CAMBRIDGE SYSTEMATICS

TxDOT Waterborne Freight Corridor Study

Task 3: Waterborne Freight Performance Measures

final

report

prepared for

Texas Department of Transportation

prepared by

Cambridge Systematics, Inc.

November 18, 2011

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Summary

- Waterborne freight performance metrics are important because they allow stakeholders (e.g., carriers, shippers, recreational users, and Federal, state, and local transportation entities) to understand the performance of the system over time; evaluate the success of various improvement strategies; and prioritize future investments.
- However, the development of maritime performance metrics is still at a very early stage of development. Though some examples exist at the Federal, state, and international level, many of these examples are qualitative, or only reflect specific parts of the waterborne freight system.
- Reasons cited for the lack of existing waterborne freight performance measures include the difficulties of objectively measuring port performance in a comparative way. There are many different types of ports; and each port operates in a different manner – in terms of uniqueness of its system, its clients, and its key commodities and their supply chains. Therefore, the choice of appropriate "standardized" measures is very difficult.
- Preliminary waterborne performance measures for Texas were created by building on the goals of the Texas Department of Transportation's (TxDOT) 2011 to 2015 Strategic Plan; building on the work completed in Phase I of this TxDOT Waterborne Freight Corridor Study; and drawing from examples from national, state, or international research efforts.
- Preliminary waterborne metrics include those meant to track the performance of the State's waterways, deepwater ports, and landside connecting infrastructure. Categories of performance measures include those that evaluate congestion, safety, economy, system preservation, and emissions.
- Additional research is required to refine these preliminary performance measures; and to ensure that they are consistent with the TxDOT's goals, other national efforts, are based on national best practices, and have minimal data collection requirements.

1.0 Introduction

A critical component of the Texas Waterborne Freight Corridor Study is to identify potential waterborne freight performance metrics for the TxDOT, which are consistent with national standards. Development and monitoring of specific waterborne freight performance metrics will allow waterborne system stakeholders (e.g., carriers, shippers, recreational users, and Federal, state, and local transportation entities) to understand the performance of the system over time; evaluate the success of various improvement strategies; and prioritize future investments. It is likely that performance measures will continue to grow in importance given current trends in federal legislative language that prioritize system performance and measurement as a basis for federal funding.

However, the development of maritime performance metrics is still at a very early stage of development. At the most aggregated level, port performance has historically been assessed by organizations, such as the World Bank, the World Economic Forum, and the Intra-American Development Bank, for the purposes of assessing the adequacy of infrastructure and its contribution to economic competitiveness. However, while these systems are comprehensive in scope, they are generally basic in design. The World Economic Forum assesses "Quality of Port Infrastructure" by measuring business executives' perception of their country's port facilities. It uses a single question "Port facilities and inland waterways in your country are (1 = underdeveloped, 7 = as developed as the world's best)" to poll stakeholders. The reliance on such subjective assessments hints at the difficulty in objectively measuring port performance in a comparative way.

Existing studies that have specifically addressed maritime performance metrics are summarized within this report, including state-level, national-level, and international efforts. In addition, this report takes the first step in identifying performance metrics for the Texas waterborne freight system. It does this by summarizing current practices and research, and then tailoring these measures to a Texas context. It also reports a series of proposed measures for TxDOT to refine in future research efforts.

1.1 Context and Organization

The TxDOT's 2011 to 2015 Strategic Plan identified goals, objectives, and strategies to address the State's multimodal transportation needs.[1] Emphasizing trans-

[1] Texas Department of Transportation, *TxDOT 2011 to 2015 Strategic Plan Excerpt*, adopted June 2010, http://www.dot.state.tx.us/about_us/strategic_plan.htm.

parency and accountability, the update of the Strategic Plan increases the focus on agency-level performance metrics that will allow the Department to track and evaluate its progress toward achieving its strategic goals. The 2011 to 2015 Strategic Plan also emphasizes the importance of the State's multimodal transportation system by introducing several new mode-neutral or nonhighway performance metrics.

Overall, the Strategic Plan provides a framework to guide the Department's planning, investments, and decision-making over the next five years. As a result, it is TxDOT's intention that the Department's planning activities, including the Texas Statewide Long-Range Plan 2035, modal system plans, and other efforts, reflect the goals and objectives defined in the Strategic Plan. The development of waterborne performance metrics increases the focus on performance at TxDOT, and is a critical step towards reaching the goals defined in the Strategic Plan.

The remaining sections of this report provide background on the various types of waterborne performance metrics suggested in literature, and currently used by Federal and state agencies. It includes the following sections:

- **Waterborne Performance Measure Research Summary**, which provides examples of recent research, as well as performance measures that have been developed by Federal or state agencies; and
- **Recommendations and Next Steps**, which introduces some preliminary performance measures for the Texas waterborne freight system, and notes where additional work is necessary before these performance measures can be put into use as part of the TxDOT planning process.

1.2 EXISTING PERFORMANCE MEASUREMENT ACTIVITIES IN TEXAS

TxDOT 2011 to 2015 Strategic Plan and TxDOT Tracker

Texas has developed a list of performance metrics that are derived from goals set forth in the strategic plan. TxDOT posts transportation performance metrics on its web site through the "TxDOT Tracker."[2] Six new goals were created in the 2011 to 2015 Strategic Plan, as shown in Table 1.1 below.

[2] http://www.txdot.gov/about_us/sppm/txdot_tracker.htm.

Table 1.1 Goals of the TxDOT 2011 to 2015 Strategic Plan

Strategic Plan Goals
• Develop an organizational structure and strategies designed to address the future multimodal transportation needs of all Texans
• Enhance safety for all Texas transportation system users
• Maintain the existing Texas transportation system
• Promote congestion relief strategies
• Enhance system connectivity
• Facilitate the development and exchange of comprehensive multimodal transportation funding strategies with transportation program and project partners

Source: Texas Department of Transportation, *TxDOT 2011 to 2015 Strategic Plan Excerpt*.

Several of these goals can be related to the waterborne system. Currently, TxDOT's public performance metrics, as shown on the TxDOT Tracker, do not specifically measure performance of waterborne freight. However, the remainder of this report summarizes relevant research that may help define the types of waterborne freight performance metrics that could be created to help the waterborne system meet goals defined in the 2011 to 2015 Strategic Plan.

GIWW Legislative Report to the Texas Legislature[3]

The GIWW Legislative Report to the Texas Legislature, required by the 1975 Texas Coastal Waterway Act, assesses the importance of the Gulf Intracoastal Waterway (GIWW). Recent biennial reports have identified problems and modifications to the waterway, and described specific recommended legislative actions for consideration.[4] The benefits and issues of the GIWW in the 2008 report highlight some potential information and data that could be used to generate waterborne freight performance metrics for Texas. The following data (Table 1.2) was presented in this report and should be considered when creating performance metrics for the waterway system:

[3] ftp://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww08.pdf.

[4] ftp://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww08.pdf.

Table 1.2 GIWW Legislative Report Potential Performance Measures[5]

Potential Performance Measures for the GIWW
• Total tonnage and value of goods moved on the GIWW
• Total one-way barge trips on the GIWW
• Total value of key industries' income generated by the GIWW (for example, total weight and value of shrimp, oysters, crab, and finfish facilitated by the GIWW)
• Cars/railcars removed from roads as a result of barge trips and resulting emissions benefits
• Safety benefits of moving by barge over other modes – total number of annual hazardous spills by barge versus other modes
• Cubic yards of sediment dredged
• Total Federal cost expended by the U.S. Army Corps of Engineers (USACE) to operate and maintain the structures and navigability of the GIWW

Source: ftp://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww08.pdf.

[5] ftp://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww08.pdf.

2.0 Waterborne Performance Measure Research Summary

2.1 Recent Developments and New Research

A number of research efforts have focused on the topic of freight performance metrics. This includes efforts by the Permanent International Association of Navigational Congresses, the National Cooperative Freight Research Program (NCFRP), the University of Texas, and the Oregon Department of Transportation (DOT), as well as international efforts from the University of Natural Resources and Applied Science/Austria Tech. These studies vary considerably in scope – some set out to provide a recommended list of performance metrics for measuring waterway performance, while others discuss in detail some of the key features of ports and waterways that are critical to effective and efficient goods movement. They are summarized in the following sections.

Permanent International Association of Navigational Congresses (PIANC)

The Permanent International Association of Navigational Congresses (PIANC) is a nonpolitical and nonprofit organization established in 1885 to bring together international experts on technical, economic, and environmental issues pertaining to waterborne transport infrastructure. Members include national governments and public authorities, corporations, and interested individuals. PIANC's most recent report on waterborne performance metrics was completed by a group of representatives from Austria, Belgium, France, Germany, the Netherlands, Spain, and the United States.[6]

The reason for the development of this report, as stated in the introduction, is a need for commonly accepted and systemwide set of performance indicators in the field of inland navigation. To this end, the report provides a recommended list of key performance indicators that supports organizations, which are responsible for development, operation, maintenance, and management of inland navigation. Categories of performance measures are summarized in Table 2.1 below.

[6] PIANC Working Group 111, Performance Indicators for Inland Waterways Transport, 2010.

Table 2.1 PIANC Recommended Categories of Performance Measures

Category	Performance Indicator Groups
Infrastructure	• Availability of locks • Total availability for service of a lock • Total stop of lockage • Lock utilization • Availability of core waterway infrastructure • Capacity of waterway section • Dredging/maintenance of waterway
Ports	• Handling capacity • Storage capacity utilization • Waiting time for service • Utilization of handling capacity
Environment	• Fuel consumption • Emission air • Emission noise • Water quality • Construction and maintenance
Fleet and vehicles	• Maintenance, service, and operating supplies • Capacity • Cargo transport • Passenger traffic • Perceived quality/user satisfaction with cargo and passenger transport
Information and Communication Technology	• Frequency of updating electronic fairway charts • Accuracy of electronic fairway charts • Availability of electronic fairway information • Availability of electronic reporting and port information systems
Economic Development	• Employment • Inland waterway transport volume compared to Gross Domestic Product (GDP) • Economic impact of passenger and cargo transport • Regional and local development
Safety	• Injuries, fatalities, material damages • Accidents • Economic impact of accidents
Security	• Thefts • Access control to inland waterway system

Source: PIANC Report 111-2010, *Performance Indicators for Inland Waterways Transport: User Guideline*, 2010.

The components of this report that are useful for the Texas Waterborne Study include the methodology for defining performance measures and metrics, as well as the suggested and recommended list of performance metrics for inland waterway systems. In addition, the report describes in detail how each of the metrics can be quantified and what data is required.

National Cooperative Freight Research Program: Report 10

In October 2011, the NCFRP published a nationwide study on freight performance measures entitled "NCFRP Report 10: Performance Measures for Freight Transportation". Though the report had a multimodal focus, the waterborne system was included as one of the transportation modes. The performance measures, developed as part of this effort, are included as Figure 2.1 below. They are broadly organized into the following categories:

- System performance,
- System condition,
- System safety,
- System environmental impacts, and
- System investment.

The recommended metrics are intended to support investment, policy, and organization decisions by a variety of stakeholders, both public and private. The production of a comprehensive report card of freight metrics would need to include participation by the U.S. DOT with the Freight Analysis Framework (FAF) and its modal agencies, the U.S. Department of Commerce, the U.S. Environmental Protection Agency (EPA), and the USACE.

The NCFRP report 10 provides valuable insights into performance measurement of the waterborne freight system. One of the most important conclusions drawn about waterborne freight is that there is a lack of consistency amongst states regarding waterborne freight performance metrics; and that generally most states only have few, broad waterborne performance metrics. The Maritime Administration (MARAD) reported to Congress that it was unable to measure the system performance of ports because of a lack of common metrics.[7]

[7] "Performance Measures for Freight Transportation", http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_010.pdf.

Figure 2.1 NCFRP 10 Recommended Performance Measures

Framework for National Freight Performance Measures

National Goals	Proposed Measurement Categories	Measures within Categories	Decision Areas Supported			
			Operations	Investment	Policy	Scope
System Performance	Freight Demand	Forecasted rate of growth for all modes of freight		■	■	National
		Truck freight forecast		■	■	All
		Rail freight forecasts		■	■	National
		Water freight forecasts		■	■	National
		Rate of growth in containerized imports/exports		■	■	National
		Transportation Services Index		■	■	National
	Freight Efficiency	NHS travel speed urban	■	■	■	National
		NHS travel speed rural	■	■	■	Variable
		Trend line of top 10 highway freight bottlenecks	■	■	■	All
		Composite Class I RR speeds	■	■	■	All
		Rail freight market share		■	■	All
		Cost of logistic as percent GDP		■	■	All
System Condition	Pavement Measures	NHS pavement conditions		■	■	All
				■	■	All
	Bridge Measures	NHS bridge conditions		■	■	All
				■	■	All
	Intermodal Connectors	Condition of NHS intermodal connectors		■	■	All
System Safety	Safety	Truck injury and fatal crashes	■	■	■	All
		Highway/rail at-grade crashes	■	■	■	All
System Environmental Impacts	Air Quality	Freight-related greenhouse emissions		■	■	Nat.
						Reg.
		Other emissions: VOC, NO_x, CO, SO_x, PM		■	■	Nat.
						Reg.
System Investment	Highway	Estimated investment in NHS versus amount necessary to sustain conditions		■	■	All
	Rail	Rail freight industry earning cost of capital		■	■	All
	Water	Estimated rail capital investment to sustain market share		■	■	All
		Inland water investment to sustain age of system		■	■	All

Source: NCFRP Report 10: *Performance Measures for Freight Transportation*.

However, this report provides substantial guidance on data issues and other items to consider when creating a group of performance metrics. Finally, the report highlights performance metrics that currently are being tracked at the national level to measure waterborne freight performance. This includes

information from the MARAD and the Bureau of Transportation Statistics (BTS). These performance measures will be discussed in more detail in the "Federal Performance Measures" section of this report.

University of Texas at Austin, Center for Transportation Research

In addition to developing an overall framework for freight performance measures in Project 0-5410, the Center for Transportation Research examined port productivity through earlier studies for TxDOT on container port developments in the Gulf. This research included a literature review that provides information about containerships, container ports, infrastructure, and other variables that influence movement of mega-containerships.[8] The study provided insights on key factors that influence port productivity, including infrastructure productivity, landside access, and other factors. In addition, a number of potential performance metrics were identified (Table 2.2):

Table 2.2 Potential Performance Metrics for Container Ports from the University of Texas at Austin

Category	Performance Metric
Container Port Efficiency	Lifts per hour per crane, crane productivity
Container Port Volume	Throughput in terms of twenty-foot equivalent units (TEU) per month or per year), over time
Container Throughput and Land Utilization	Throughput (TEUs per acre, per year)
Container Operations Efficiency	Container dwell time
Rail Movement Constraints on Port Access Tracks	Number of at-grade rail/street crossings, low bridges, or tunnels

Source: Center for Transportation Research: *Mega-Containerships and Mega-Containerports in the Gulf of Mexico: A Literature Review and Annotated Bibliography.*

Oregon State University and Oregon DOT

Researchers from Oregon State University, working on behalf of the Oregon DOT, recently completed a research effort to describe the state of the practice and appropriate data sources for use in developing and tracking freight performance metrics.[9] One goal of the study was to produce measures that could be used to

[8] Harrison, R., et al., *Mega-Containerships and Mega-Containerports in the Gulf of Mexico: A Literature Review and Annotated Bibliography*, Center for Transportation Research, the University of Texas at Austin, May 2000, http://www.utexas.edu/research/ctr/pdf_reports/1833_1.pdf.

[9] McMullen, S., *Freight Performance Measures: Approach Analysis*, created by Oregon State University for the Oregon DOT and the Oregon Transportation Research and Education Consortium, May 2010.

"make informed decisions regarding the allocation of resources and effort between modes".[10]

The report highlights various data sources that can be utilized to help track performance of waterborne freight systems. These sources, which are discussed in more detail later in this report, include U.S. Coast Guard safety data and mobility/congestion/reliability data from the USACE. The report also suggests ideal performance metrics. Table 2.3 below highlights some of these. This table also includes an index that shows how available this data is to an agency.

Table 2.3 Oregon DOT Recommended Performance Metrics for Waterborne Freight

Metric	Observed	Estimated	Data Availability
Safety			
Value of cargo lost or damaged per Tons or Value of Cargo moved		✓	b
Containers damaged or lost per containers handled/total containers		✓	b
Maintenance			
Percent of tons on river moving through locks with constraints (delays)[a]	✓		c
Unscheduled lock closure times			d
Channel depths at the ports divided by depth at key competitive ports	✓		c
Mobility, reliability, or congestion			
Tons of traffic arriving at key ports by barge	✓		d
TEUs passing through key ports (throughput)	✓		d
Gate reliability or truck turn time	✓		c
Ship unload rate (time per container)	✓		b
Ship load rate (time per container)	✓		b
Average delay per barge tow on Columbia River	✓		d
Accessibility and Connectivity			
Shippers within 50 miles of river port (for barge accessibility)		✓	b

[10] McMullen, S., *Freight Performance Measures: Approach Analysis*, created by Oregon State University for the Oregon DOT and the Oregon Transportation Research and Education Consortium, May 2010.

Metric	Observed	Estimated	Data Availability
Environmental			
Pounds of greenhouse gas (GHG) emissions		✓	b

Source: Oregon State University, *Freight Performance Measures: Approach Analysis*.

[a] This metric operates on the premise that: 1) incomplete maintenance can result in locks not operating at full capacity; and 2)unscheduled maintenance can cause blockages, constraints, and delays. It is meant to measure the amount of total freight subject to these maintenance-related delays.

[b] Data not available, requires collection.

[c] Data available, but manipulation or analysis needed.

[d] Data available to collect metric; no data manipulation needed.

International Example: University of Natural Resources and Applied Science and Austria Tech

Researchers from the University of Natural Resources and Applied Sciences and Austria Tech – Federal Agency for Technological Measures recently published a report, which provides a thorough evaluation of the development of performance metrics and analytical tools for inland waterway systems internationally in an attempt to improve efficiency and competiveness of these systems.[11]

The report includes a literature review on past studies about performance metrics, both general and transportation specific; and offers advice on the system components to consider when developing performance metrics, as well as sample measures and metrics.

Performance Measurement Scoping

The research highlights the importance of detecting "basic parameters, conditions, and influences of the inland waterway navigation system." To this end, the authors outlined key components that need to be considered when selecting performance metrics, including the following:

- **Main processes**, which are carried out while the physical execution of goods transportation along inland waterways occurs;
- The **related infrastructure**, which is needed to execute the physical execution of goods transportation;
- The **necessary resources** (IT, employees, vehicles, etc.) for the execution of the processes;
- The **traffic conditions**, which influence the performance of the transport mode;

[11] Posset, M., R. Pfliegl, and A. Zich, *An Integrated Set of Indicators for the Assessment of Inland Waterway Transportation Performance*, TRB 2009 Annual Meeting CD-ROM.

- The **critical success factors** within the process mapping; and
- The **stakeholders** of the inland waterway navigation system.

An understanding of these system components is necessary to begin assessing the system and selecting performance metrics. In addition, the document suggests that the following three questions be used to define the scope of the performance metric development to scope out the project:

1. Which processes have to be assessed?
2. Where does inland waterway navigation start, and where does it end?
3. Which links to supply chain partners have to be considered?

Performance Metrics and Grouping

The research also provided categories and sample performance metrics for consideration. Table 2.4 below highlights these general categories and sample performance metrics. Some of these performance metrics were used to inform the potential performance metrics for the Texas waterborne system.

Table 2.4 European Performance Metric Categories and Examples for Inland Waterways

Category	Performance Metric
Cargo and Passengers	• Degree of executed transports as contractual agreed compared to previous years • Number of documented complaints per company
Economic Development	• Quantity of direct and indirect generated employment with reference to a certain time period • Employees in inland navigation in a certain region
Environment	• Discharge of emission (air) • Tons of CO_2, PM, SO_X, NO_x, HC, resulting from transport related to performance in this field by other modes
Fleet and Vehicles	• Average maintenance costs per ton – kilometer (tkm) compared to default value • Current value, operator, tons deadweight all told (tdwat)/drive power, days in use/year, crew, repairs, insurance, miscellaneous, amortization/depreciation, interest, overhead shipping company, costs in €/T tdwat per year, differential-cost factor, tdwat range
Information and Communication Technology	• Coverage of the waterway with AIS shore side infrastructure • Data about availability of shore side equipment

Category	Performance Metric
Infrastructure	• Availability of the waterway (considering total stop of navigation through icing, flood, etc. days per year) compared to other years • Water level, locks and barriers, nautical bottlenecks, estuaries, waterway classification, incline, height of fall, flow speed
Mobility and Reliability	• Risk of a breakdown of a lock compared to previous months • Hours of navigation interruption due to electromechanical failures on locks and bridges on Trans European Networks (TEN-T) waterways
Ports and Transshipment Sites	• Total container capacity of a certain port, utilization, average storage times • Storage companies, covered storage, racks, open storage, storage for hazardous materials, special storage, customs storage, free port zone
Safety	• Injured persons per 1,000 vessel km • Injuries, fatalities
Security	• Vehicles • Degree of systemwide identification of vehicles within a specific waterway section compared to previous years

Source: *An Integrated Set of Indicators for the Assessment of Inland Waterway Transportation Performance*, Transportation Research Board (TRB), 2009.

The Cargo Handling Cooperative Program: Improving Marine Container Terminal Productivity[12]

This study sought to benchmark U.S. container port productivity and scrutinized the effectiveness of some of the more common metrics used to assess container port efficiency. The measures were broken down according to the following categories:

- Land Use Measures;
- Container Yard Storage Factors;
- Container Yard Capacity Measures;
- Container Crane Measures;
- Vessel Measures; and
- Berth Measures.

One finding of the study is that throughput density per acre should be measured against container yard acres (as opposed to gross acres within a terminal), since

[12] *Improving Marine Container Terminal Productivity: Development of Productivity Measures, Proposed Sources of Data, and Initial Collection of Data from Proposed Sources*, The Tioga Group, 2010.

terminals can devote portions of their territory to uses other than container handling including rail facilities. Other notable metrics are summarized in Table 2.5 below.

Table 2.5 Metrics to Measure Marine Container Terminal Productivity

Suggested Measure	Description
Annual TEU per Slot	Measures how many containers are produced by each slot annually
Annual TEU per Crane	Measures adequacy of crane infrastructure, and whether excess crane capacity exists
Vessel Size Ratio	Measures whether draft and berth length at the terminal is being fully utilized
Average Vessel TEU Capacity	
Annual TEU per Berth	Measures the productivity of each berth

Source: The Tioga Group, 2010.

2.2 FEDERAL PERFORMANCE METRICS

In addition to academic and industry research into freight performance measurement, a number of Federal agencies are beginning to implement systems and approaches to allow them to better track the performance of specific waterborne system components. This includes agencies that work specifically with waterways (MARAD, USACE) and those that have a more general function, but also measure waterway performance as part of their overall requirements (BTS, White House Office of Management and Budget(OMB)). These agencies are described briefly below, and key findings in terms of waterborne performance metrics also are summarized.

United States Army Corps of Engineers (USACE)

The USACE is responsible for maintaining national security through infrastructure development – from construction of army bases to dredging waterways and to construction of storm damage reduction infrastructure.[13] The USACE Ports and Waterways Division includes the Navigation Data Center, which publishes information on the waterway system in the U.S., including data on commodity movements, dredging statistics, entrances/clearances, lock statistics and characteristics, port statistics, and other data.[14]

While the USACE does not directly present performance metrics for tracking on its web site, the data provided on the web site can be used to track performance

[13] http://www.usace.army.mil/about/Pages/Home.aspx.

[14] http://www.ndc.iwr.usace.army.mil//data/data1.htm.

metrics. USACE tracks the performance of locks in the waterborne freight system.[15] This site shows useful information, such as average vessel delay, lock closures (scheduled and unscheduled), as well as other pieces of information about goods movement through locks. It is important to note that these data do not show overall waterway congestion – they only show delays that occur at the locks themselves.

In a 2010 presentation at a summer TRB meeting, Mark Hammond from the USACE presented several metrics for performance measurement of the Ohio River using USACE available data.[16] The metrics presented include the following:

- Total tonnage per lock, river system;
- Total value per lock, river system;
- Total operations and maintenance funding for the system, current and real dollars;
- Lock availability, percent, by lock or all locks;
- Project closures, scheduled and/or unscheduled, by locks or all locks, hours.[17]

White House OMB

The OMB, while not directly responsible for the performance of waterways, does oversee the performance of Federal agencies such as the USACE. In doing so, the OMB has created performance metrics to track whether agencies such as the USACE are performing well. The OMB publishes performance on its web site, http://www.expectmore.gov, where a drop-down menu allows researchers to select the agency of interest.

When reviewing performance of the USACE, several performance metrics are of interest to this study. They are summarized in Table 2.6 below.

[15] http://www.ndc.iwr.usace.army.mil/lpms/lpms.htm.

[16] Hammond, M., *Ohio River Corridor – Performance Measures*, presented at the TRB Joint Summer Meeting, Multimodal Freight/Waterways Track, July 12, 2010, http://onlinepubs.trb.org/ onlinepubs/mb/Joint_Meeting/Mark_Hammond.pdf.

[17] http://www.ndc.iwr.usace.army.mil//lpms/lpms.htm.

Table 2.6 OMB Recommended Performance Metrics

Category	Performance Metric
Coastal Ports and Harbors	The percent of time that high commercial traffic-navigation channels are available to commercial users.
Operating Projects	The amount of operating projects (dams, levees, channels, flood gates, etc.) that are located in Zones 21 to 25 (High Risk).
Environmental Stewardship	Mitigation Compliance. This metrics demonstrates the USACE performance in meeting mitigation requirements that are specified in project authorizations.

Source: The White House OMB.

United States DOT Maritime Administration (MARAD)

MARAD is the agency within the U.S. DOT responsible for waterborne transportation. The agency is responsible for a number of specific waterborne activities, including promotion of the use of waterborne transportation, seamless integration with other components of the transportation system, and national security as it pertains to waterborne activities.

MARAD tracks performance metrics that can be used to track general trends in the waterway system. The NCFRP-03 research discussed earlier mentions that MARAD addresses freight volumes, commodity movements, ship movements, and metrics of employment and economics in waterborne freight.[18] The report also highlights the degree of difficulty in attempting to create a set of performance metrics to measure port efficiency and performance.

In preparing this report, MARAD reviewed articles and studies from the academic and scientific communities that set forth methodologies for measuring port efficiency. The literature reviewed supported MARAD's finding that there is no widespread agreement on an approach to measuring the efficiency of a port as a link in the logistics chain. A 2004 article in Maritime Policy and Management states: "Measures of port efficiency or performance indicators use a diverse range of techniques for assessment and analysis, but although many analytical tools and instruments exist, a problem arises when one tries to apply them to a range of ports and terminals. Ports are very dissimilar and even within a single port the current or potential activities can be broad in scope and nature, so that the choice of an appropriate tool of analysis is difficult. Organizational dissimilarity constitutes a serious limitation to enquiry, not only concerning what to measure but also how to measure. Furthermore, the concept of efficiency is vague and proves difficult to apply in a typical port organization extending across production, trading and service industries.

[18] Gordon Proctor and Associates, *NCFRP-03 Draft Report – Performance Measurement for Freight Transportation*, October 2010.

MARAD, in its Strategic Plan for 2003 to 2008, developed performance metrics that support three goals of commercial mobility, national security, and environment.

In addition, in 2009, the 2010 National Defense Authorization Act was signed, which laid out funding for marine highway corridors in the U.S. The Federal Register laid out the type of information used to evaluate all candidate corridors as marine highway corridors. This includes the following:

- The landside infrastructure that a marine corridor would benefit, as well as associated travel delay on that corridor, major cities nearby, and other factors that impact landside corridor performance;
- Potential shift of traffic from the landside corridor to ship;
- Estimated congestion reduction on the landside corridor as a result of moving goods to waterborne freight; and
- Emissions benefits, landside infrastructure maintenance cost benefits, safety impacts, and others.[19]

These criteria could be converted into potential performance metrics, as they relate to items of importance. For one, it could be possible to measure the emissions and congestion benefits of using the marine mode as opposed to highway or rail.

United States Coast Guard (USCG)

The USCG is one of the five armed forces in the U.S. and is tasked with protecting the maritime economy and environment, defending U.S. maritime borders, and saving those in peril.[20]

The Coast Guard maintains data on "marine casualty or accidents" that occur on navigable waterways in the United States. The Marine Information for Safety and Law Enforcement (MISLE) combines all operational missions of the USCG in one system. For the purpose of freight safety performance measurement, the accidents labeled as "collisions" and "allusions" (collision between vessel and fixed object such as a bridge) would be most relevant.

2.3 STATE-SPECIFIC PERFORMANCE METRICS

Other states throughout the U.S. have implemented performance metrics to measure the effectiveness of their transportation system. Some states are still in the process of developing major statewide transportation performance metrics.

[19]http://edocket.access.gpo.gov/2010/pdf/2010-7899.pdf.

[20]http://www.uscg.mil/top/about/.

Others, such as Missouri, already have created many metrics to monitor a wide variety of transportation-related subjects. Below we highlight several states that have incorporated waterborne freight performance metrics to some degree. For further detail about what each state is doing in terms of transportation performance measurement, Washington State has created an on-line report with links to each state's performance measurement and strategic planning mechanisms.[21]

Florida

In 2003, Florida established a Strategic Intermodal System (SIS) to help prioritize freight investments. The SIS includes waterborne freight assets, such as waterways and ports. The Florida DOT has created a new web site that focuses solely on communicating the performance of the transportation system.[22] Performance measurement of the SIS is guided by the long-range goals of the 2025 Florida Transportation Plan. On the web site, the Florida DOT has made an SIS Performance Report available, which outlines key SIS performance goals and metrics to highlight whether the SIS is moving towards meeting the stated goals.[23]

Waterborne freight currently is a part of the SIS system and is discussed in the performance measure discussion. However, there are only a few performance metrics that relate to SIS waterways and facilities. These are summarized in Table 2.7.

Table 2.7 Florida DOT Waterborne Performance Metrics[a]

Category	Performance Metric
Environment	The percentage of total transportation greenhouse gases produced by boats or ships over time
Throughput	SIS seaport tonnage over time
Security	Percentage of port containers inspected annually

Source: Florida DOT SIS Performance Report.

[a] http://floridaperforms.com/Indicators.aspx?si=SI_024.

Missouri

The Missouri DOT tracks an extensive list of performance metrics every quarter to assess how well the Department delivers products and services to its customers. This process and tool, known as the MODOT Tracker, currently monitors

[21] http://www.wsdot.wa.gov/Accountability/Publications/Library.htm.

[22] http://www.dot.state.fl.us/planning/performance/.

[23] http://www.dot.state.fl.us/planning/performance/SIS-Performance.pdf.

more than 120 performance metrics on a quarterly basis. The two that relate directly to waterborne freight are summarized in Table 2.8.

Table 2.8 Missouri DOT Waterborne Performance Metrics[a]

Category	Performance Metric
System Throughput	Freight tonnage by mode
Throughput	Missouri River and Mississippi River waterborne freight tonnage

Source: Missouri DOT.

[a] http://www.modot.org/about/general_info/Tracker.htm.

Background information on the metrics is provided and updated on a quarterly basis. For instance, Missouri is attempting to increase waterborne freight on the Missouri River, and is therefore tracking tonnage on the Missouri River in order to monitor how these efforts are progressing.

Louisiana

Louisiana's Department of Administration publishes performance metrics for every agency receiving an appropriation, as required by the 1997 Louisiana Government Performance and Accountability Act.[24] This includes the Department of Transportation and Development (DOTD), which has a variety of performance metrics that it collects to meet two key objectives[25]:

1. To develop and implement a Statewide Marine Transportation System (MTS) Program for Louisiana's navigable waterways to facilitate economic development and mitigate highway congestion by June 30, 2013; and
2. To conduct the State's maritime infrastructure development activities to ensure that Louisiana maintains its top position in maritime commerce as measured by total foreign and domestic cargo tonnage.

Within these two objectives, further performance indicators exist to measure how well they are being met:

- Number of navigation projects completed in Louisiana;
- Number of navigation projects initiated in Louisiana;
- Return on investment;
- State's share of construction expenditures; and
- Total construction expenditures (Federal and state).

[24] http://wwwprd.doa.louisiana.gov/lapas/public/index.cfm?action=browse&fy=2010&dept=07&agy=275&pgm=A&obj=4&pi=1.
[25] http://wwwprd.doa.louisiana.gov/lapas/public/index.cfm?action=browse&fy=2011&dept=07&agy=275&pgm=A.

Each of these indicators has performance standards. In addition, the objectives can change annually. These indicators are focused more on investment in waterway projects.

3.0 Recommendations and Next Steps

While port performance measurement may be complex and difficult to implement, it will ultimately be necessary to establish a consistent method for measuring deepwater port performance if the United States is to develop a coherent national freight strategy. Fortunately, the international nature of maritime cargo flows could aid the standardization of metrics for deepwater port performance.[26]

Parties that operate at multiple ports are in a particularly good position to make comparisons as to how the ports compare against each other. For example, international stevedoring companies that operate terminals in the United States and other countries may be useful in generating metrics to convey the comparative efficiency of port infrastructure. Intermodal drayage companies that operate at multiple terminals may be useful in conceptualizing landside efficiency of ports. While proprietary data is a concern, this is not expected to be uniquely problematic for maritime freight when compared with other parts of the freight sector.

3.1 Preliminary Waterborne Performance Metrics for Texas

While the lack of agreed-upon performance metrics for deepwater port transportation is concerning, it also presents an opportunity for Texas ports to help shape the discussion and ensure that performance metrics that do emerge are consistent with diversity of cargo types handled at Texas ports. The combination of existing national and international research, performance metric development activities of state and Federal agencies, and the development of TxDOT's 2011 to 2015 Strategic Plan provide a solid foundation on which to develop and implement waterborne freight performance metrics.

Table 3.1 provides a list of potential performance metrics developed from the sources described in this report. Because some measures are applicable to multiple

[26]Standards need not be perfect in order to be universally adopted. For example, due to early U.S. leadership in the development of containerization, the entire world now uses the "Twenty-Foot Equivalent Unit" as a standard measure for container transportation. Given the predominance of the metric system, it is clearly a less than optimal measure from the perspective of most countries, yet it has had tremendous value in standardizing the language of containerized trade around the world.

aspects of the maritime system, each performance measure is assigned to one or more of the following areas of the maritime system, including inland waterways (WW), deepwater ports (P), and landside infrastructure (L).

Table 3.1 Preliminary Waterborne Freight System Performance Metrics for Texas

Category	Performance Metric	WW	P	L
Congestion	Total stop of navigation on a specific waterway section measured in days	✓	✓	
	Total navigable days per year within a maritime corridor	✓	✓	
	Average vessel delay at locks	✓		
	Frequency and duration of lock closures	✓		
	Number of lockages/lock capacity	✓		
	Truck turn time		✓	✓
	Container throughput and land utilization: (TEUs per Container-Yard acre/year)		✓	
	Container dwell time		✓	
	Ship unload rate (time per container/ton)		✓	
	Ship load rate (time per container/ton)		✓	
	Average time in transit per barge tow on GIWW	✓		
	Annual TEU or Tons per Crane		✓	
	Port-handling capacity per quay meter and per truck loading bay		✓	✓
	Rail movement constraints on port access tracks: delay from at-grade rail/street crossings		✓	✓
	Average ship travel time in bottleneck areas		✓	
	Miles of the GIWW with unsuitable channel width, as defined by TxDOT	✓		
	Miles of the GIWW with unsuitable channel depth, as defined by TxDOT	✓		
	Miles of the GIWW with difficult turns and one-way zones, as defined by TxDOT	✓		
Safety	Vessel to vessel collisions (annually)	✓	✓	
	Vessel to fixed object collisions (annually)	✓	✓	
	Percentage of port containers inspected annually		✓	
	Hazardous spills by water modes/hazmat carried by water	✓	✓	
	Number of locations to park a barge along the GIWW (mooring structures)	✓		

Category	Performance Metric	WW	P	L
Economy	Number of direct jobs sustained through waterborne commerce	✓	✓	✓
	Ratio of imports/exports		✓	✓
	Logistics cost/percentage of state GDP	✓	✓	✓
	Tons of traffic arriving at key ports by barge/alternative modes	✓	✓	
	Annual TEU or tonnage per berth		✓	
	Total tons and value of freight moving on the GIWW	✓		
	Total tons and value of freight moving on the GIWW			
	Total value of key industries income generated by the GIWW (for example, total weight and value of shrimp, oysters and finfish facilitated by the GIWW)	✓		
System Preservation	Acres of land available for future maritime industrial use		✓	
	Number of rail miles abandoned			✓
	Average age of waterway infrastructure assets	✓	✓	
	Average age of cranes and other major cargo handling assets		✓	
	Dollars spent on freight marketing and education to the general public	✓	✓	✓
	Annual increase in acreage of developed properties along navigable waterways	✓	✓	
	Total cost of maintenance per lock, per month	✓		
	Cubic yards of sediment dredged/projected	✓	✓	
Emissions	Tons of CO_2, PM, SO_X, NO_X, HC related to marine engine combustion	✓	✓	
	Discharge of waste and ballast water		✓	
	GHG emissions/tonnage	✓	✓	✓
	Evaporative emissions by vessels in transit	✓	✓	

WW – Inland Waterway, P – Deepwater Port, and L – Landside Infrastructure.

Source: Cambridge Systematics, Inc., 2011.

3.2 NEXT STEPS

Though Table 3.1 offers preliminary performance measures for tracking performance of the Texas waterborne system, additional research is necessary before any performance measures can be implemented. TxDOT should refine and finalize these preliminary metrics as part of its next Strategic Plan update, tentatively scheduled to begin in 2012. Finalizing these metrics is an important next step for TxDOT to take. Doing so will allow for stakeholders (e.g., carriers, shippers, recreational users, and Federal, state, and local transportation entities) to understand the performance of the system over time, evaluate the success of various improvement strategies, and prioritize future investments.

For consideration for implementation, potential performance metrics should:

- **Be consistent with TxDOT's vision and strategic goals.** Similar to the current transportation performance metrics tracked by TxDOT, any newly developed performance metrics should align with goals in the current 2011 to 2015 Strategic Plan.
- **Be consistent with national efforts of NCFRP, USACE, MARAD, and others.** Performance metrics from national groups and agencies should be considered, and selected metrics should be consistent with performance metrics nationally.
- **Have minimal data collection requirements.** It is important that data used to create performance metrics is either readily available, or not difficult or time intensive to collect.
- **Address key waterborne issues.** The Phase I report identified a number of major issues affecting the condition and performance of the Texas port and waterway system. These major issues should be the focus of some of the performance metrics and efforts to track progress.
- **Be based on best practices.** There a number of states that already have developed and implemented waterborne performance metrics. Understanding and learning from these experiences will strengthen the performance metrics developed as part of this effort.