recently, funding the U.S. Atlantic and Gulf port projects linked to the expected increase in Panama Canal lock traffic has further weakened support for GIWW projects. Finally, demand is falling on many GIWW segments; the system is essentially sustained by petrochemicals and products related to oil and gas fracking activities, particularly in Texas.

U.S. inland waterway and GIWW investments have frequently failed to target resources on projects that support and sustain system-wide infrastructure needs. Funding has been inadequate and weakly focused, plagued by engineering cost overruns and complicated by a spate of federal earmarks over three decades. The upshot is that many of the inland waterway and GIWW locks are now over 50 years old and in need substantial improvement to provide the reliable 24/7 window needed for competitive barge services. The GIWW also provides social benefits excluded from the typical calculation of financial and economic impacts, even though it provides an important environment for fish, birds, animals, and humans. These benefits are not addressed in this study but should be part of long-term economic analysis at a megaregional level.

Megaregions

The study focus was triggered, initially, by the findings of a 2006 Regional Plan Association (RPA) Report that forecasted U.S. population clusters in 2050 and predicted that two-thirds of the U.S. population would live in 11 megaregions—typically multistate entities containing fast-growing current metropolitan regions whose boundaries overlap to form “interlocking economic systems, shared natural resources and ecosystems and common transportation systems that serve the communities”(RPA. 2006). One such megaregion was the Gulf Coast, which included parts of Texas, Louisiana, and Mississippi, where a substantial portion of the U.S. chemical and petrochemical industries are located. The importance of this megaregion was strengthened by the work published in 2007 which identified regions based on their luminosity from space (Florida, 2007). The structure of this study therefore began by evaluating whether there were common GIWW goals at the state level that could inform coordinated regional economic policies to promote higher levels of GIWW investment. The Gulf Coast megaregion is served by several transportation modes—highways, rail, pipelines, deep water ships, and GIWW barges—some private, others public. Was there any common ground that made a strong case for joint multimodal planning that would serve the growing Gulf Coast

megaregion? The 2013 study results in this report show that only Texas and Louisiana had an effective joint range of strategic priorities that could be easily combined to form a multistate program. It also demonstrated the challenge of maintaining consistency over time, because its findings slightly differed from the recent Texas Department of Transportation (TxDOT) GIWW-T report (Kruse et al. 2014), which found that renovating a single structure was the highest priority on the Texas portion of the waterway. If this new information were incorporated into this UTCP study results, an even stronger joint position could be taken by megaregion planning advocates.

Superficially, it is obvious that modest investments in key elements of the GIWW system, where demand is either stable or growing, are desirable and likely to be justified by cost-benefit analysis. Why, then, have federal and state departments of transportation impacted by the GIWW system not explicitly recognized the value of those system-wide investments? The U.S. Senate version of the Water Resources Development Act of 2013 (WRDA 2013) gave the GIWW a failing grade, allocating a low priority to the system. Are there other issues—negative or positive—that were not considered and merit a review that might raise the relevance of a regional waterway system that provides a variety of economic and social benefits?

Study Purpose, Structure, and Findings

This report examines the question of GIWW viability and utility from a policy perspective, using economic and planning data to provide strategic evidence for a range of potential multistate policies. It is organized to identify and describe the limitations, financing and operational challenges associated with alternative policies. It considers the potential value gained by megaregional planning and identifies opportunities to coordinate, rather than compete, with other modes on a multistate basis. It finds evidence to strengthen GIWW operations, both in terms of state and multistate perspectives. It also recognizes that there may be future transportation water-based freight technologies that can be adopted as long as the GIWW right-of-way is not lost through encroachment or abandonment.

The outline of the report, together with some specific findings, is as follows:

- Chapter 1 provides a historical background detailing the struggle to build and operate the waterway in the face of railroad competition.
- Chapter 2 examines Texas GIWW demand and the enhanced role a waterway might play in supporting a multimodal transportation system capable of offering competitive shipper services over the next four decades. It finds that the GIWW is currently limited by the operating conditions of the water—low speed, stagnant demand (until fracking began), and operational weaknesses in terms of authorized dimensions and the need for more areas to safely secure barges during adverse weather and port congestion.
- Chapter 3 describes the current GIWW needs to raise efficiencies within the present system and enhance them where demand justifies the investment. It also examines whether there are mutually beneficial goals across the five Gulf States served by the GIWW, which could lead to a multistate program of needs. It ties these study findings into the recommendations of the TxDOT-sponsored *Texas Gulf Intracoastal Waterway Master Plan* (Kruse et al. 2014), currently the most up-to-date document on the subject, which provides a framework for a state-supported program to improve the waterway in Texas.

- Chapter 4 examines GIWW funding and opportunities for financial support from non-traditional sources. It finds that no easy solutions acceptable to the barge industry and its customers, even though some are based on simple cost-benefit outcomes where operational benefits (like higher productivity) are greater than the revenues required (like raising fuel tax).
- Chapter 5 reports that recent changes in barge design have taken a substantial share of cargo away from the GIWW. This answers, to some degree, the vexing challenge of explaining the relatively flat demand on the GIWW since 1986. Succinctly, articulated barges (ATBs) have been introduced into U.S. coastal shipping over the last decade and the latest ATB design has over ten times the bulk liquid capacity of a GIWW barge and is four times faster in open water. It is classified as a barge and meets all the Jones Act requirements. These barges operate over segments of the U.S. coast and on the Lower Mississippi. This enables their operators to use both river and deep water routes to move bulk products between Texas ports and locations on the Lower Mississippi without using either traditional GIWW barges or its waterway. Transportation modes have all benefitted from economies of scale, whether in terms of the modes carrying the cargo or the operational systems that allow greater size or length. Now the barge industry has a system that matches the economic benefits of other systems—providing a barge solution equivalent to longer, heavier trains, larger container ships, and bigger freight planes. This is a key finding and while data need to be collected, it could explain while GIWW demand only recently neared 1986 levels, while the industries it serves have doubled production over the same period.
- Chapter 6 summarizes the findings for policy recommendations for federal and state consideration. It finds that while other U.S. inland waterway projects may be more compelling in terms of their immediate benefits to shippers and barge operators, relatively small, well-targeted investments in the GIWW system are justified in nominal cost-benefit terms and would protect the integrity of the system for new technologies and barge designs.

In November 2014, the Texas state demographer Lloyd Potter announced that his office estimated the state population would rise to over 54 million over the period 2010–2050 (Potter and Hoque 2014) if migration continued at the rates of the first decade. The impact of this growth, even if it diminishes, will be substantial on the state transportation system and its modes. In 2050, the Gulf States—particularly Texas, Louisiana, and Mississippi—might find themselves benefiting from having preserved a coherent, integrated coastal canal right-of-way system that serves deep and shallow draft ports and operators alike through marine design, communication, and safety system technologies unknown or unperfected in 2015.

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Disclaimer

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Chapter 1. Background and Report Outline

Inland waterways—rivers, lakes, and both inland and coastal canals—formed the major intercity trade transportation network upon which the U.S. Industrial Revolution was founded over two centuries ago. The first time inland waterways were officially recognized was in 1807 when the Secretary of the Treasury, Albert Gallatin, proposed a national system of internal improvements to highways, rivers, lakes, and canals in the United States. Moreover, this transportation system, described in a report entitled “Public Roads and Canals,” was to be funded in part by the federal government using a version of what now would be termed a public-private partnership. The inland waterway system has continued to play a minor, though significant, role since that time and even in 2015 several key constraints to its potential contribution to moving goods within the U.S. remain to be addressed.

Table 1.1 provides a historical sequence of events that produced the current Gulf Intracoastal Waterway (GIWW) system. The italicized events can be regarded as critical stages in both the development of the U.S. waterway system in general and the GIWW in particular. It shows a flurry of legislation in the first quarter of the 19th century, from Gallatin’s 1808 report to the General Survey Act of 1824. The latter is of note because only the federal government had the authority and resources to undertake the strategic planning of all the waterway resources of the U.S., so the U.S. and its Army engineers undertook the challenge of improving the inland waterway navigation. In 1819, Secretary of War John Calhoun proposed that the Army Engineers be used extensively in the surveying, planning, and supervising internal improvements of the waterways. In this period, therefore, two key elements were established. First, the U.S. Army Corps of Engineers (USACE) became the key federal agent of inland waterway management and operations. Second, the most feasible Gulf coast waterway system was one linking St. Marks, Florida, to Lake Pontchartrain, Louisiana—essentially what is now termed the eastern leg of the current multistate GIWW.

Table 1.1: Milestones in the U.S. Waterways and GIWW Development

Date	Milestones
1808	<i>“Public Roads and Canals”</i> Secretary of the Treasury
1816	<i>“Survey of National Defense”</i> War and Army Engineers
1819	<i>“Roads and Canals”</i> Secretary of War
1824	<i>General Survey Act</i> (President Monroe)
1887	Interstate Commerce Act (Grover Cleveland)
1904	U.S takes over building the Panama Canal
1905	<i>Interstate Inland Waterway League</i>
1909	Congress recognizes US system of inland waterways
1925	<i>Rivers and Harbors Act</i>
1942	Congress authorizes completion of the GIWW

Table 1.1 also shows a break of almost a century before interest in the GIWW returned. This was due to the difficulty of building inland waterways in the populous and politically powerful regions of the U.S. and, more importantly, the advent of steam locomotion, which needed less right-of-way and less capital to both build and expand networks. Rail rapidly

eclipsed other transportation modes and is indelibly linked with the key achievements of the Industrial Revolution. The success of U.S. railroads was based on fast, regular services and brutal competition with other modes, especially waterways. This ranged from monopolistic pricing for customers not served by other modes or rail companies¹ to price fixing below the operating costs of modal competitors like canals to drive them out of business². The 1887 Interstate Commerce Act was passed in an attempt to control the more egregious practices used by railroad companies. Those private companies negatively impacted often had access to alternative, but neglected, river systems and the end of the 19th century saw the formation of agencies and associations that demanded improvements in the waterway system to challenge the domination of railroads.

Arguably, the most successful of these associations was based in Victoria, Texas, where a group of business leaders formed the Interstate Inland Waterway League with the ambitious role of promoting a navigable inland waterway system linking the Great Lakes, major rivers, and the Louisiana and Texas coastlines.³ The League changed its name first to the “Intracoastal Canal Association of Louisiana and Texas,” and the later to its current title of the “Gulf Intracoastal Waterway Association” and there is compelling evidence that without this association the GIWW might never have been built. The 1925 Rivers and Harbors Act authorized a continuous canal from New Orleans to Galveston and two years later it was extended south to Corpus Christi. It proved an immediate commercial success and stimulated the states of Mississippi, Alabama, and Florida to complete the canal system along the eastern edge of the Gulf coast. Legislation passed in 1942 authorized the completion of the current system from St. Marks to Brownsville, a distance of around 1200 miles, as shown in Figure 1.1.

The strategic benefits of a functioning inland waterway system first proposed 135 years earlier were amply demonstrated during the Second World War (WW2) when it was used to move vital materials and counter an initially devastating campaign by German submarines. The GIWW offered a protected lifeline for key commodities and moved over 1.7 billion barrels of petroleum products by 1945, prompting the Department of Defense to state that “if the GIWW had never moved anything other than WW2 products it would have justified its construction” (Alperin 1983). That critical role was in one sense the highlight of the GIWW in the 20th century. In the 1950s, demand concentrated on bulk commodities, particularly energy-related products from the growing number of refineries along the coasts of Texas, Louisiana, and, to a lesser extent, Mississippi. The 1960s saw the development of the interstate highway system⁴ (IHS), a 45,000-mile highway system completed in 1992. The IHS removed auto and truck through traffic from the center of the cities it served⁵ and propelled the truck to become the major freight mode for U.S. freight, carrying around 70% of U.S. domestic freight by value in 2012 (USDOT 2013). The daily range of a truckload carrier typically doubled with the IHS and the maximum gross weight of the largest truck increased from around 58,000 lb. in 1958 to the current limit of 80,000 lb. in 1982, further asserting truck dominance in the U.S. domestic freight market.

¹ This feature remains a Surface Transportation Board responsibility when considering approval of mergers after the passage of the Staggers Act, which deregulated railroads in 1980.

² This is still used in certain cases, as exemplified by the rail rates competing for container on barge services; see Bomba and Harrison, 2002.

³ As an example, they argued that in 1912, Pennsylvanian coal could be brought to Louisiana or Texas at half the price charged by railroads, saving \$2 million each year in transportation costs.

⁴ The Federal Aid Highway Act was signed by President Eisenhower in 1956, linking all cities over 50,000 (at that time), all states, and national borders. Planning began almost immediately and construction peaked in the 1970s.

⁵ The promotion of this system included the phrase “coast to coast without a red light.”



Figure 1.1: GIWW: U.S. States, Ports, and Texas Counties

The current condition of the GIWW system is arguably neglected, although over certain segments barges continue to offer competitive services to shippers, particularly those moving bulk products like grains, aggregate, and coal, together with a variety of liquid chemical and petrochemical commodities. The Texas GIWW had relatively constant or declining demand until 2011, when fracking gained momentum in Texas, which weakened the economic cost-benefit ratios of federal investment relative to other waterway projects. Most of the GIWW locks are over 50 years old and need substantial improvement to provide a 24/7 window for barge services. The GIWW also provides social benefits not included in the cost-benefit calculations based on commercial operations, since it provides an important environment for both the coastal environment—fish, birds, and animals—and humans⁶.

USACE still supervises and funds—sometimes partially—GIWW capital and maintenance needs from three District Offices in three Corps Divisions. Of the five GIWW states, Texas has the longest section and is the only one whose state Department of Transportation acts as a non-federal sponsor to the waterway. This role has traditionally focused on activities related to the disposal of dredged material on over 200 disposal sites along the Texas coast, such as using eminent domain to buy coastal property for disposal purposes. Recently, the creation of a Maritime Division has broadened Texas Department of Transportation (TxDOT) planning to include Texas deep and shallow draft ports, the GIWW, marine intermodal projects, and to link TxDOT with marine stakeholders. Table 1.2 provides basic data on the GIWW dimensions, demand, and USACE locations for all five state segments.

⁶ The BP Deepwater Horizon oil spill in 2010 is a tragic reminder of U.S. Gulf environmental costs, causing widespread damage to beaches, creeks, plants, seabirds, and land animal and fish species.

Table 1.2: GIWW Dimensions and USACE District and Division Locations

	Texas	Louisiana	Mississippi	Alabama	Florida
Length (miles)	406	310	306	60	125
Tonnage 2011	74652	63384	17295	4733	1812
NonFederal Sponsor	TxDOT	Parishes	NA	NA	NA
Corps District	Galveston	New Orleans	New Orleans	Mobile	Mobile
Corps Division	Dallas	Vicksburg	Vicksburg	Atlanta	Atlanta

Investment in transportation infrastructure funded by state and federal taxes has fallen to critical levels and the GIWW, to function effectively, currently needs 1) protection from encroachment, 2) the replacement or renovation of key locks, and 3) an effective dredging program to maintain authorized dimensions (12 ft. draft and a 125 ft. minimum width). The strategic policy question is simple: is it worth it? The Senate version of the Water Resources Development Act (WRDA 2013) gave the GIWW a failing grade, allocating a low priority to the system. This SWUTC report examines the question from a policy perspective, using economic and planning data to provide strategic evidence for a range of policies and investment opportunities.

1.1 Report Outline

Chapter 2 examines Texas GIWW demand and the enhanced role a waterway might play in supporting a transportation system capable of offering competitive shipper services over the next four decades. It finds that it is limited by the operating conditions of the water—low speed, lack of growth until fracking began in Texas, and operational weakness in terms of dimensions and the immediate need to provide safe areas to tie barges needed for a variety of reasons (including weather and port congestion). Chapter 3 describes the current GIWW needs to raise efficiencies within the present system and enhance them where demand is highest. It combines the findings from this study with the recommendations of the *Texas Gulf Intracoastal Waterway Master Plan* (Kruse et al. 2014), currently the most up-to-date framework for a state-supported program to improve the waterway in Texas. Chapter 4 examines GIWW funding and opportunities for financial support from non-traditional sources. It finds no easy solutions acceptable to the barge industry and its customers, even though some are based on simple cost-benefit outcomes where operational benefits (like higher productivity) are greater than the revenues needed to support the improvements.⁷ Chapter 5 reports that recent changes in barge design may have diverted a substantial share of cargo off the GIWW system. Succinctly, articulated barges (ATBs) have been introduced to U.S. coastal shipping over the last decade and the latest ATB design has over ten times the bulk liquid capacity of a GIWW barge and is four times faster in open water. These barges operate most frequently over segments of the U.S. coast and on the Lower Mississippi on multi-year contracts to the largest chemical, petrochemical plants and refineries. They are double hulled and Jones Act compliant.⁸ Chapter 6 summarizes the findings for policy recommendations for federal and state consideration. It finds that while other U.S. inland waterway projects may be compelling in terms of their immediate benefit to shippers and barge operators, relatively small, well-targeted investments in the GIWW system are justified in nominal cost-benefit terms and protect the integrity of the system for new

⁷ The most obvious source would be raising the fuel tax.

⁸ The Jones Act requires that coastal shipping crews are U.S. citizens and the vessels built in U.S. shipyards.

technologies and barge designs. Currently, researchers are being challenged to think fifty years ahead in terms of transportation technologies, modes, and system planning. Thinking ahead to 2060, the Gulf States—particularly Texas, Louisiana, and Mississippi—may have benefited enormously from preserving a coherent, integrated coastal canal right-of-way benefiting deep and shallow draft ports alike⁹.

⁹ Many DOTs are evaluating the transportation needs in 2050 and beyond. TxDOT has a 2050 strategic focus on technology, multimodal performance, and the efficient use of all transportation infrastructures.

Chapter 2. Demand for GIWW Services

“A Texas GIWW working efficiently at full capacity has a positive impact all along the Texas coast.”

(Kruse et al. 2014)

Maritime services provide substantial economic contributions to the state of Texas, as exemplified by economic impacts studies sponsored by individual deep water ports (Martin Associates 2007 and 2012) and TxDOT (Siegesmund et al. 2008), as well as Maritime Division sponsored research. Deep water ports and private terminals play major roles in making Texas (a) the leading state when import and export values are aggregated and (b) second in total maritime tonnage at almost 490 million tons in 2012. In the same year, GIWW operators On the Texas segment accounted for around 78 million tons or 16% of total maritime cargo weight, comprising petroleum and petroleum-related products, chemicals (many hazardous), and bulk materials such as rock, coal, and, increasingly, fracking sand.

A multistate planning perspective—national or megaregional—demands that the system be treated holistically, although this report concentrates attention on the Texas portion, where it could play a more significant role in the state transportation system. Moreover, demand on the western leg (Louisiana and Texas) is now substantially greater than that on the eastern leg (Mississippi, Alabama, and Florida), enhancing the mutual economic benefits of well-defined Texas-Louisiana investments. Nevertheless, even the western leg has not shown similar growth rates to those of deep water maritime, rail, and truck modes. The Figure 2.1 graph of total GIWW tonnage since 1970, calculated by the author, clearly shows that the system has not grown at the same rate as the Texas Gulf coast economies or the highway and rail modes over the same period. Figure 2.2 shows the output of diesel and gasoline in U.S. refineries in the period 2004–2012, measured in barrels per calendar day (bbl/cd) over one third of which is produced in Texas and Louisiana and served by the GIWW.

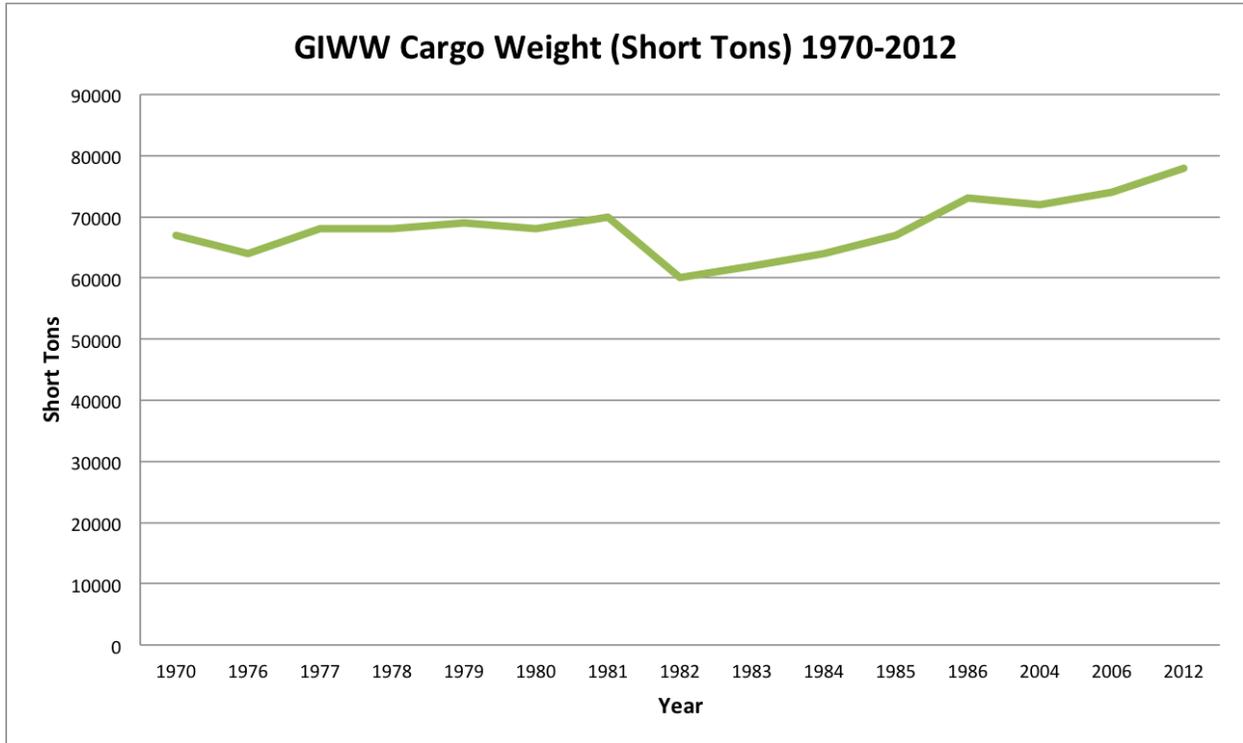


Figure 2.1: Forty Years of GIWW Tonnage Data in Texas

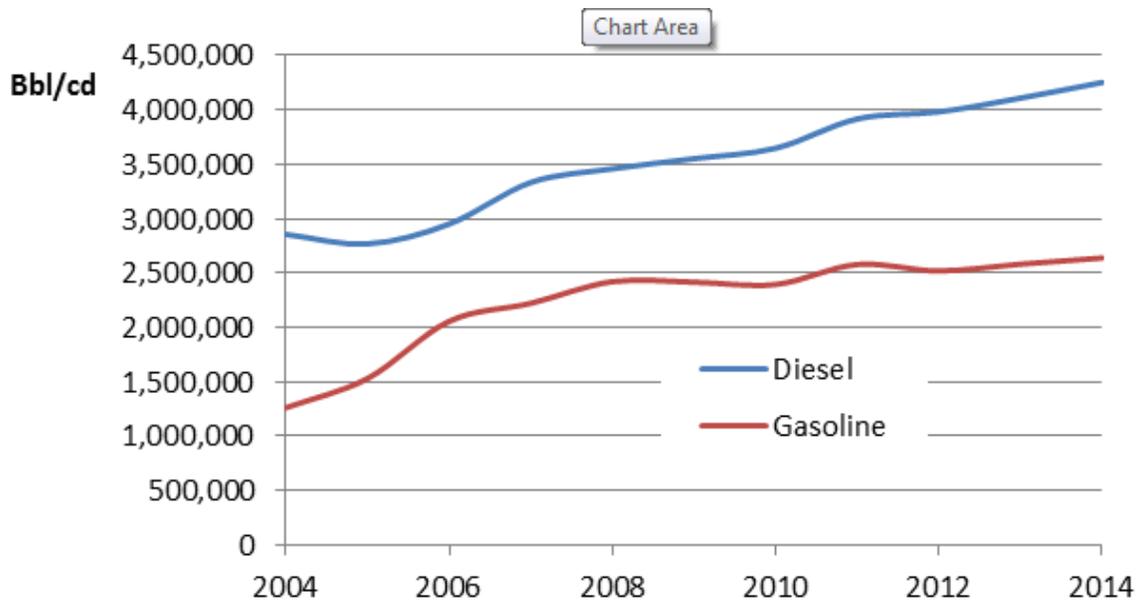


Figure 2.2: U.S. Diesel and Gas Fuel Oil production 2004–2012 (EIA, 2014.)

In fact, demand has only recently returned to 1986 levels of tonnage (Burke and Garrett 1989), although the recent *Texas Gulf Intracoastal Waterway Master Plan* (Kruse et al. 2014) correctly identifies the system as having the potential to strengthen the multimodal capability of

the state transportation system at a time of sustained reductions in traditional sources of funding for highways.

European transportation planners would probably be astonished to learn that demand on the GIWW has failed to grow substantially during the last 40 years, given the substantial growth in tonnage and commodity values at most deep water and shallow draft ports served by the GIWW. In other countries, established waterway systems have been an element in most national transportation plans. Freight flows in the European Union (EU), for example, have benefitted from improved inland waterway systems since its inception in 1993. EU commodities range from traditional bulk products to containers, with over one-third of boxes destined for Germany and landed at the Port of Rotterdam traveling to receiving docks on German rivers and waterways on ships or barges. Moreover, many of those locations have attracted clusters of companies providing logistics and light manufacturing services (Sheffi 2012) that support local employment and reduce total transportation costs. Investment in waterborne container services has also been undertaken in parts of China and Southeast Asia and it is reasonable to expect that the GIWW, with its links to the major U.S. inland waterway systems, would be in a position to provide competitive service.

Several constraints have prevented the GIWW from taking a more significant role in Gulf State transportation system planning. First, the GIWW has not received adequate capital or maintenance funding over the last two decades and has now reached the point where barge services and schedules are negatively impacted. The consequences of this are described in the 2014 *Texas Gulf Intracoastal Waterway Master Plan* (Kruse et al. 2014) and in supporting documentation (Siegesmund et al. 2008). Second, the GIWW barge configuration(s), size, and design technologies¹⁰ have remained constrained by the authorized dimensions of the GIWW. Third, the Jones Act protects U.S. shipbuilding by requiring ships and barges operating on coastal and inland waterways to either be built in U.S. shipyards or carry a substantial import tax if imported into the U.S. This negative impact has been mitigated, to a degree, by the introduction of ATBs, described in more detail in Chapter 5, that are too large to use the GIWW. Finally, no regular container services are currently offered by GIWW operators—a potential growth market for petrochemical exporters. One notable exception was when Osprey Lines, based in Houston, did provide a range of container-on-barge services a decade ago including moving U.S. food aid¹¹ and returning empty containers a short distance from big-box warehouses located across the Houston Channel to the Barbours Cut terminal¹².

2.1 Potential Growth Areas on the GIWW

Two case studies—one on a shallow draft port (Port of Victoria) and another on a deep water port (Port of Beaumont)—demonstrate how new commercial opportunities, funded by private companies, have strengthened the relevance of the GIWW in Texas.

¹⁰ Navigation technologies are, of course, excluded from this statement.

¹¹ This comprised shipments from Lake Charles, Louisiana, to the Port of Houston, where cargo was transloaded to Maersk Shipping for overseas delivery.

¹² This is an unexpected market “slot” since cost analysis typically puts barge services in the 300-mile-plus range.

2.1.1 Port of Victoria

The Port of Victoria is located in Victoria County near the Texas mid-coast region between Houston and Corpus Christi. It is served by the Victoria Barge Canal, a 35-mile waterway that connects the port turning basin to the GIWW. It has a 12 ft. authorized depth but some shoaling north of the barge canal and the GIWW junction has limited loads over the past 5 years. It is a landlord port—renting land and berths for users—and has a small staff. It is a beneficiary of the Eagle Ford shale play, which since 2011 has created a substantial economic uptick at the Port; see Box 2.1. The Eagle Ford play imports substantial amounts of sand and gravel, special fracturing or “fracking” sand, and also exports oil and distillate from the various wells it serves, transferring product from trucks and more recently pipelines to barges.

Box 2.1: Fracking’s Economic Impact on the Port of Victoria in 2013

The volume of cargo by weight at the Port of Victoria has increased substantially from 1.4 million tons in 2007 to 6.7 million tons in 2013.

Jobs created by the port—direct and indirect—over the same period have grown from 9,200 to 21,000.

Source: Martin Associates 2014

Figure 2.3 provides 2013 oil export data for the Port of Victoria. Other commodities related to the energy and agriculture sectors have also grown. In 2014, almost 6000 barges called at the port facilities carrying sand and gravel (52%), oil and chemicals (39%), and farm products (10%). Fracking sand is delivered from sites on the Mississippi River while oil from Eagle Ford wells is transported to refineries in Houston and Lake Charles, and Southern Louisiana refineries—reflecting megaregional transfers.

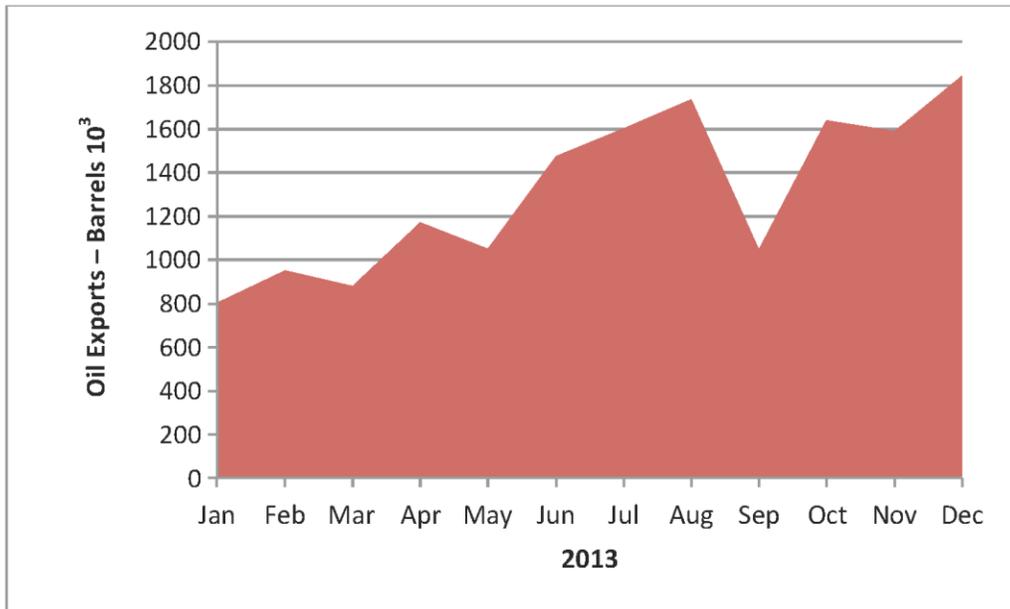


Figure 2.3: Oil Exports from the Port of Victoria in 2013

The growth in oil exports was first dependent on trucks but grew strongly after a system of 8 inch pipelines linking the port were completed, including one known as the “Louisiana Express” connecting distribution units in the Eagle Ford play with the Port of Victoria storage

facilities. Monthly data on oil exports from the Port of Victoria are given in Figure 2.3 and show a significant change over the twelve-month period of 2013.

The challenges of forecasting modal demand is exemplified by considering the energy sector in Texas. Virtually all pre-2009 waterway, rail, and rural highway demand studies failed to address the impact of fracking. The multi-million dollar series of studies commissioned to examine the feasibility of larger locks on the Panama Canal entirely omitted the impact of oil and gas production from plays such as Eagle Ford and Permian Basin II. Panama Canal Association staff made a presentation addressing new energy forecasts at the 2015 Offshore Technology Conference (Sosa 2015) that details significant changes to the original forecasts, now capturing both oil and gas flows—the latter in liquefied (LNG) form—predicted for the Asian markets. An analysis of the end-to-end movement of oil, condensates, and gas from new or revitalized production sites shows that a number of shallow draft ports and terminal used GIWW barges to deep water export terminals or to refineries along the Gulf coasts served by the GIWW.

On the global energy markets, natural gas derived from plays like the Eagle Ford is relatively inexpensive and has attracted the attention of international corporations like BASF, who are considering transferring some production from the EU—which is largely dependent on Russian gas—to its Louisiana or Texas facilities, or building new facilities in both states where viable. Caterpillar has a large plant near the port that will finally have the capacity to produce a product line from 12 to 49 tons and employ 800 workers. Currently it makes a 36-ton Model 336E that can be moved under permit relatively safely on state highways, although heavier models destined for export will create more transportation problems. Caterpillar has been in discussions with the Port of Victoria to evaluate the benefits of constructing a relatively short oversize/overweight (OS/OW) corridor, permitted through legislation passed in the Texas Legislative session in 2013, to link the plant to the Victoria barge canal. This would allow large, heavy Caterpillar exports—currently moved by road—can be moved to the Ports of Houston or Corpus Christi using the GIWW. Legislation that permits OS/OW corridors has been passed; this legislation impacts the lower Rio Grande Valley (which falls under the auspice of the Hidalgo and Cameron County regional mobility authorities) together with authorized routes at the deep water ports of Freeport and Brownsville. It is not unreasonable to believe that a route would be supported in the Legislature given the economic impact of the Caterpillar facility. This would also clearly benefit TxDOT highways currently used by the Department of Motor Vehicles to route OS/OW export loads from the plant location to deep water export terminals.

2.1.2 The Port of Beaumont

Beaumont arguably lies at the epicenter of vehicle fuels manufacturing in the United States, with four major refineries and numerous liquid bulk terminals located in a 20-mile radius of the port. These refineries collectively produce some 60% of the nation's gasoline and jet fuel, consuming about 1.4 million barrels of crude oil every day. Historically, the bulk of this crude oil has been supplied to the refineries by range of oceangoing tankers, including shallow draft ships for Central and South American reserves to larger deep draft ships from Middle Eastern sources. Most of the refineries in Southeast Texas are set up to consume heavy sour crude, the kind of oil that also comes from Canada, which is then blended at the refinery with the lighter “sweet” crude oil found in the Permian Basin and several shale oil plays. The major petrochemical refining companies are interested tapping the Canadian heavy oil reserves, which are economically cheaper and more politically reliable than traditional sources of heavy, sour

crude, which is traditionally transported by tanker ships from Mexico, Venezuela, and Saudi Arabia.

The Port's Jefferson Transload Railport now provides an alternative to the ocean transport of crude oil to Texas. Figure 2.4 provides an image of the terminal in February 2015 where construction can be seen on storage tanks and a steam plant. It is only in the early stages of build out and will finally have further rail capacity, storage, and steam treatment systems to enable the heavy oil to be carried and pumped in its natural state. Unit trainloads of crude oil from shale formations in the U.S. and oil sand plays in Canada are now being unloaded at Jefferson's Port of Beaumont terminal, which is located on the Sabine-Neches River in Orange County. The crude terminal, which opened in December of last year, is unique in that it has the ability to receive full unit trains of crude oil from three Class 1 railroads—Union Pacific, Burlington Northern, and Kansas City Southern—that serve the burgeoning oil shale production areas in North America and oil sands regions in Canada. Notable features of the terminal design are the unloading stations that allow 120 rail cars to be simultaneously unloaded, together with its unobstructed access to the Neches-GIWW waterway system.



Figure 2.4: GIWW Liquid Bulk Barges Loading at Jefferson Terminal Port of Beaumont

Currently, the terminal is being expanded to add additional rail loops, including tracks equipped with steam lines to unload pure bitumen from Canadian oil fields, as described in Box 2.2 (Roby 2015). More storage tanks are also being built, two of which will be heated to handle the Canadian crude oil. Once unloaded from rail cars, the crude oil is currently pumped directly into barges serving area refineries via the GIWW; lighter oil can be transferred to storage tanks on the terminal and moved out using other modes, like smaller pipelines or trucks.

There is little doubt that domestic energy activities at the state, megaregional, and national levels have created demand for GIWW barge services on the upper reaches of the Texas GIWW located north of Corpus Christi. However, the growth in refining out has taken place over a much longer period than shale oil production, as shown in a

later chapter, so it appears that a number of factors have coincided to limit GIWW demand. One of these factors could be associated with a growing list of needs, some relatively minor, which have created bottlenecks or lowered operating efficiency on the waterway. These are addressed in the next chapter.

Box 2.2: The Jefferson Terminal at the Port of Beaumont

“The new steam heated transfer system at the terminal is now being tested to allow heavy viscous oil to be transferred from railcars to heated GIWW barges. The first train is expected to arrive at the end of March 2015. This is the largest investment made on Port of Beaumont property and will have the most significant strategic impact in two decades.”

Source: John Roby, Director Logistics and Public Affairs, Port of Beaumont, February 2015

Chapter 3. Current GIWW Needs

All transportation infrastructures exhibit economic life cycles, dictated by changes in demand (customers), the needs of the products being moved (size, weight, value), competitive modal responses (prices), and the requirements of the specific infrastructure element, such as the need for safety. Highway bridges, for example, can be maintained substantially longer than their service life. Many bridges are replaced not because the risk of collapse but rather on safety grounds—their design cannot serve the traffic levels adequately,¹³ which raises the accident risk. The same infrastructures have another shared characteristic—namely, they are expensive to build and this cost has to be met before the first truck, train, airplane, ship, or barge generates revenues.

The GIWW has exhibited a long and relatively inexpensive total cost over its life. Locks are built to serve specific customer barge dimensions and there are less than 15 locks on the whole of the waterway, almost all centered around New Orleans. Locks have an economic life based on capacity, demand, performance, and physical wear, tear, and decay. Their dimensions are first adopted to serve the largest types of barge or ship at the time of construction and then later act as a constraint to using larger ship designs that offer improved economies of scale. This is best illustrated by the locks on the Panama Canal system; see Box 3.1. Panamax ships became uncompetitive handling bulk or containers about 20 years ago and a new set of locks is currently being completed. However, since the new locks were designed, containerships have grown in size beyond the new canal dimensions, suggesting that a further set may be needed if global demand increases over the next three decades.

Barge size is not the key problem with the GIWW locks because there is virtually no current demand for larger barges. A problem arises due to either the condition of the current locks—a lock can close to traffic if it fails—or the approach from the lock to the main channel, which impacts operator safety and operational efficiency.¹⁴ Locks—their capacity, condition, and safety in terms of approach—fall into one of several categories of GIWW need.

In an attempt to see if a multistate portfolio of joint needs could be recommended to the five states served by the GIWW, the following unranked needs were selected for state review:

Box 3.1: The Panama Canal Locks

The Panama Canal, opened in 1914, was designed to serve the largest ships of the time. The locks, needed to raise and lower ships over the high Gatun cordillera, are approximately 1100 ft. long, 40 ft. deep, and 112 ft. wide. They were adequate for almost all ships until WWII and the 1950s, when naval architects began to develop much larger ships. The strategic significance of the canal in terms of global shipping led to the development of a Panama standard design—termed *Panamax*—which allowed the largest possible ship to pass safely. A new set of larger locks is under construction and will open in 2016.

Source: Harrison and Trevino, 2013

¹³ Highway bridges are sometimes given an economic life of 50 years but this number can rapidly decrease depending on the volumes of trucks and auto traffic.

¹⁴ One barge operator informed the author in 2013 that recent improvements to a key lock at New Orleans were planned without adequate operator input and had made the approach more dangerous in certain conditions.

1. **Structures**, defined as locks, floodgates, approaches to locks, and rail and highway bridges.
2. **Dredging**, defined as the maintenance of authorized dimensions—125 ft. width and 12 ft. depth.
3. **Disposal sites**, defined as locations where material removed to maintain dimensions could be safely and efficiently placed. In Texas, these are obtained by TxDOT through negotiation or invoking eminent domain, which creates the largest number of placements on the GIWW.
4. **Environmental needs**, defined as measures to mitigate the impacts of GIWW operations and accidents on beaches, wildlife, and water quality.
5. **Recreation**, a category that recognizes that the GIWW as a system has sections with a diminished level of commercial barge traffic, creating opportunities for small boats for personal use, sometimes linked to vacations.
6. **Encroachment**, defined here as the operational and safety problems created by placing people or businesses at the edge of, or actually in, the right-of-way of the mode. Encroachment is a growing issue that is impacting transportation system efficiency. It is particularly relevant to rail systems in metro areas (Loftus-Otway 2009) and has now extended to parts of the GIWW. The GIWW was designed to carry freight and support the economies of the Gulf States. The waterway has served many commercial interests but has focused on agricultural, chemicals, petrochemical, and bulk products. In many states, particularly Texas and Mississippi, farm land is being sold to developers who are using the proximity to the GIWW as a social lure for prospective home and ranch owners. This is creating the potential for barge impedance and accidents with recreational boats or boat docks constructed at the edge of the GIWW right-of-way, particularly in Texas.

A review was undertaken to group those GIWW states with similar issues—first to see if there was any system coherence and second to determine if multistate interests could be packaged to promote improvements to the system that would benefit several states. This would be useful for federal multistate planning, especially since the concept of megaregions is growing—albeit at a slow but positive rate—in Washington D.C. The work was conducted in 2013 and should form a basis for more detailed analysis since the core conditions—economic growth and strong petrochemical demand—have not significantly altered.

The review results are shown in Table 3.1 and essentially report the impact of dredging on the Texas-Louisiana sections, together with the significance of recreation on the western sections of the GIWW.

Table 3.1: Multistate GIWW Priorities in 2013

	Texas	Louisiana	Mississippi	Alabama	Florida
GIWW Priority 1	Dredging	Structures	Encroachment	Mobile Bay	Recreation
GIWW Priority 2	Disposal Sites	Dredging	Recreation	Dredging	Encroachment
GIWW Priority 3	Structures	Environmental			
GIWW Priority 4	Encroachment				

First, it should be recognized that GIWW siltation is a recurring issue predominantly on the western leg of the canal, created by topography, fluvial, drainage, and Gulf currents, in addition to heavy storms or hurricanes. All states reported that locks around New Orleans—their performance, condition, and the detours required when taken out of service—impact GIWW system efficiency. In Texas, the TxDOT Executive Director decided to evaluate a strategic action, permitted under state law, to provide financial assistance to maintain authorized depth over much of the GIWW system in the state. At that time, USACE estimated that around \$50 million of additional funding to supplement federal funds would be required to maintain GIWW authorized depth in Texas and TxDOT felt that such a modest figure could perhaps be reached through a public-private partnership (Wilson 2012), where the state contribution was supported by the beneficiaries of higher barge productivity,¹⁵ as outlined in Box 3.2.

The response to questions posed to those responsible for the western leg—Mississippi, Alabama, and Florida—reflected a low priority placed on GIWW investments. Alabama reported few problems over the short stretch of the GIWW that passes the state boundaries, while Florida and Mississippi faced choices between important revenue and job creation in the recreational coastal areas. In Mississippi, for example, several retirement and vacation communities were concerned about plans to increase the capacity of the state petrochemical plants in response to the supply of new oil and gas from regional fracking areas. This raised the problems that can be grouped under the general term of “encroachment” with two sub-groups: the first are landside properties that impact barge safety, such as fixed objects on the canal inner boundary, and second are those individuals and families living or vacationing near the canal who fear air quality degradation from enhanced refining facilities.

This admittedly small scale exercise suggested that Texas and Louisiana had sufficient joint benefits from system improvements that they could form a megaregional position to retain the GIWW as an important future transportation corridor to complement rail, highway, and pipeline modes in the next 40 years.

A larger, more recent piece of research, completed by staff at the Texas Transportation Institute (TTI) provides greater detail on the specific needs and recommended policy options of the GIWW system in Texas, termed *GIWW-T*. It is a state-specific analysis and different from the more general, holistic approach of this report. Nevertheless, there are some interesting

Box 3.2: GIWW Support

“If truckers are willing to pay the marginal cost of operating at higher weights, why would barge operators and their customers not contribute to higher productivity and lower costs per ton for their shipments?”

Source: Phil Wilson, TxDOT Executive Director, 2012

¹⁵ In Texas, this figure has been estimated to be between \$50 million (Kruse and Ellis) and \$100 million (Kruse and Harrison).

overlaps between the two pieces of work. Table 3.2 reports a ranked order of the six most important issues for the GIWW-T; these issues inform TxDOT’s 2014 *Texas Gulf Intracoastal Waterway Master Plan* (Kruse et al. 2014).

Table 3.2: Critical Issues Reported in the TxDOT 2014 GIWW Master Plan

Ranking	Issue	Impact
1	Brazos River Floodgates	Navigational Issues for tow operators <i>Safety, river flooding and silting</i>
2	Additional Fleeting Areas	Holding areas for barges <i>Repairs, storage, repairs, safety</i>
3	Replace Caney Creek Bridge	Obsolete swing bridge <i>Mechanism jams, navigation, safety</i>
4	Encroachment	Right-of-way infringement <i>Capacity, safety, efficiency</i>
5	Placement Areas	Meeting environmental legislation <i>Planning future needs</i>
6	Expanded Mooring Access	Inadequate for future needs <i>Safety, efficiency</i>

Source: Kruse et al. 2014

This report suggests that this list can be broken down into two categories: 1) system-wide GIWW elements likely to find support from other states served by the waterway and 2) more expensive, state-specific investments. System-wide investments related to locks and bridges need to be placed on a multi-year funding time table while those that impact safety and efficiency, especially when they can be accomplished with modest investment, should be given a higher priority. Texas can fund these from its own customers, users, and state agencies based on cost-benefit analyses that reflect both operating and social benefits. The largest annual cost at current levels of demand is \$59 million for maintaining authorized dimensions, particularly depth. This cost is five times larger than the estimated annual impacts of the Brazos River floodgates at current estimates reported in the Master Plan, and the final benefits fall further once the final floodgate cost is determined. The U.S. inland waterway lock replacements have been plagued by extraordinary cost overruns and it is therefore likely that final Texas floodgate costs will be much higher than currently estimated.

The *Texas Gulf Intracoastal Waterway Master Plan* is an essential document for policy makers as they consider how to make the waterway more efficient and safer. This report suggests that needed investments can be categorized in two ways. First, investments that support the GIWW as a multistate system should be developed by the six state DOTs as a regional alternative to complement existing and planned highway and rail systems. Energy movements alone deserve a regional investment program to support the economic advantage the U.S. now has in the global production of petrochemicals. The second category comprises those investments that support movement within state segments of the GIWW and these include the maintenance of authorized dimensions on those sections of the GIWW-T where demand warrants the increase, determined by cost-benefit analysis.

GIWW users, it can be argued, have fallen into a static mindset where no cost recovery mechanism finds strong support, even though the economic benefits for many projects clearly exceed investment costs. This is unfortunate because the GIWW, like other U.S. inland

waterways, needs a well-crafted, effective, and stable stream of funding to provide a reliable infrastructure to grow market share. The next chapter describes the current funding mechanism, shortfall, and recommendations made to remedy this situation.

Chapter 4. GIWW Financing and Funding

This subject has a somewhat complicated history and is currently under review. It is highly recommended that the reader consult an excellent summary undertaken by C.V. Stern at the Congressional Research Service entitled “Inland Waterways: Recent Proposals and Issues for Congress” (NTIS 2012). Construction, maintenance, and improvements to the U.S. inland waterways over the past 30 years have been almost exclusively funded through legislation contained in the Water Resources Development Acts of 1986 (WRDA 1986) and 2007 (WRDA 2007). Most projects have been funded through a 50/50 cost sharing basis between federal funds and a barge fuel tax revenues, which have been channeled through the Inland Waterways Trust Fund (IWTF). In the first decade of the 1986 legislation, fuel taxes rose from 8 to 20¢ per gallon. Thereafter, like the Highway Trust Fund, the barge fuel tax remained at that figure, not indexed for inflation. In 2014, it was raised to 29¢ following strong bipartisan approval of an industry-sponsored 9¢ per gallon increase in the inland waterway fuel user fee.¹⁶

It can be argued that waterways legislation and the IWTF investment strategies, weakened by earmarks, have had a greater negative impact on the waterway system than the Highway Trust Fund deficits have had on highways and truck productivity. The IWTF was set up in the first Revenue Act of 1978 but no funds were expended until 1986 when a surplus of \$260 million had accumulated. Since that date, balances have fluctuated quite widely and the IWTF’s impact has been adversely affected by large cost overruns on key projects (see example in Box 4.1) and the wide range of project types—engineering, maintenance, shoreline, water quality, and environmental needs—that have been diluted by the limited IWTF funds. In addition, federal earmarking distorted strategic planning and left many projects unexecuted or unfinished. The Obama White House proposed higher fuel taxes—actually in the form of user fees rather than taxes—in FY 2010, FY 11, FY12, FY 13, and FY 14. Several efforts to reach an acceptable position between all interested parties (examining alternative forms of funding such as lock fees; moving locks; performing dam construction and maintenance; raising fuel taxes/fees) failed to result in any broad agreement until 2014. In that year, a new version of the legislation, entitled the Water Resources Reform and Development Act (WRRDA 2014), was passed by Congress and carried a 9¢ increase in fuel tax for inland waterway users. It is intended to stimulate interest in funding from third parties or beneficiaries to leverage federal funding. It also stipulates that all of the funds collected under the Harbor Maintenance Trust Fund be fully devoted to meet the original purpose of the legislation by 2025—namely, to support port and harbor effectiveness by dredging. It also increases support for levee integrity and safety, as well as expediting project delivery processes.

Box 4.1: Olmsted Lock and Dam

This project on the Ohio River is the largest and most expensive on the U.S. inland waterway system. Over a 30-year planning and construction period, costs have risen from \$771 million to \$3.1 billion and it now consumes almost all of the annual \$160 million in user fuel and matching federal revenues in the IWTF. It is now inextricably linked to the Ohio economy and continues to draw strong support in Congress.

Source: Schneider 2014

¹⁶ Ultimately it was signed into law (Public Law 113-295) as part of H.R. 5771, which extended expired tax provisions.

It is apparent that users (barge industry and customers) are expected to play a larger role in the future funding of U.S. inland waterways, yet the most obvious mechanism—fuel taxes—unfortunately meets the same resistance on waterways as on highways. While it is obvious, at least to most economists and planners, that contributions to maintain transportation infrastructure must be related to the benefit of both commercial users and their customers, there are other important reasons why this principle is difficult to apply on waterways. Perhaps three crucial reasons are (a) the wide variety of beneficiaries or agencies seeking improvements, (b) the monolithic USACE, and (c) Congressional interference through earmarking and a reluctance to spend the existing IWTF balance or raise revenues. Actual expenditures over the past 25 years between 1987 and 2013 demonstrate inadequate levels of IWTF spending, as Figure 4.1 shows.

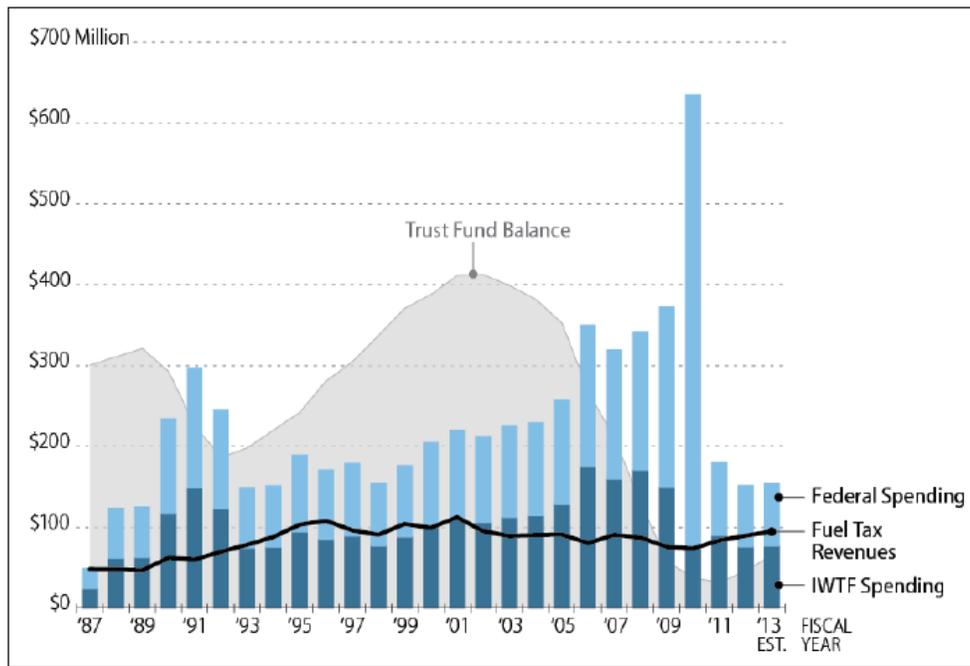


Figure 4.1: Inland Waterways Actual and Projected Trends 1987–2013 (Stern 2013)

Several striking elements combine to support a past inconsistent strategy of inland waterway investment. Several World War II locks needed replacement during this period, yet for many years the IWTF ran a large balance. Second, fuel tax revenues were effectively stable since 1995—the last date they were raised. Thirdly, federal funding broadly matched the fuel revenues with one exception. Fourthly, that exception was a \$400 million infusion from the American Recovery and Reinvestment Act, which was intended to boost U.S. construction and jobs by funding “shovel ready” projects, of which—one imagines—there must have been a good number.

A number of initiatives were undertaken in the last six years to offer constructive changes to the current funding system. Most have focused on “tuning” the existing system and have avoided the fuel tax mechanism. One exception was the 2010 Inland Waterways Users Board (IWUB) proposal recommendation (IMTS 2010):

1. Increase the IWTF fuel tax by 6–9¢ per gallon,
2. Increase Federal Share of waterway costs and move a larger portion of projects to general revenue,
3. Increase overall spending on waterways, and
4. Improve USACE project development and increase IWUB involvement on evaluating engineering projects from a user perspective.¹⁷

This proposal also offered a number of specific projects for consideration once the funding was strengthened. It suggested that projects should be subject to a multi-criteria analysis that includes condition, asset performance, and system impacts. This approach concentrated on selecting the candidates with the highest economic impact but the report did not suggest funding mechanisms—that was left to Congress. It is noted that the Water Resources Reform and Development Act of 2014 contained many of these recommendations, including raising fuel tax by 9¢ per gallon.

Other groups have advocated increasing the user contributions to support inland waterways and reduce the federal portions, currently 100% of operations and maintenance (O&M) and 50% of construction. These groups include the National Commission on Fiscal Responsibility and Reform (NCFRR 2010) and a number of reports from the Congressional Budget Office (CBO 2011). Most recommendations focus on raising the contributions from users, although most do not provide detailed mechanisms for attaining this goal. Two exceptions are those of the Bush and Obama Administrations. The Bush Administration focused on lock user fees, since locks accounted for most of the inland waterway capital construction costs. This approach was rejected by both Senate and House appropriations committees based on the “unacceptable burden” placed by those that used locks—obviously removing subsidies could not be contemplated.

The Obama Administration (Whitehouse.gov 2012) proposed a similar lockage fee, although other elements were proposed. The existing fuel tax would be maintained but a “two-tier” annual fee would be set to differentiate between those ships that used locks and those that did not. Exact fees were not mentioned but new fee targets were set:

1. FY12 – Not less than \$35 million
2. FY 13 – Not less than \$75 million
3. FY 14/21 – Not less than \$900 million
4. FY 22 onwards – As needed to maintain a \$50–\$150 million balance in the IWTF

The Administration estimated that the new fees would raise \$1 billion for the IWTF, but like all the reform initiatives of the 21st century, it failed to pass from lack of support at one level or another.

The GIWW is one of 17 waterways receiving O&M funds provided by USACE. The Congressional Research Service Report 7-5700 provides an interesting comparison of fuel tax revenues and O&M expenditures relative to estimated ton-miles¹⁸ on each of the 17 waterways

¹⁷ A survey respondent in this study claimed that an improved New Orleans lock was now more difficult to safely enter when certain currents were present.

¹⁸ Ton-miles is cargo tonnage times the trip distance.

during the period 2005–2009. The GIWW was the fourth largest recipient of O&M funding as shown in Table 4.1.

Table 4.1: Fuel Tax, O&M, and Ton-miles on the GIWW and the Ohio and Mississippi Rivers

	Fuel Tax (\$10 ³)	OM (10 ³ \$)	Ton Miles (\$billion)
GIWW	9	56	19
Ohio	20	80	56
Upper Miss	10	120	29
Lower Miss	15	18	129

Notes: Average Fuel Tax, Av Annual 2000–2008
 Average Annual O&M 2000–2008
 Ton Miles 2005–2009

The table suggests that the GIWW has been favorably treated when compared with other inland waterways under the current flawed system. Unfortunately, the evidence from the Bush and Obama two-term Administrations suggests that it will take further time to put inland waterways, including the GIWW, on a more stable funding basis. TxDOT is evaluating user involvement, perhaps through a cost-sharing mechanism between itself, USACE, and operators and it is to be hoped that the multimodal planning reflects the importance of maintaining the GIWW.

Funding remains a critical issue to be addressed in any strategic evaluation of the GIWW. The recent TxDOT GIWW-T report (Kruse et al. 2014) is very helpful in guiding policy makers through a variety of mechanisms; Table 4.2 lists the funding options suggested in the report.

Table 4.2: Potential Texas GIWW Funding Strategies

Potential Texas GIWW Funding Strategies
1: Promote Texas GIWW Projects to USACE and Congress
2: Apply for Marine Highway Corridor Designation
3: Compete for Federal Discretionary Grant programs
4: Explore Florida’s Inland Navigation District Model for Texas
5: Evaluate the use of CEPRA Funds
6: End State Diesel Tax Exemptions
7: Public-Private opportunities

Source: Kruse et al. 2014

Texas shows that it is willing to consider putting the GIWW-T on a more secure footing—either working with other GIWW states or going it alone to enhance the canal so that it offers a competitive, safe, environmentally sound, and reliable Gulf coast transportation system. TxDOT interest and support is crucial at this time, especially as a national panel of U.S. experts met several times in the last 2 years to recommend policies to be considered by federal and state

authorities. Appendix A summarizes the terms of reference for the committee, and their deliberations are due soon. Note that “inland waterways,” as defined by TRB, excludes the GIWW—thus, the strategies and decisions of TxDOT carry even greater significance. Texas is therefore taking the lead in promoting this endeavor.

This report noted that tonnage on the GIWW, including the GIWW-T, has been flat until recently and even then the increase has been modest. This was a puzzle since the total production of chemicals, petrochemicals, and refined products has grown strongly over the past two decades. The impact of various modes could have played a role—particularly rail and pipelines. The research undertaken for this report identified a new type of barge (the articulated barge or ATB) and found that it is carrying cargo that might otherwise travel on the GIWW. ATBs are the subject of the next chapter.

Chapter 5. Articulated Barges: A Major Factor Reducing Current GIWW Demand?

Freight transportation, irrespective of mode, should be recognized as a conservative sector, characterized by high capital costs of entry, long life cycles, competition, and modest returns. A concept highly prized by efficient transportation companies is economies of scale—selecting the best combination of modal size to move the volume of cargo needed by the customer. It is not purely based on the size of ship, train, truck, airplane, or barge, but rather finding the optimal cargo size that can be handled by all modes in the supply chain. The implications of mismatching modal size within a supply chain are severe and impact competitiveness or even change the business model—see Box 5.1.

Chemicals, petrochemicals, and refined products in the U.S. are carried in longer, heavier trains, through networks of pipelines, trucks, and Jones-Act-compliant deep water ships. All offer economies of scale that translate to lower cost per ton mile and faster service than barges. Succinctly, barges and the infrastructure on the inland waterway systems they use have been unable to offer economies of scale to the industries they serve. This report suggests that this is the main factor that has kept demand virtually constant on the GIWW since the early 1980s. A second factor, which this report noted, was the development of a larger, more efficient barge that equates to the heavier train and larger ship.

Barges have been both pulled and pushed since canals were dug. The motive power either pulled the barge or propelled it, depending on the waterway. In the 1950s, some experimental barges were developed where the tug was integrated into the hull of the single barge. This was a different way of moving barges. Generally, small barges, which could pass through narrow locks, were built into a large “tow” and pushed from the back by a single power unit. These worked the inland river systems—particularly the Lower Mississippi River—although they had to be broken down for many of the other river locks. On the GIWW, locks are not numerous and tows are typically either two barges either pushed in line or tied together and are separated for lock transit. The history and details of the early development of the ATB systems are clearly summarized by Robert P. Hill in a two-part series published on MarineLink.com (Hill 2002).

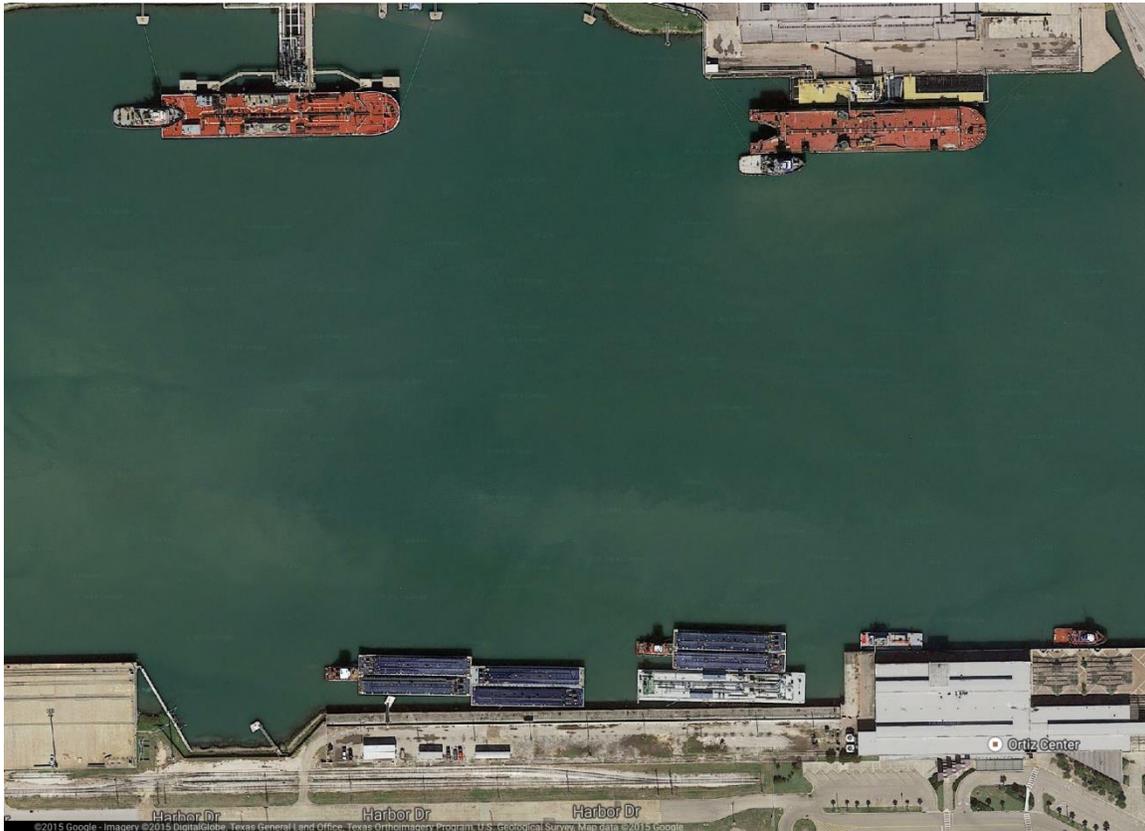
The precursors to ATBs were integrated tug barges (ITBs), first developed in the late 1950s. In the 1970s, a naval architect named Edwin Fletcher worked with Bludworth Engineering to develop the first single degree of freedom system applied to a tug and large barge. This, in turn, led to the U.S. Coast Guard implementation of NAVIC 2-81, where tug-barge units were split into two distinct groups: push-mode ITBs and dual-mode ITBs. These rules recognized the unique safety advantages of mechanically connecting a tug and barge at sea,

Box 5.1: Impact of Large Containerships

18,000 TEU ships are replacing smaller ships on two main lanes: China to the U.S. West Coast and Southeast Asia to Europe via the Suez Canal. The smaller containerships, less than 10,000 TEU capacities, call around 20 times on the EU-Suez routes to drop off and pick up boxes, while the biggest ships stop once at each continent or load center. Even beyond a port's need to be capable of handling the higher volumes, ports must be reconfigured to handle the additional loads and landside systems. On some routes, vessel sharing agreements (VSAs) are formed because no single carrier can fill the ship capacity.

and the improvements were given full recognition and approval (Hill 2002). The dual mode provided various forms of hinged connections that allowed the tug to pitch independently of the barge and became known as the articulated tug barge (ATB). The mechanism was further improved with the “Intercon”¹⁹ system, which has subsequently been developed further by companies such as JCOMARIN, Blutworth, Artubar, and Articouple.

The ATBs now rival Jones Act tankers. The upper portion of Figure 5.1 shows two ATBs being loaded with Eagle Ford shale oil at Corpus Christi; the lower portion shows empty GIWW barges waiting to be taken back to their shallow draft loading points (such as Victoria, Texas) on the GIWW-T. In the upper right of Figure 5.1, one ATB has de-coupled from its hull and the design of its coupling area is clearly visible.



Source: Google Maps, May 2015

Figure 5.1: ATBs and GIWW Barges on the Main Channel at the Port of Corpus Christi, Texas

Several barge operators run ATBs of various sizes over key lanes on the West Coast, East Coast, Gulf, and inland waterways like the Lower Mississippi. Figure 5.2 shows a medium size double-hulled barge; the rack into which the barge interlock fits can be seen in the stern.

¹⁹ As developed by the Intercontinental Engineering-Manufacturing Corp, Kansas City, and Robert P. Hill.



Figure 5.2: 2010 Image of a 160,000 Barrel ATB Barge Built by EMI for Express Marine

Crowley Maritime Corporation has been a leader in the design of the ATB and now operates three classes, the largest of which carries ten times the capacity of a GIWW barge (327,000 barrels) with a transfer rate of 30,000 barrels per hour—the capacity of a standard GIWW tank barge. The latest ATBs are different in almost every respect from the barges of the 1950s when GIWW traffic was at its highest. The design elements related to navigation, safety, efficiency, and speed are unparalleled in barge history and have begun to replace the Jones Act tankers on many routes, from Alaska to the Gulf. There is little doubt that they must impact demand for traditional GIWW barges on key routes, including the Lower Mississippi to Texas ports and Texas refineries to Florida. At the moment, heavy oil is being transported by Kirby Marine Transportation from the Jefferson Transload Railport terminal at the Port of Beaumont to Texas refineries by GIWW barges, but as demand ramps up it is likely that ATBs will transport some of the product. The smaller ATB class, compared to a GIWW tow, can transport more oil, travel on the Nueces River to deeper water, and deliver to any Texas refinery. Moreover, when they reach deeper water, they can increase their speed to 12–14 knots so their trip time will be shorter.

The tug shown in Figure 5.3 now forms part of a mid-sized ATB fleet operating for Express Marine, principally on the eastern coast of the U.S. Crowley has now introduced its largest class to date, which competes with the largest Jones Act tanker. The Crowley 750 class

carries 330,000 barrels of oil and the tug is powered by a heavy oil 16,000 BHP engine rated for EPA Tier 3 emissions. It has state-of-the-art hydraulic valves, tank balancing systems, vapor collection, radar, and navigation systems.



Figure 5.3: Tug “Freedom” Built for Express Marine Inc. to Match the Barge Shown in Figure 5.2

The ATB steers better than a towed barge. However, steering performance is even better than designs mating the tug to barge with fenders and backing wires. This is because the connection between tug and barge is made with a rigid, transverse axis. Steering then is positive, absolutely identical to that of a ship. This is also a great benefit when entering ports with tricky bar situations, where towed barges often wait long periods for the waters to subside before entering or departing in heavy seas.

Mr. Joe Pyne, CEO of Kirby Marine Transportation, summarizes why ATBs are making a substantial contribution to barge productivity, even though such designs are unable to access the GIWW. He stated in 2014 that “With the coastal fleet utilization around 90%, increasing demand for the coastwise movements of crude and natural gas condensate, and continued progress in expanding our coastal business to inland customers, new capacity is needed to meet demand. The 185,000 barrel ATB unit has the flexibility to access ports that restrict larger vessels, while still delivering large volumes of product for our customer” (Almeida 2014).

The GIWW segments that serve petrochemical plants, especially in Texas and Louisiana, will use standard barges to reach shallow draft oil delivery terminals and then connect with loading dock and storage plants at deep water facilities where Jones Act tankers and ATBs will move the product long distances at faster speeds. Clearly, ATBs are playing a crucial role in moving U.S. chemicals and petrochemicals efficiently and safely and, in their way, have given

support to the viability of the shallow draft GIWW, which connects key production plants and customers in the Gulf.

The next chapter summarizes the findings of this report and offers policy recommendations for preserving the GIWW at both state and megaregion levels.

Chapter 6. Study Findings and Recommendations

6.1 Findings

Chapter 1 provides a historical background, detailing the struggle to build and operate the waterway in the face of railroad competition which exists to this day.

Chapter 2 examines Texas GIWW demand and the enhanced role a waterway might play in supporting a multimodal transportation system capable of offering competitive shipper services over the next four decades. It finds that the GIWW is currently limited by the operating conditions of the water—low speed, stagnant demand until fracking began, and operational weaknesses in terms of authorized dimensions and the need for more areas to safely secure barges during adverse weather and port congestion.

Chapter 3 describes the current GIWW need to increase efficiencies within the present system and enhance them where demand justifies the investment. It also examines whether there are mutually beneficial goals across the five Gulf States served by the GIWW, which could lead to a multistate program of needs. It ties these study findings into the recommendations of the TxDOT-sponsored *Texas Gulf Intracoastal Waterway Master Plan* (Kruse et al. 2014), currently the most up-to-date document on the subject, which provides a framework for a state-supported program to improve the waterway in Texas.

Chapter 4 examines GIWW funding and opportunities for financial support from non-traditional sources. It finds that no easy solutions acceptable to the barge industry and its customers, even though some are based on simple cost-benefit outcomes where operational benefits (like higher productivity) are greater than the revenues required (like raising fuel tax).

Chapter 5 reports that recent changes in barge design have taken a substantial share of cargo away from the GIWW. This answers, to some degree, the vexing challenge of explaining the relatively flat demand on the GIWW since 1986. Succinctly, articulated barges (ATBs) have been introduced into U.S. coastal shipping over the last decade and the latest ATB design has over ten times the bulk liquid capacity of a GIWW barge and is four times faster in open water. It is classified as a barge and meets all the Jones Act requirements. These barges operate over segments of the U.S. coast and on the Lower Mississippi. This enables their operators to use both river and deep water routes to move bulk products between Texas ports and locations on the Lower Mississippi without using either traditional GIWW barges or its waterway. Transportation modes have all benefitted from economies of scale, whether in terms of the modes carrying the cargo or the operational systems that allow greater size or length. Now the barge industry has a system that matches the economic benefits of other systems—providing a barge solution equivalent to longer, heavier trains, larger containerships, and bigger freight planes. This is a key finding and while data need to be collected, it could explain why GIWW demand only recently neared 1986 levels, while the industries the GIWW serves have doubled production over the same period.

6.2 Recommendations

This section summarizes the findings in terms of policy recommendations for federal and state consideration. It finds that while other U.S. inland waterway project impacts may be higher in terms of their immediate benefits to shippers and barge operators, well-targeted investments in the GIWW system are justified in nominal cost-benefit terms. Moreover, they would protect the integrity of the system for future new technologies and barge designs. This process has already

benefit recognized in Texas with the development of a GIWW-T master plan that contributes to TxDOT's goal of facilitating a multimodal freight transportation plan. It also offers state and regional policymakers a range of transportation funding options.

The GIWW system is not included as a current priority for policy makers examining the future of U.S. inland waterways whose terms of reference are given in Appendix A of this report. However, for those states served by the coastal waterway, it remains an important mode inexpensively maintained compared to the costs of highway and rail investments. The future is difficult to imagine and it is easier to extend current modes—and their shortcomings—to address the needs of specific calendar years like 2040 or 2060. The challenges are evident when the difficulties of planning the multistate IH 69 are considered. There has been modest progress developing the IH 69 in only one state—Texas—after over two decades. Yet the GIWW comprises an existing *five-state* 1100-mile right-of-way that could play a crucial role by 2060.

New barge technologies and control systems could revolutionize freight demand on coastal canals, increasing their impact on multistate economies and job creation while providing a range of social benefits, including environmental support, disaster recovery, and social impacts not explicitly measured at this time. William Ward, the TxDOT District Engineer who supervised the first freeway in Texas and ended his career contributing to a new system of land-based transportation modes, summarized the transportation challenge in five words: “preserve sufficient right of way” (Ward 2001). Preserving the existing GIWW to meet future demand is crucial to the success of multimodal megaregional freight planning. Demand is already growing on segments of the waterway, allowing it to serve new industries and customers, including the following:

- a. Steel from shipbreaking at Brownsville.
- b. Heavy oil from Beaumont to Texas refineries.
- c. Sand and other materials for maintaining fracking output when oil prices rise, new wells are drilled, and existing ones need refracking.
- d. Containers—a perennial service that has not established itself on the GIWW. It might do so if economic demand for freight flows is maintained and highway construction does not keep pace with congestion.
- e. Offering an alternative mode to shippers moving heavy loads, especially if truck size and weight legislation does not change due to federal and/or state inaction. Heavier loads can be moved on the waterway using new technologies in future decades.
- f. A major threat to the viability of the GIWW as a system is the conversion of land adjoining the waterway from agriculture to small, private lots, as Box 6.1 attests. The growth of multiple small-parcel land owners creates a potential safety issue and can result in political resistance to industrial expansion, such as building capacity at petrochemical plants. In recent years, metropolitan expansion—the exact phenomenon that stimulated the concept

Box 6.1: Texas Gulf Coast Auction: April 21, 2015

Costa Grande Ranch, 5221 Acres:
Offered in Tracts and Combinations

5+ miles of Intracoastal Waterway
Frontage with Deep Water Access

Abundant Wildlife

Great hunting and potential high
fence property

Adjacent to future state park

Only 2.5 hours from Houston,
Austin or San Antonio

www.hallandhall.com

*Source: Austin American
Statesman, 2015*

of megaregions—has placed homes and apartments close to busy transportation corridors and hubs, creating congestion and noise pollution. This has been studied most closely on rail networks (Loftus-Otway 2012) but can be applied to any freight corridor or load center, such as terminals. Freight corridor land use planning is essential to maintain a balance between acceptable service levels and equitable treatment for landowners and citizens.

The megaregion approach is slowly gaining support as a federal planning concept but to work requires a regional freight perspective at a time when states are only now developing new state freight plans. A 2012 CTR/TSU study provided a summary of the potential megaregional freight benefits and showed the value of multistate megaregional planning of the type recommended in this report (Harrison et al. 2012). If the U.S. is to maintain economic competitiveness, it must inevitably move to integrated transportation regional planning over the next three decades. Why has it not been implemented, or at least tested, over the decade since it was first proposed?

This study focused on Texas because of state interest in the GIWW and its membership in the original 13 megaregions. What can Texas accomplish by promoting further support for maintaining a viable GIWW system? Four reasons are provided:

1. TxDOT planners can recognize that logistic systems are multistate and multinational and build this into state planning. They should incorporate a greater understand of the GIWW potential as a regional transportation system, just as they should monitor logistic planning and modal investments in Mexico that impact NAFTA trade flows and developments in key export markets. Target TxDOT support through providing matching funds to private contributions that, when combined with USACE funding, allows the maintenance of authorized dimensions over the most heavily used segments of the waterway in Texas.
2. Develop a joint strategy with Louisiana to address maintenance of authorized dimensions and lock renewal. Although the review of the five states served by the GIWW reveals little potential for a harmonized program of needs, a smaller grouping of Texas and Louisiana, with Mississippi joining if right-of-way preservation is included, is feasible. Obviously, the U.S. oil and gas exploration strengthens the relevance of this partnership. This megaregion carries the responsibility of being the largest chemical and petrochemical producer in the U.S. and few other states can take their place.
3. If that is too ambitious at this time, Texas could take the lead and develop its segment of the waterway as described in the recent GIWW-T master plan. This would raise federal interest and support the chemical and petrochemical industries growing in, or relocating to, the state.
4. Recognize the strategic utility of maintaining the GIWW-T not only for economic reasons but also for safety and social benefits from hurricanes and other activities that can close down a deep water port. The state can continue functioning in such conditions based on modal redundancy.

In November 2014, the office of the Texas state demographer Lloyd Potter released a report estimating that the state population would rise to over 54 million over the period 2010–2050 (Potter and Hoque, 2014) if migration continued at the rates in the first decade. The impacts

of this growth, even if diminished, will be substantial on the state transportation system and its modes. In 2050, the Gulf States—particularly Texas, Louisiana, and Mississippi—might find themselves benefiting from having preserved a coherent, integrated coastal canal right-of-way system serving deep and shallow draft ports and operators alike through the public and private implementation of marine design, communication, and safety system technologies unknown or unperfected in 2015.

References

- Almeida, Rob (2014) "Kirby to Order New ATB." GCaptain.com. Accessed at http://gcaptain.com/kirby-atb-order/#.VYc37_1VhBd.
- Alperin, L.M. (1983) "History of the Gulf Intracoastal Waterway," National Waterways Study, U.S. Army Engineer Water Resources Support Center, Institute for Water Resources, January 1983.
- Austin American Statesman* (2015) Advertisement on Section F page 8, March 8, 2015.
- Bomba, M.S. and R. Harrison (2002) "Feasibility of a Container-on-Barge Network along the Texas Gulf Coast," Transportation Research Record 1782, Paper No. 02-4007, Transportation Research Record, Washington, DC, 2002. Accessed at http://uts.cc.utexas.edu/~harrison/pdf_other/02_4007.pdf.
- Burke, D. and H. Garrett (1989) "Economic Impact of the Gulf Intracoastal Waterway System in Texas," Texas Sea Grant College Program, College Station, April 1989.
- Congressional Budget Office (CBO) (2011) "Reducing the Deficit: Spending and Revenue Options." Pub. No. 4212, Washington D.C. March 2011. Accessed at <http://www.cbo.gov/publication/22043?index=12085>.
- Florida, R., T. Gulden, and C. Mellander. (2007) "The Rise of the Megaregion". The Martin Prosperity Institute at the University of Toronto. Accessed at http://creativeclass.typepad.com/thecreativityexchange/files/florida_gulden_mellander_megaregions.pdf
- Harrison, R., D. Johnson, L. Loftus-Otway and C. Lewis (2012) "Megaregion Freight Planning: A Synopsis." TxDOT Technical Report 0-6627-1; Center for Transportation Research, University of Texas at Austin. Accessed at: www.utexas.edu/research/ctr/pdf_reports/0_6627_1.pdf
- Harrison, R., and M. Trevino (2013) "Evaluating the Impacts of the Panama Canal Expansion on Texas Gulf Ports" SWUTC/13/476660-00062-1
- Hill, Robert (2002) "The ATB: A History of the State-of-the-Art." MarineLink.com. Accessed at <http://www.marinelink.com/news/article/the-atb-a-history-of-the-state-of-the-art/307537.aspx>.
- Inland Marine Transportation Systems (IMTS) (2010) Capital Projects Business Model, Final Report. Accessed at http://www.iwr.usace.army.mil/Portals/70/docs/Wood_doc/IMTS_Final_Report_13_April_2010_Rev_1.pdf.
- Jensen, R. (1995) *Texas' Water Transportation System: Ports and GIWW Are a Major Economic Force, but Is There an Environmental Cost?* Texas Water Resources Institute, Spring 1995, Volume 21, No. 1. See <http://twri.tamu.edu/newsletters/texaswaterresources/twr-v21n1.pdf>.
- Kruse, C.J., D. Ellis, A. Protopapas, N. Norboge, and B. Glover (2014) *Texas Gulf Intracoastal Waterway Master Plan: Technical Report*. TxDOT Research Study Report 6807-1, Texas

- Transportation Institute (TTI) College Station. Accessed:
<http://ftp.dot.state.tx.us/pub/txdot-info/tpp/giww/technical-report-0814.pdf>.
- Loftus-Otway, Lisa (2012) “Urban Planning Around Freight Corridors: NCFRP 16 Research Results.” Presented to the Baltimore Planning Commission and Planning Department, May 28, 2012.
- Loftus-Otway, Lisa, C. Michael Walton, Lynn Blais, and Nathan Hutson (2008) *Protecting and Preserving Rail Corridors against Encroachment of Incompatible Uses*, TxDOT Research Report 0-5546-1, Center for Transportation Research.
- Martin Associates (2007 and 2009) Local and Regional Economic Impacts of the Port of Houston.
2007: Published 2010 Accessed at: <http://www.portofhouston.com/inside-the-port-authority/communications/business-news/port-commission-considers-economic-impact-study/>
2010: Published 2012 Accessed at: <http://www.portofhouston.com/about-us/economic-impact/>
- Martin Associates (2012) Economic Impacts of the Port of Victoria. Summarized in the 2012 Texas Ports Association (TPA) Legislative Report. Accessed at:
<http://www.texasports.org/files/2013/01/TPA-MARTIN-STUDY-EXECUTIVE-SUMMARY-2011.pdf>
- National Technical Information Service (NTIS) (2012) Inland Waterways: Recent Proposals and Issues for Congress, April 12, 2012. Accessed at
<https://www.ntis.gov/Search/Home/titleDetail/?abbr=PB2013104326>.
- National Commission on Fiscal Responsibility and Reform (NCFRR) (2010) “\$200 Billion in Illustrative Savings.” Accessed at:
https://www.fiscalcommission.gov/sites/fiscalcommission.gov/files/documents/Illustrative_List_11.10.2010.pdf.
- Potter, Lloyd and Nazrul Hoque. (2014) *Texas Population Projections, 2010 to 2050*. Texas Office of the State Demographer.
- Roby, J., Director Logistics and Public Affairs, Port of Beaumont, Personal call, February 2015
- Regional Plan Association (RPA), America 2050: Megaregions. Accessed at
<http://www.america2050.org/megaregions.html>
- Siegesmund, Peter, Jim Kruse, Jolanda Prozzi, Rene Alsup, and Rob Harrison (2008) *An Analysis of the Value of Texas Seaports in an Environment of Increasing Global Trade*, TxDOT Research Report 0-5538-1, Center for Transportation Research. Accessed at:
www.utexas.edu/research/ctr/pdf_reports/0_5538_1.pdf.
- Sheffi, Y. (2012) “Logistics Clusters: Delivering Value and Driving Growth,” The MIT Press, Cambridge Massachusetts.
- Stern, C.V. (2013) “Inland Waterways: Recent Proposals and Issues for Congress,” Congressional Research Service, 7-5700, Washington D.C.

- Sosa, Juan (2015) Offshore Technology Conference, May 5, 2015, Houston, Session 7.30-9.00
“Panama and the Panama Canal: A New Horizon in Shipping and Energy Distribution”
<http://2015.otcnet.org/>.
- Schneider, Keith (2014) “Despite Delays and Billions in Overruns, Olmsted Locks and Dam Project Rolls On.” Accessed at <http://www.circleofblue.org/waternews/2014/world/despite-delays-billions-overruns-olmsted-locks-dam-project-rolls/>.
- TxDOT 2030 Committee (2011) “It’s About Time: Investing in Transportation to Keep Texas Economically Competitive.” Executive Reports accessed at:
http://texas2030committee.tamu.edu/documents/final_03-2011_report.pdf.
- US Department of Transportation (USDOT) (2013) “Freight Facts and Figures.” Accessed at:
http://www.ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/13factsfigures/pdfs/fff2013_highres.pdf
- US Energy Information Administration (EIA) (n.d.) “International Energy Statistics” Accessed at
<http://www.eia.gov/cfapps/ipdbproject/docs/unitswithpetro.cfm>.
- Ward, William 2001 Personal Communication related to SWUTC/91/71247-2 report on the Texas 2020 Corridor.
- Water Resources Development Act (WRDA) of 1986. Accessed at
<http://www.epw.senate.gov/wrda86.pdf>.
- Water Resources Development Act (WRDA) of 2007. Accessed at
http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=e1f8a6b1-0962-4da8-bff2-80d537536d45.
- Water Resources Development Act (WRDA) of 2013. Accessed at
<https://www.govtrack.us/congress/bills/113/s601/text>.
- Water Resources Reform and Development Act (WRRDA) of 2014. Accessed at
<https://www.govtrack.us/congress/bills/113/hr3080/text>.
- Whitehouse.gov (2012). Accessed at
<http://www.whitehouse.gov/sites/default/files/omb/budget/fy2012/jointcommitteereport.pdf>.
- Wilson, Phil (2012) TxDOT Executive Director, Policy Research Project (PRP) Review, LBJ School of Public Affairs, Austin, December 2012.

Appendix A: “Evaluating Reinvestment in Inland Waterways: What Policy Makers Need to Know”

A national panel of U.S. experts met several times in the last 2 years to recommend policies to be considered by federal and state authorities. This appendix summarizes the terms of reference used in that study; the committee’s deliberations are due soon (forthcoming from TRB). Note that the term “inland waterways,” as defined by TRB, *excludes* the GIWW.

This study will address: (1) the transportation role and importance of the federally funded Inland Waterway System (IWS); (2) its costs and benefits; (3) estimated levels of investment required to achieve an efficient inland waterways system and options for funding; and (4) who should pay for the required investment.

1. The committee will assess the role of the IWS in the national freight system by examining specific corridors where commodity shipments by waterways are particularly important. For a subset of these corridors, the committee will consider the implications for shippers, alternate modes, and the general public of lost or significantly degraded water transportation both now and at projected future levels of freight demand. In corridors where the IWS competes with other modes, the committee will consider how public investments could impact the efficiency of freight movements in that corridor, regardless of mode or funding mechanism.
2. At a conceptual level, the committee will describe the full range of benefits and costs of maintaining rivers and coastal channels for inland water transportation, the issues and challenges associated with characterizing as well as quantifying these costs and benefits, and the extent to which they are they captured in cost-benefit analyses of the U.S. Army Corps of Engineers (USACE).
3. The committee will examine alternate estimates of the level of investment required for an efficient inland waterway navigation system, taking into consideration the difference in peak demand (and therefore capital requirements) that non-structural alternatives, such as tolls and lock scheduling, could make and the potential for disinvesting in lightly used sections of the IWS.
4. The committee will assess how IWS costs are currently shared among users, the public, and other beneficiaries. It will also assess whether (a) general fund subsidies to inland waterways appear to be commensurate with public benefits; (b) user fees reflect costs imposed; and (c) a full accounting of benefits and costs (including those that can only be described qualitatively) offers insight into how capital and operating costs of the inland waterway system should be apportioned between users and the public. In examining beneficiaries of navigation investments, the committee will assess whether there are grounds and mechanisms for the non-transportation beneficiaries of the IWS to be charged for the benefits they derive from public investments in the system. The study will provide answers to the questions posed above with existing information and identify gaps in information and knowledge required to answer these questions, including uncertainties surrounding external benefits and costs associated on the IWS and freight system.

Appendix B: Selection of ATB Images

The following images were provided by Crowley Marine, Inc.



Figure B.1: A Crowley 550 ATB demonstrates a tight turning radius



Figure B.2: Crowley 650; to the casual observer, an ATB looks like a ship



Figure B.3: The Crowley 650 ATB in deep water



Figure B.4: Traditional single GIWW-T barge