Texas Water Resources

Texas Water Resources Institute

Spring 1995
Volume 21
No. 1

Texas' Water Transportation System:

Ports and GIWW Are a Major Economic Force, But is There an Environmental Cost?

By Ric Jensen, Information Specialist, TWRI

Ask Texans what they picture when they think of water and you'll get many answers: landscape and agricultural irrigation, drinking water, and a place to catch fish or water ski. Few Texans may know that coastal waters provide ports and waterways that support a large marine transportation industry.

Texas' ports and waterways are a resource to those who use and rely upon them, but many citizens are raising environmental concerns. Ports and waterways have to be maintained by dredging or else they will become so shallow that ships carrying heavy cargoes can't use them.

The Houston Ship Channel supports a thriving shipping industry.

The U.S. Army Corps of Engineers (Corps), the federal agency responsible for maintaining coastal waterways, works with ports to seek economical ways to dredge and dispose of dredged materials (historically by dumping them in open bays). Environmentalists maintain that such practices lower water quality, increase turbidity, and resuspend toxic substances. Confrontations between those who favor and oppose dredging were regular occurrences

until recently, especially in the case of the Houston Ship Channel (HSC) and the Lower Laguna Madre.

Compromises seem to be emerging that may satisfy both sides of the dredging controversy. The Corps set a precedent in working with environmentalists when it sought to enlarge the HSC. It created an interagency coordination team (ICT) by inviting all parties with an interest in dredging to contribute ideas about how dredged material could be beneficially used. After much give and take, the plan to enlarge the HSC now contains provisions to use dredged material to create wetlands and safe sanctuaries for boaters, lessen erosion, and improve islands for bird habitats. At the same time, artificial oyster reefs will be created from oyster shells.

This issue of *Texas Water Resources* examines these issues. In particular, we'll point out the widespread involvement of university research in studying these issues and finding solutions to them.

Background Information

To understand the role that Texas' coastal waters play in shipping and navigation, some history needs to be provided.

Texas now has 12 deep-draft ports and 11 shallow-draft ports. Most of these ports have been substantially modified and improved by man's activities. Galveston was historically plagued by sandbars that blocked the entrance to the port from the Gulf of Mexico. The Corps worked on many projects to improve Galveston's port in the late 1890s, including dredging a deep ship channel and constructing long jetties. The port of Houston was established in 1909 by the Texas Legislature and was approved by local voters who created the Houston Ship Channel Navigation District.

The Gulf Intracoastal Waterway (GIWW) is part of a national system of waterways that extends along the U.S. coast. The GIWW originated in the federal 1873 Rivers and Harbors Act that called for detailed surveys of the Texas coast. Construction of the GIWW began in 1905 when canals were dredged to a depth of 5 feet and a width of 40 feet along some parts of the Gulf Coast. By 1909, the GIWW extended from Corpus Christi to Aransas Pass, from Aransas Pass to Pass Cavallo, and from the Brazos River to West Galveston Bay. In 1934, the GIWW was extended from Galveston Bay to the Sabine River. Finally, in 1949, the last reach of the waterway was completed from Corpus Christi to Brownsville.

There have even been attempts to develop a system of inland waterways. In the 1960s, voters were asked to approve and fund the Trinity Barge Canal, which would link the Dallas-Fort Worth area with Galveston and Houston. The project was defeated because voters opposed the cost and potential environmental damage the project might bring.

Assessing and comparing the economic impact of Texas ports is difficult because there are subtle differences that must be taken into account. Still, some general information

about the value of ports can be shown. Today, many of Texas' deep draft ports -- Houston, Texas City, Beaumont, Port Arthur, and Corpus Christi -- are among the top 20 in the U.S. in terms of the value and amount of cargo shipped. In 1992, Texas seaports handled roughly 378 million tons of cargo. In 1993, 54 million tons of imports worth $11 billion and 25 million short tons of exports valued at $14 billion moved through Houston, making it the busiest port in the U.S. An economic study conducted for the Port of Corpus Christi in 1993 suggests the port generated more than 38,000 jobs and $40 billion in sales, that port payrolls were $650 million, and that total port cargo was 72 million tons.

Research at the University of Texas at Brownsville (UT-B) provides more insights into the impact of ports on local economies. In 1993, Suzanne Hardebeck of the UT-B Business Administration Department and Luis Cabezas and John Cox of the UT-B School of Business and the Texas Engineering Extension Service (TEEX) assessed the economic impact of the Port of Brownsville. Their studies show that the port directly and indirectly generates 3,700 jobs producing more than $60 million in wages, more than $207 million in sales in Cameron County, and roughly $2.5 million in taxes.

Barges travel through the GIWW into ports like Houston.

The GIWW now extends along the entire length of the Texas coast. In most places, it is 12-feet deep and 125-feet wide. The GIWW transports 100 million tons of goods annually. It links Texas ports to U.S. and international destinations.

In 1984, the Texas Department of Transportation formed a GIWW Advisory Committee that is comprised of members from the Texas Natural Resource Conservation Commission, the Texas Parks and Wildlife Department (TPWD), the Texas General Land Office, and the Governor's Office. A role of the Committee is to find environmentally and economically acceptable dredge disposal sites. Finding these sites is difficult because many people oppose having dredged materials placed on their land. Potential sites become uneconomical if dredged material has to be transported too far. So far, the Committee has identified and acquired roughly 1,800 acres of upland sites that could be used for disposal of dredged material, but as many as 3,000 more acres could be needed.

Erosion control is also needed. A section of the GIWW at Sergeant Beach near Freeport suffers from as much as 36 feet of erosion each year. If the erosion continues, waters from the Gulf could enter the GIWW, make navigation difficult, and close traffic south of that point. In response, the Corps engineered and will construct a 7-mile stone and concrete seawall to stabilize the shoreline.

Research by Hillary Garrett and Dock Burke of the Texas Transportation Institute (TTI) at Texas A&M University (TAMU) provides some insights on the value of the GIWW. The Texas portion of the GIWW transported 73 million tons of commodities worth more than $21 billion in 1986. Roughly 65% of GIWW cargo flowed from Houston to Beaumont and Port Arthur, while the portion of the GIWW from Corpus Christi to Brownsville was used the least. Total revenues that could be directly attributed to the GIWW totaled $3.1 billion. Previous studies estimate that roughly 20% of Texas' gross state product can be linked to water-related transportation and that 20,000 Texans are employed statewide by water transportation industries.

Researchers at the LBJ School of Public Affairs at the University of Texas at Austin are now assessing the economic impact of Texas ports. The studies are led by Leigh Boske and will gather data on port facilities, links to highways and railroads, the volume and value of commodities shipped, the use of the GIWW, dredging needs for port maintenance, environmental aspects of port operations, marketing strategies, and policy issues.

Dredging the HSC

For many years, the ports of Houston and Galveston have been working to enlarge the ship channel for economic and safety reasons. Currently, the Corps plans to enlarge the HSC from its current depth of 40 feet to 45 feet and from its existing width of 400 feet to 530 feet. The Galveston Ship Channel will be enlarged from 40 to 45 feet deep. Where Galveston Bay meets the Gulf of Mexico, the channel will be enlarged to 47 feet deep and 800 feet wide. More than 78 million cubic yards of material will have to be dredged from the Bay bottom and disposed of during construction, while 5 million cubic yards will have to be dredged annually to maintain the Channel. The project is expected to cost roughly $412 million, which includes $50 million in environmental restoration costs. Construction is scheduled to begin in 1998.

Proponents of the proposal say it will make the HSC safer. Many barge and ship pilots say that the channel is so narrow it is difficult and dangerous to navigate safely through it. A commonly practiced maneuver that is used in the ship channel is the "Texas Chicken" in which two vessels first head directly towards each other and then turn sharply to pass. Although this is a commonly accepted and typically safe practice, it resulted in a serious accident and oil spill in 1990.

The project will increase port revenues. Many ships entering the HSC cannot carry a full load of cargo because the Channel is too shallow. Deepening the HSC will allow them to

carry more goods and make fewer trips. Widening it will reduce delays while waiting to enter and exit the HSC.

Another way to make it safer to navigate through the HSC is being developed by the Port of Houston. The Houston Area Navigation System uses a computerized grid of the ship channel as a map, a digital global positioning system, and mathematical channel coordinates to provide a continuous display of the precise location of ships and potential hazards.

Texas ports are seeking environmentally sound ways to dispose of dredged materials. Dredged materials are typically comprised of 80% water and have a large volume. The Port of Houston has developed a crust management program that uses ditches and trenches to dewater dredged materials.

The Corps conducted and sponsored studies to assess the environmental impact of dredging the HSC on aquatic species in Galveston Bay. Gary Ray and Douglas Clarke of the Corps' Waterways Experiment Station and Robert Bass of the Corps' Galveston office gathered data on bottom dwelling (benthic) organisms that live in Galveston Bay and studied how open bay disposal of dredged materials affects them. Preliminary results suggest that some benthic colonies recover less than 18 months after open bay dredge disposal.

The Corps sponsored research involving 3-dimensional hydrodynamic and salinity modeling, estimating how enlarging the HSC may affect oyster reefs, and methods to mitigate environmental damage. Eric Powell, then with the TAMU Oceanography Department, developed techniques to precisely map oyster reefs using high resolution acoustic profiling and created a model to simulate how the project may affect oyster populations. As part of the process to develop a supplemental Environmental Impact Statement (EIS), the Corps sponsored studies to gauge the amount of contaminants in bottom sediments, and to assess potential upland and offshore disposal sites for dredged materials.

There are concerns that sediments from the Channel may be polluted because many industries are located there. The City of Houston and the U.S. Environmental Protection Agency (EPA) are now assessing the toxicity in water, sediments, and fish tissues in the HSC, side bays, and tributaries.

Environmental Work in the HSC

An exciting aspect of the process of expanding the HSC has been the teamwork between the Corps and other agencies and groups. When the Corps initially debated how to best enlarge the Channel, they decided to invite other interested parties to join an ICT. The idea was that the Corps could make more progress by working together and obtaining input from others, even those groups who often had opposing points of view, than by working alone. Cornerstones of the ICT process were that participants did not have to endorse the HSC enlargement project, that all organizations were asked how they would

like to see dredged material used beneficially, and that the final decision of the recommended plan would be made by team members. As the process evolved, the Corps led efforts to create focus groups within the ICT that discussed contaminants, wetlands and other habitats, oyster productivity, the development of oyster models, benthic recovery, and hydrodynamic computer models.

One component of the ICT was the beneficial uses group (BUG), that was formed in 1990. The goal of the BUG was to identify and implement beneficial uses for dredged materials that few people had wanted before. BUG recommendations include the creation of 4,250 acres of intertidal marsh in Galveston Bay to help offset the loss of acreage caused by enlarging the HSC, construction of boater access channels in mid and lower Galveston Bay, building an island in lower Galveston Bay where birds can build nests, restoration of Goat Island to its 1944 size and shape, construction of a near-shore underwater berm to lessen the force of tidal waves and slow erosion, and the creation of 118 acres of oyster reefs. Some material dredged from industrialized parts of the Channel that has low levels of contaminants will be placed in confined upland disposal sites.

The ICT process and the recommendations that resulted from it are significant, according to Corps officials in Galveston. This is one of the first times the Corps has used the ICT approach nationally. Because of its success here, they hope it may be used by the Corps elsewhere.

Volunteers work to restore this marsh on Atkinson Island near Galveston Bay.

The Corps is also working with the Port of Houston and other partners to develop environmental restoration efforts. Large amounts of dredged material from the region are now being used to provide a soil base for a 220-acre demonstration marsh that is now being planted with cordgrass on Atkinson Island. They are also working with Sammy Ray and Andre Landry of the Marine Biology Department at Texas A&M University-Galveston (TAMU-G) to determine if non-toxic byproducts from lignite coal power plants can be used to develop new oyster reefs.

Dredging the Laguna Madre

Recently, there have been concerns by many environmental groups that the section of the GIWW that runs through the Laguna Madre may not be economically viable. There is also criticism that the GIWW may pose environmental risks, especially concerning the need for maintenance dredging, disposal of dredged materials, and the risk that barge accidents may occur and introduce pollutants into these waters. These concerns have

been heightened because maintenance dredging was needed recently and because the Mexican government has proposed to extend the GIWW south to Tampico, which would likely increase the volume of traffic.

Because of these tensions, the Laguna Madre has become the subject of much controversy and legal action. Only a brief attempt will be made to summarize these developments here.

Research by the Conrad Blucher Institute (CBI) at Texas A&M University-Corpus Christi (TAMU-CC) by Adele Militello and Nick Kraus (1994) used historical records to identify sections of this part of the GIWW that need dredging most often. They used hydrodynamic computer simulation models to determine how winds and currents build up sediments in the Transition Flats. The results suggest that building shallow mats with dredged materials may lessen the amount of sediments that flow into the GIWW and decrease dredging needs.

A 1994 report by the Texas Center for Policy Studies, *Subsidized Destruction: The GIWW and the Laguna Madre*, focused on environmental and economic issues associated with dredging this portion of the GIWW. It argues that the environment in the Laguna Madre needs to be preserved because it supports shrimp, crabs and sportfish. Endangered migratory birds like redheaded ducks visit the area in huge numbers because they eat shoalgrasses that grow there. The report shows that fishing and recreation generate as much as $400 million annually for the region's economy, but notes that this section of the GIWW is underused and costly to maintain. An environmental group, the Lower Laguna Madre Foundation, has urged that this portion of the GIWW be closed permanently. Studies by the National Biological Survey (Onuff, 1994) suggest that the GIWW may cause losses of shoalgrass in some areas because it lowers salinities that introduce other seagrass species, and it decreases the amount of light that seagrasses need.

Chris Onuff of the National Biological Survey works with students at Texas A&M University-Corpus Christi to take samples of seagrasses in the Lower Laguna Madre. The studies were done to help assess the ecological impact of dredging the GIWW.

In response, a group of waterway users formed the South Texas Association for Reliable Transportation (START). They commissioned research by Steve Roop and Richard Dickinson of TTI (1993). Those studies report that closing the canal would add $4 to $6 million annually in the cost of fuels shipped to the region and would have a disastrous effect on related businesses. They note the GIWW may benefit the environment because it increases circulation and lowers high salinities.

In early 1994, the Corps issued a temporary dredging moratorium. In July 1994, a draft reconnaissance study was published. That report evaluated navigation and maintenance needs along the GIWW, environmental concerns and restoration measures, and the need

to reroute the channel near Port Isabel to aid navigation. The report concluded that maintenance dredging was economically viable because shipping by barge is less expensive than rail or truck traffic. It evaluated such alternatives as not maintaining the waterway and allowing it to become shallower and narrower as silt accumulates. The report assessed if "sector gates" could be installed at each end of the Mud Flats to regulate salinity and circulation. These recommendations are now being evaluated by the Corps.

Maintenance dredging resumed in September 1994 as part of a short-term maintenance plan. In that plan, the Corps said it would experiment with new ways to use dredged material including placing it behind submerged, confined levees, placing dredged materials in open bays at depths that could help revegetate seagrasses, and limiting the amount of material that would be dredged to 600,000 cubic yards. Many environmental officials are concerned that these steps may not reduce the amount of turbidity and suspended solids introduced into the clear waters of the Laguna Madre by dredging.

As part of that plan, the Corps entered into an agreement with TAMU-CC to monitor the environmental effects of the maintenance dredging and open bay dredge disposal. Lead researchers include Nick Kraus, Cheryl Brown and Chris Faucette of the CBI and Wes Tunnell of the Center for Coastal Studies (CCS). CBI researchers installed six data platforms along the Laguna Madre to automatically gauge water quality and used a roving boat to gather more data. Data were analyzed using two-dimensional simulation models. A tiered hydrodynamic numerical model will be used in the future. Goals are to determine if dredged material is encroaching on seagrass beds, to assess if sediments are transported by winds and currents back into the main waterway, and to investigate the impact of dredging on water quality.

CBI staff have also monitored how open bay disposal affects water quality in the upper and lower Laguna Madre and Corpus Christi Bay. Turbidity measurements were taken by state of the art instruments on fixed data platforms and roving boats. Data show that turbidity levels taken before dredging in the upper Laguna Madre (where brown tide is abundant) were higher than they were in the lower Laguna Madre (where less brown tide occurs). Preliminary results suggest that open bay disposal may have a greater but temporary adverse impact on turbidity in the lower Laguna Madre. Some of the dredged material placed on emergent islands has already eroded, and ways to stabilize the islands are being studied.

In September 1994, a Federal judge in Brownsville ruled on a suit by the National Audubon Society that charged that the Corps had to develop an EIS. The judge ruled there is no need to order the Corps to prepare an EIS because they have already begun environmental studies.

There are also concerns about erosion, a plague of brown tide, and poor circulation that may result in high salinities. Part of the GIWW runs through the Aransas National Wildlife Refuge near Corpus Christi. Many of these near coastal marshes have been the winter home to whooping cranes and other migrating birds but have lately been

experiencing as much as 3 feet of erosion each year. Jun Zhang and Frances Ting of the TAMU Civil Engineering Department gathered field data and applied computer models to compare the amount of energy caused by barge traffic, waves, and winds along the GIWW. Their study (1993) suggests that barge and tugboat traffic exports roughly 20 times more energy into GIWW waters than natural waves or winds. The amount of erosion barges cause has not been determined.

Researchers at TAMU-CC are now investigating whether there could be environmental benefits to raising the John F. Kennedy Causeway, which crosses the Laguna Madre and connects Corpus Christi to Padre Island. It has been suggested that raising the causeway or dredging a channel through Padre Island could improve circulation and lessen the areas now being afflicted with brown tide. The work is being done by Wes Tunnell of the CCS and Nick Kraus of the CBI. It involves monitoring water circulation between Corpus Christi Bay and the Laguna Madre, developing and testing mathematical computer simulation models, and collecting samples of aquatic organisms.

Many researchers at UT MSI including Terry Whitledge, Paul Montagna, and Ken Dunton, are studying issues that relate to the GIWW and the ecology of the Lower Laguna Madre, including work focusing on brown tide, benthic organisms, and nutrient buildup in the area.

Other University Research

Throughout Texas, university scientists are learning more about the importance of water-based navigation and commerce and are developing tools to keep these waterways open while minimizing environmental damage.

Evaluating the economic and environmental impacts of water-based transportation and commerce has been an on-going focus of work at TTI.

TTI researchers Charles Giammona, Dock Burke, and Roy Hann (1990) developed a way to compare methods to dispose of dredged material. The method includes ranking the economic and environmental effects of placing dredged materials using qualitative and quantitative methods. The method is useful because it produces a scoring system that can be used to rank alternatives.

TTI researchers Stephen Roop, Daryl Wang, and Kay McAllister (1992) investigated how a closure of the GIWW may impact Texas' transportation system. The project assessed the chance that the GIWW could be closed by erosion, accidents and structural failures, and how this may affect traffic on Texas highways and railroads.

TTI and TAMU-G recently created a new Research Center for Ports and Waterways to aid in marine transportation planning, investigate links between ports and highway and rail transportation, study ways to stimulate port economics, and assess environmental impacts. Partners include TAMU-CC, UT-B, and Lamar University. TTI recently created a regional division at TAMU-G that will study issues dealing with marine transportation.

The TAMU Center for Dredging Studies focuses on education and research related to dredging ship channels and waterways, disposal of dredged materials, and the environmental impact of these practices. Center activities include research using wave simulation tanks and field studies, hands-on training for industry and government professionals, and information transfer through newsletters and databases. Recent research has investigated resuspension of bottom sediments, the environmental impact of open bay disposal of dredged material, dredging contaminated sediments, and studying if dredged materials can be used to cap industrial sites (Krishnamohan and others, 1993). Center Director Robert Randall has investigated preliminary engineering and design issues that will need to be addressed if Mexico extends the GIWW.

Stephen Fuller of the TAMU Agricultural Economics Department studied how deepening Texas ports may affect the amount of grains and other crops that are imported and exported. Fuller found that deepening the HSC would substantially increase grain exports that would otherwise flow through other Gulf of Mexico ports. Fuller is now investigating how proposed hikes in user fees for tugboat operators may affect grain flow patterns.

Researchers at TAMU-CC are developing a system that may make navigation safer. Nick Kraus of the CBI is working with local ship pilots and the Port of Corpus Christi to create a system called "FlowInfo." This system involves transmitting continuous offshore measurements of water level and wind data at Aransas Pass and Corpus Christi Bay to a central computer. Ship and barge pilots can dial into a special phone number to receive and use this data. Plans for this project include adding more reporting stations, extending this technology to the mouth of the Brazos River near Freeport, and incorporating digitally recorded voice messages.

In case spills do occur, TAMU-CC operates the National Spill Control School, which provides training to professionals who respond to marine accidents. TEEX offers programs that focus on how to deal with coastal spills and fires and how to rehabilitate wildlife that have been damaged by these events.

Summary

Obviously, Texas' coastal waters play a vital role in the State's economy. Texas' ports and the GIWW are a valuable economic resource because they support shipping, and lay a foundation so that related industries can flourish.

Coastal waters will have to be maintained by dredging if they will continued to be used for transportation and shipping. A significant challenge will be to find environmentally sound and economical methods to conduct dredging and dispose of dredged materials.

Although dredging operations have been marked by controversy and conflict, the recent experience of the Corps in the Houston Ship Channel holds promise as a solution all parties can accept and endorse. In this case, the Corps invited participation from all interested parties, listened to them, and accepted many of their ideas. If this becomes a

framework for dredging in Texas, maybe some of these problems and delays can be avoided in the future.

For More Information

Alperin, L., *History of the GIWW*, U.S. Army Corps of Engineers (USACE) Water Resources Support Center, 1983.

Cox, J., "Barging through the Laguna Madre" and "The Gulf Intracoastal Waterway," *Texas Parks and Wildlife*, TPWD, Austin, TX, January 1995.

Diaz, A., and M. Kelly, *Subsidized Destruction: The GIWW and the Laguna Madre*, Texas Center for Policy Studies, Austin, TX, 1994.

GIWW: Corpus Christi Bay to Port Isabel (Draft Reconnaissance Study), USACE, Galveston, TX, 1994.

Garrett, H., and D. Burke, *Economic Impact of the GIWW in Texas*, TTI, TAMU, College Station, TX, 1989.

Giamonna, C., R. Hann, K. Wooters and D. Burke, *Optimum Disposal Methods for Use on the Gulf Intracoastal Waterway*, TTI, TAMU, College Station, TX, 1990.

Hardebeck, S., L. Cabeza, and J. Cox, *Port of Brownsville Economic Impact Study*, School of Business, UT-B, 1993.

Krishnamohan, R., J. Herbich, and F. Williams, "Feasibility of Capping Industrial Waste Disposal Sites with Dredged Material," in *Proceedings of the International Dredging Conference*, TAMU, College Station, TX, 1993.

Miletello, A., and N. Kraus, *Investigation of Current and Sediment Movement in the Laguna Madre and Implications for Dredging of the GIWW*, CBI, TAMU-CC, 1994.

Roop, S., D. Wang, and K. McAllister, *Closure of the GIWW and Its Impacts on the Texas Highway Transportation System*, TTI, TAMU, College Station, TX, 1992.

Onuff, C., "Seagrasses, Dredging and Light in the Laguna Madre," *Estuarine, Coastal, and Shelf Science*, Vol. 39: 75-91, 1994.

Pendergrass, B., *In the Era of Limits: A Galveston District Update, USACE Galveston District (1976-86)*, Galveston, TX, 1990.

Recommended Beneficial Uses Plan for Placement of Dredged Materials, Turner Collie and Braden, Inc., for the Port of Houston, 1995.

Roop, S., and R. Dickinson, *Economic Impacts of a Closure of the GIWW Along the Laguna Madre*, TTI, TAMU, 1993.

Zhang, J., F. Ting, D. Hershberger, H. Yu, and C. Spell, Bank Erosion of the GIWW at the Aransas National Wildlife Refuge, TAMU Civil Engineering Department, 1993.

Rice University is sponsoring a workshop on the Houston Ship Channel May 18-19 in Houston. For details, call Hanadi Rifai at Rice University at (713) 527-4700.